Preliminary results regarding the simulation of a streamflow strongly influenced by anthropogenic use in an alpine context: the case of the Grosina valley (northern Italy).

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EGU22-1882

HS 2.1.4 - Mountain hydrology under global change: monitoring, modelling and adaptation

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UNIVERSITÀ DEGLI STUDI DI MILANO

EGU General Assembly 2022

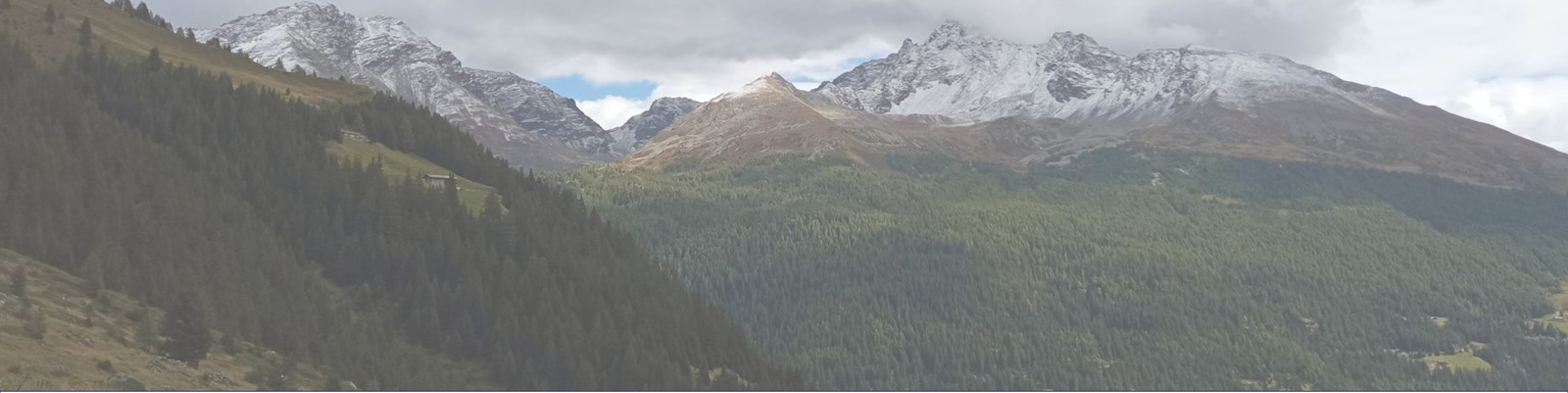
LINK TO THE ABSTRACT:

Main goals:

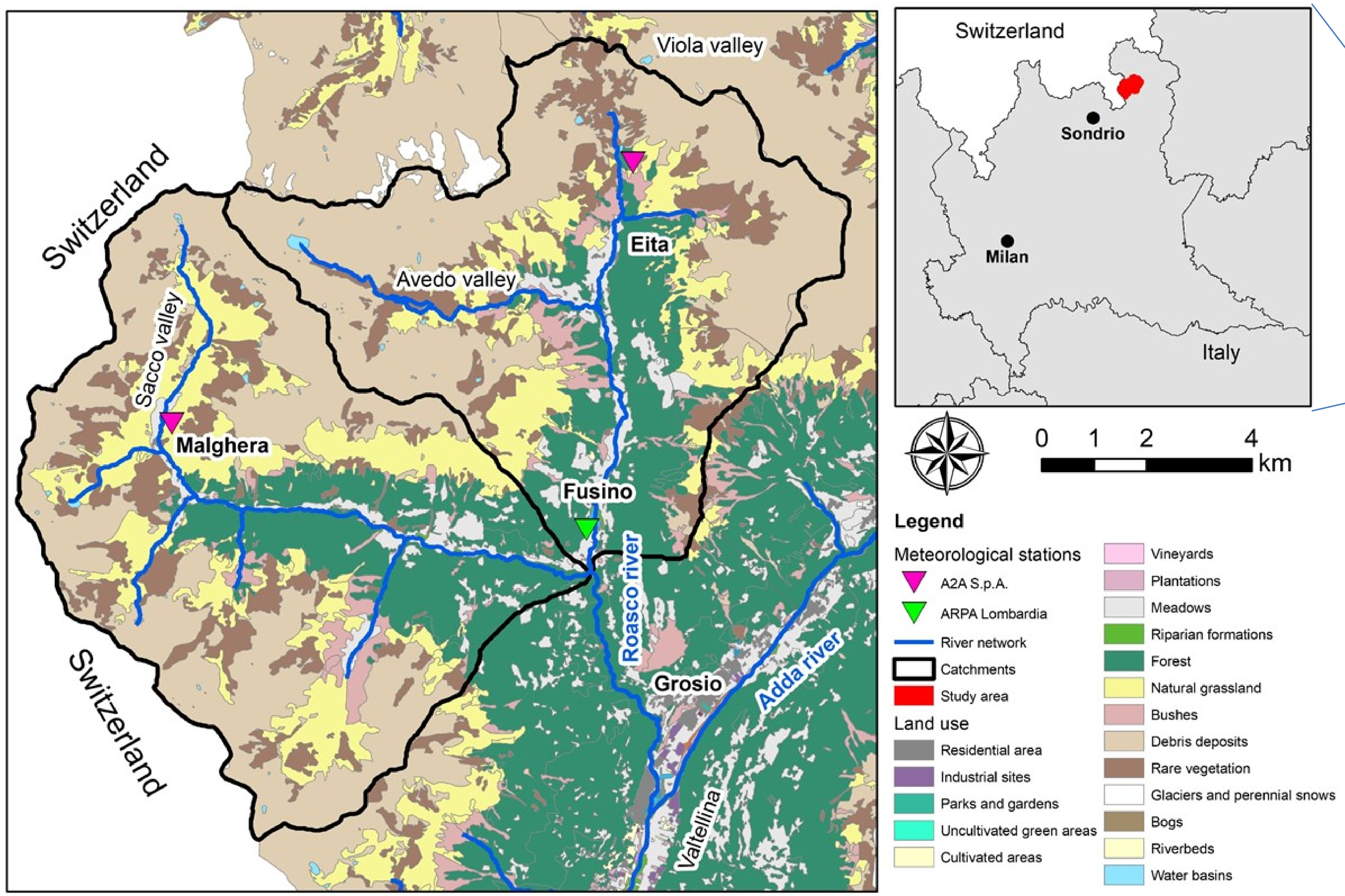
- set up a prototypal operational hydrologic model (**short-term objective**)
- estimate impacts of climatic changes on water resources and the hydrologic cycle (**medium/long-term objective**)

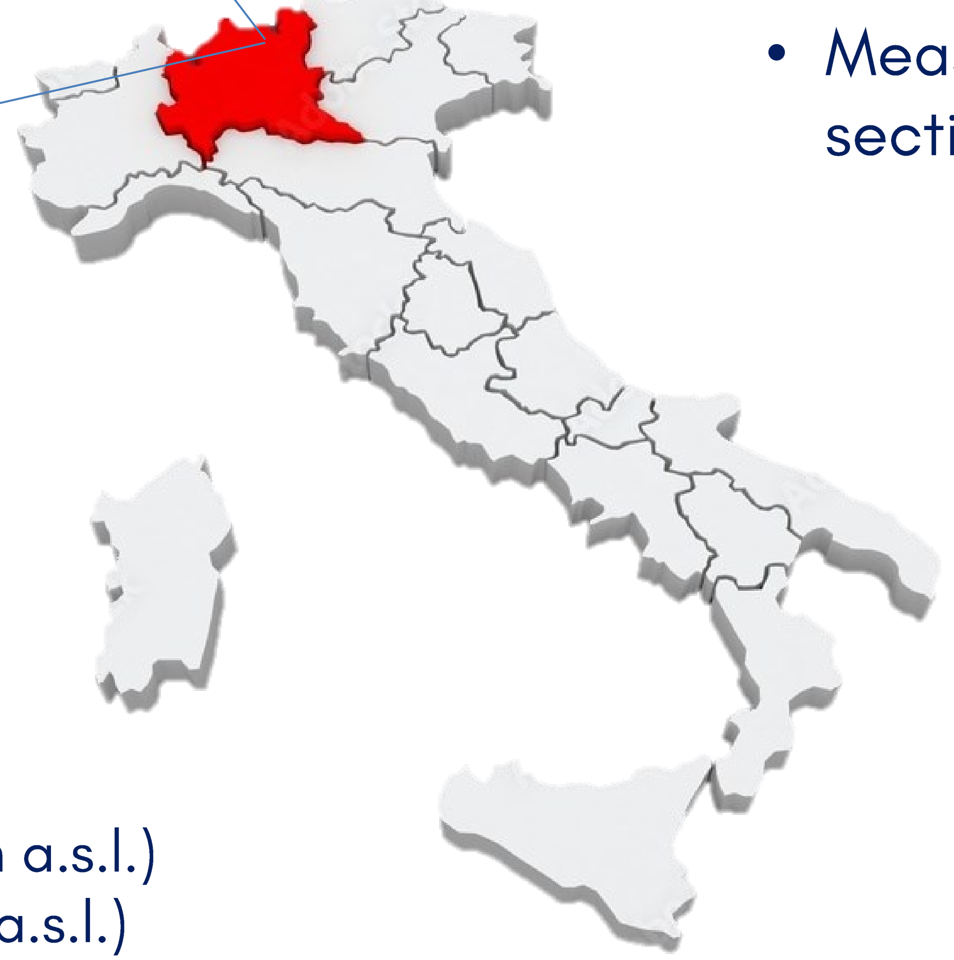
First step →

definition of the conceptual model and the implementation-calibration of a **hydrologic model of the study area**



Study area and Available data





Available data:

- DEM (5mx5m, 20mx20m);
- P/T timeseries 2010-2020;
- Radar P data 2005-2020;
- Derived discharges 2008-2020;
- Measured discharge at the closure section 2010-2016

ARPA LOMBARDIA Agenzia Regionale per la Protezione dell'Ambiente

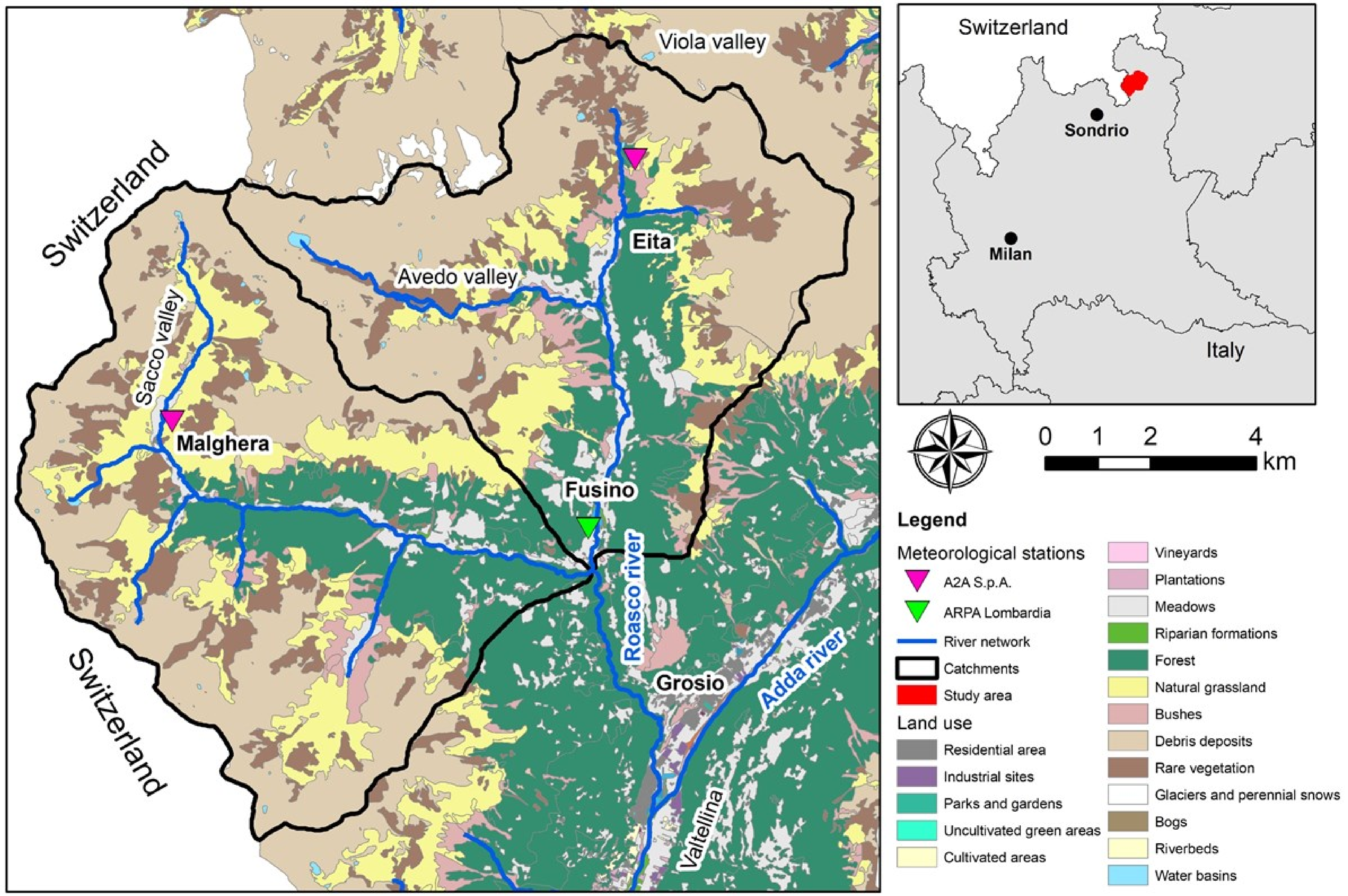
MeteoSwiss

a2a

Sacco catchment: 71 km^2 (1030.0 ÷ 3260.6 m a.s.l., mean value of 2249.6 m a.s.l.)
Eita catchment: 62 km^2 (1030.0 ÷ 3370.0 m a.s..l., mean value of 2254.9 m a.s.l.)

The climate is of central-alpine type, with medium-low precipitation (800-1000 mm), more consistent in spring and summer(max of 1700 mm/y). The main lithotypes are represented by micaschists and gneisses with local lenticular intercalations of quartz and greyish micaceous quartzites → Runoff>>Infiltration

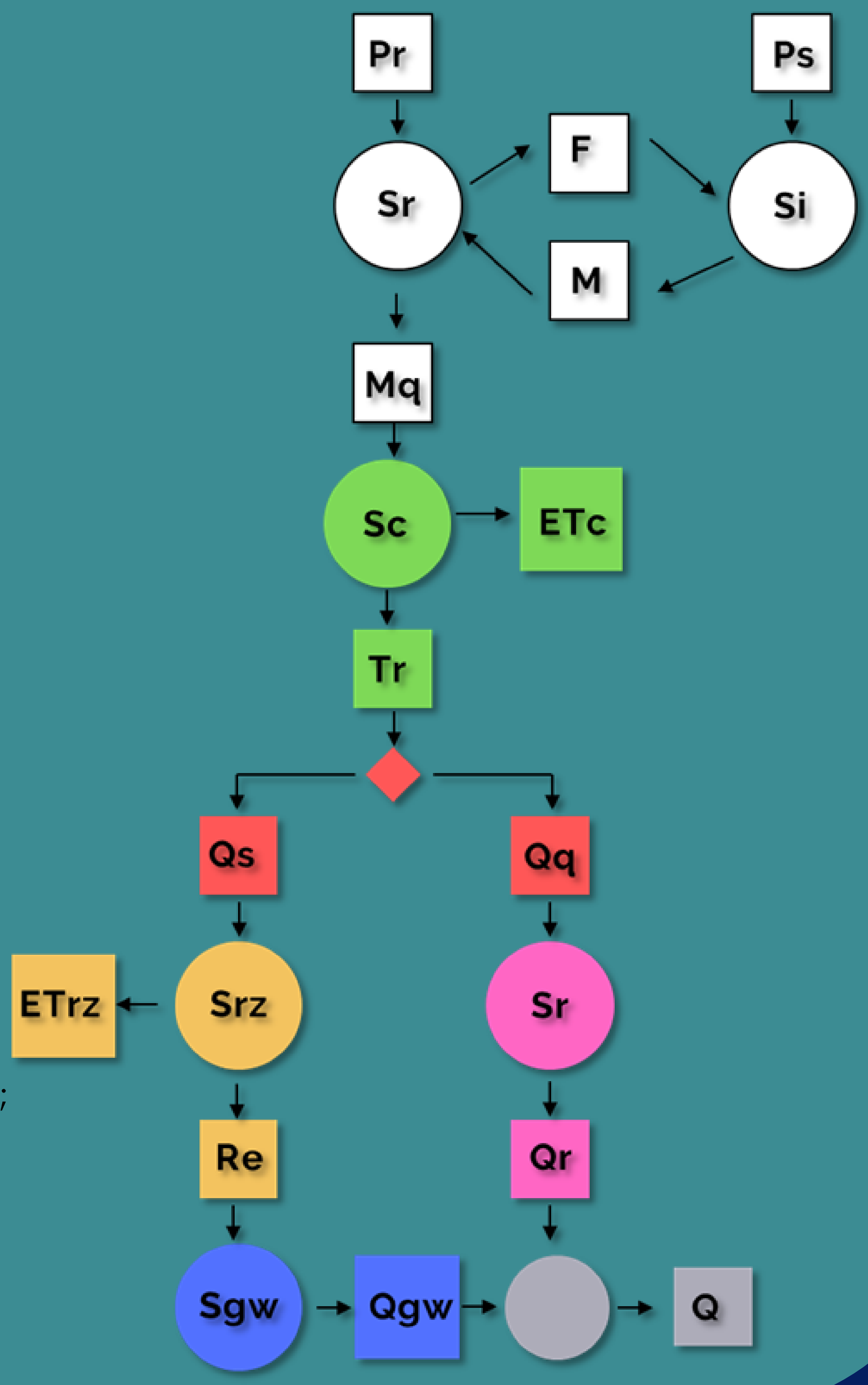
Study area and Available data



Dam crest: 1212.5 m a.s.l.
Total length: 450.5 m
Store capacity: 1.2×10^6 m^3

The construction work began in 1956 and was completed in **1960**. It is part of the Grosio plant and directly collects waters from **Roasco d'Eita stream** and, through a short penstock, those from the **Roasco di Sacco stream**. The main inflow is the **Premadio-Valgrosina diversion canal**. The Grosina valley reservoir, used for daily modulation of inflow waters, feeds the **Grosio power plant** downstream.

- Snow
- Canopy
- Splitter
- Root zone
- Groundwater
- Runoff
- Sum



Pr – Rainfall;
Ps – Snow;
Sr – Rainfall storage;
Si – ice storage;
F – Freezing;
M – Melting;
Mq -Snowmelting /Rain;
Sc – Canopy storage;
Etc – Canopy evapotranspiration;
Tr – Throughfall;
Qs – Slow flow;
Qq – Quick flow;
Srz – Root zone storage;
Etrz – Root zone evapotranspiration;
Re – Groundwater recharge;
Sgw – Groundwater storage;
Qgw – Groundwater flow;
Sr – Runoff storage;
Qr – Runoff flow;
Q – Simulated streamflow.

GEOframe

(Formetta et al., 2014; Bancheri, 2017)

It is an open-source hydrological modeling system developed by the University of Trento.
It is a partially distributed model formed by different components that simulate the streamflow and that can be used independently or in combination between them.

1 HRU definition

2 Component computation

3 Streamflow simulation following the topology scheme

HRUs definition

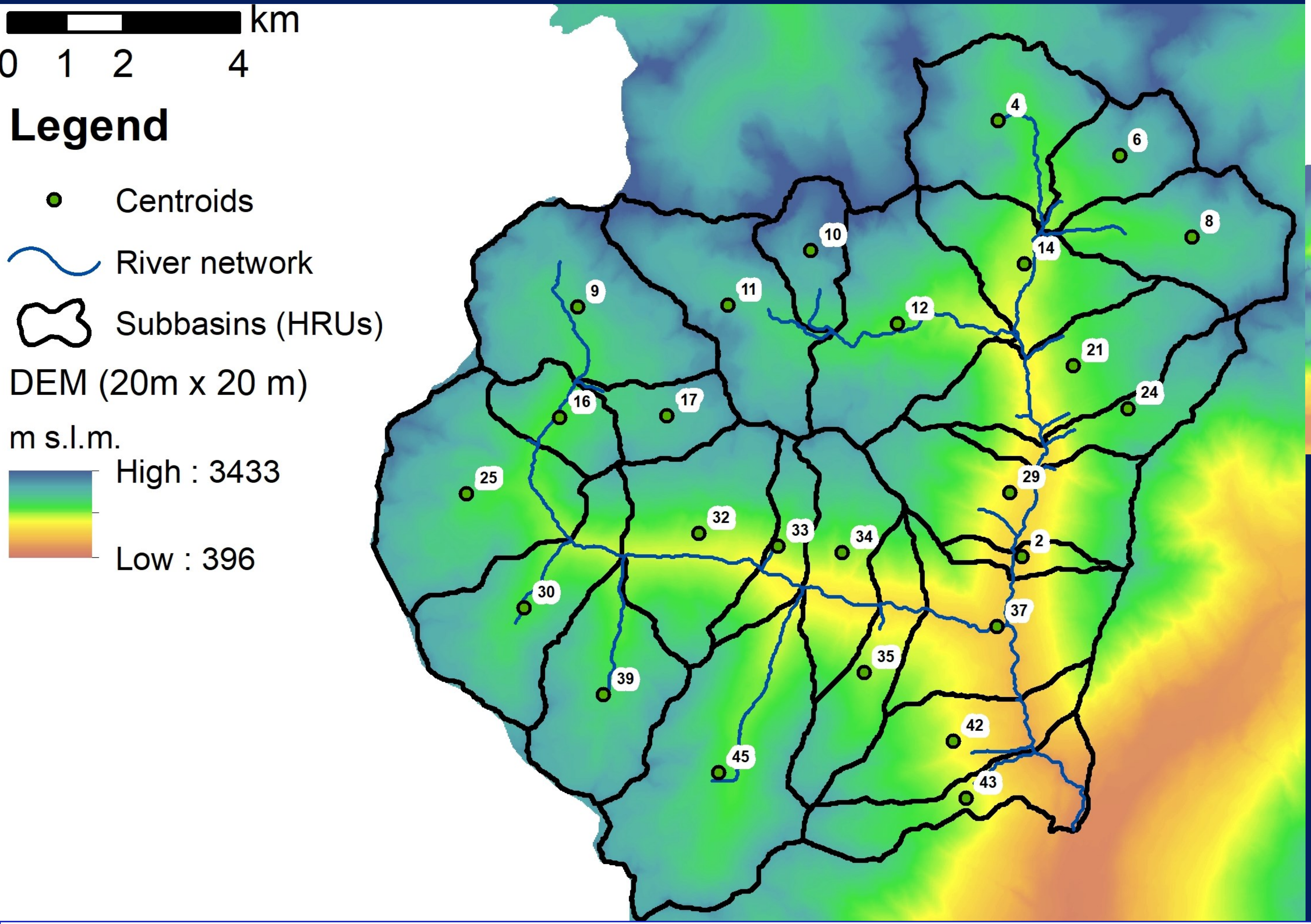
Geomorphological analysis

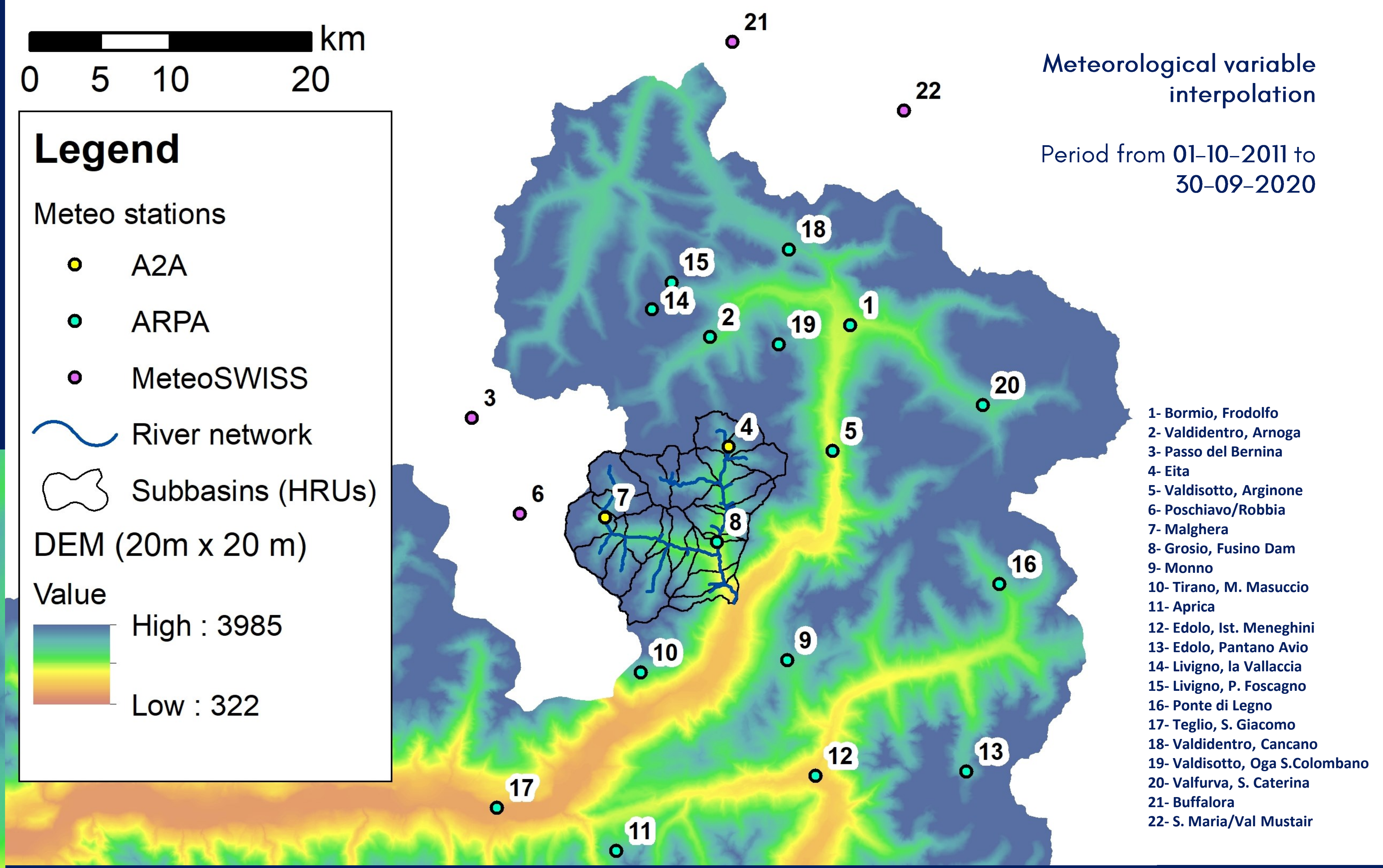
Input data:

Digital Elevation Model (5mx5m or 20mx20m)

Output:

Discretization of Hydrological Response Units.





Input data:

Hourly Precipitation and Temperature dataset from 22 stations.

Output:

Hourly Precipitation and Temperature dataset in the centroids of each HRUs.

Component computation

Component calculation

RADIATION

Idso model (1981)

Input data:

Hourly temperature and Skyview factor.

Output:

Shortwave radiation, Longwave radiation, Net radiation → Wm^{-2}

EVAPOTRANSPIRATION

Priestley-Taylor model (1972)

Input data:

Hourly temperature, Hourly net radiation, Atmospheric pressure.

Output:

Evapotranspiration → mm

SNOW

Hock (1999) e Degree-day models

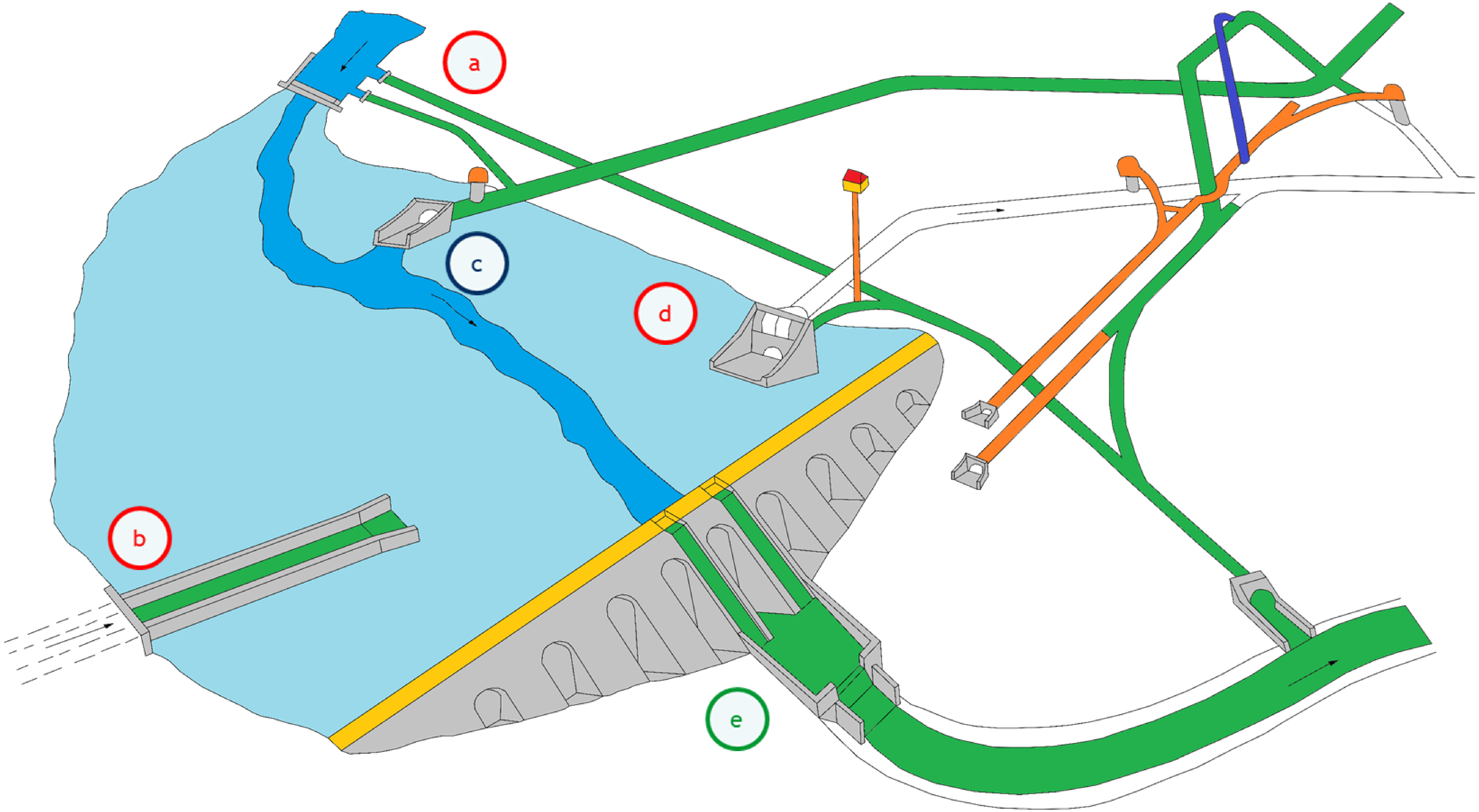
Input data:

Hourly Temperature, Hourly Precipitation, Hourly Net Radiation, Skyview factor

Output:

Snow Water Equivalent (SWE) and Melting → mm

Topology scheme



a Eita diversion canal

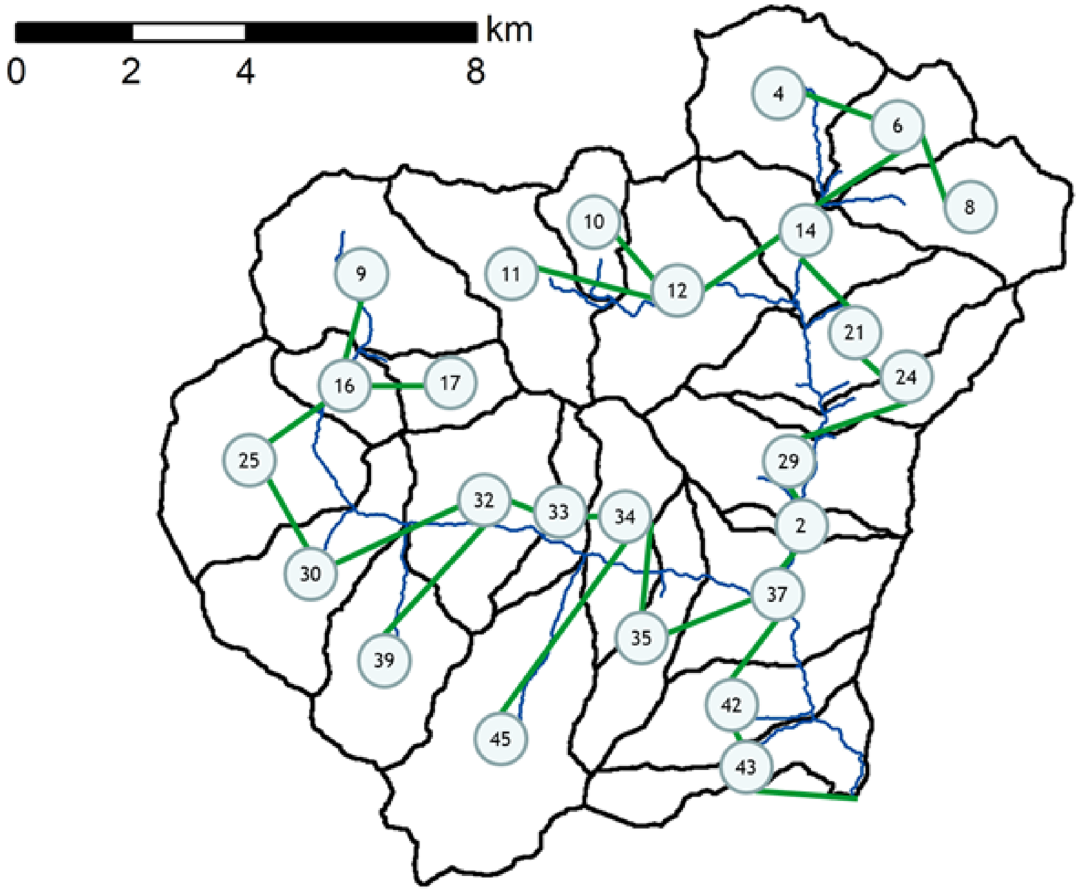
c Premadio-Valgrosina diversion canal

e Downstream dam discharges

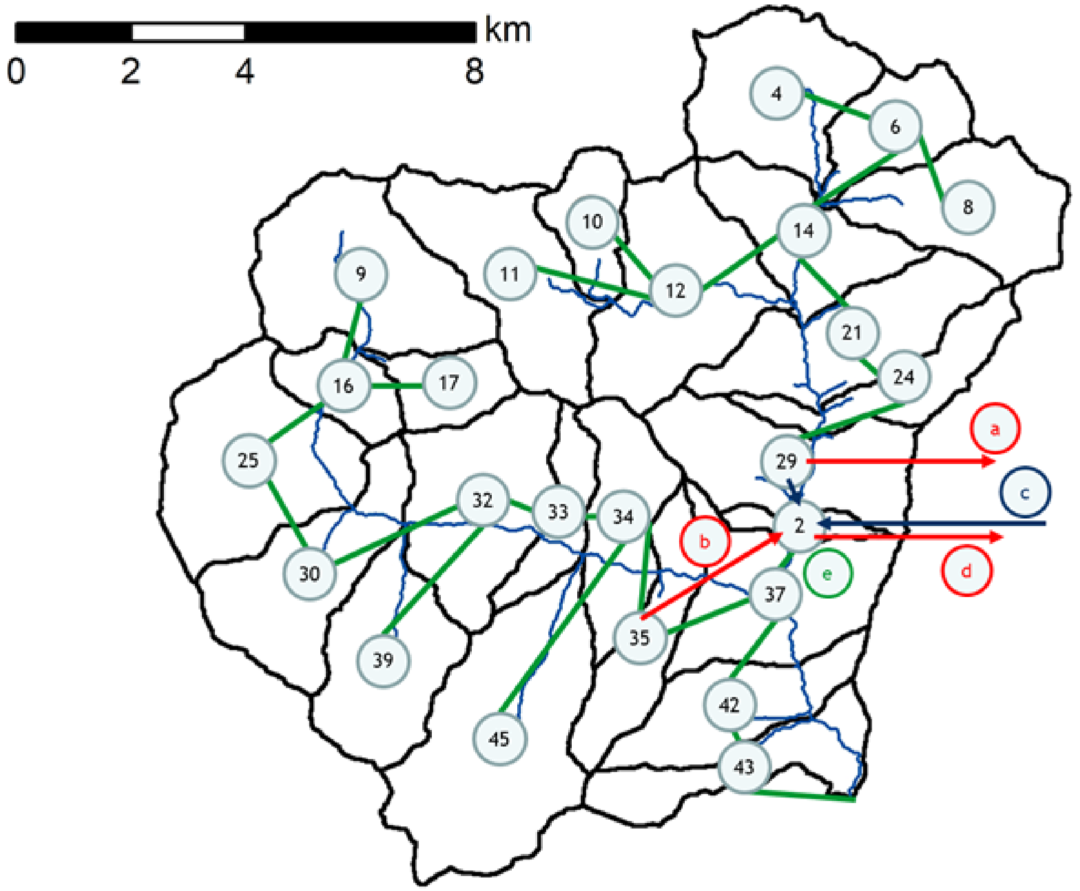
b Sacco diversion canal

d Flow diverted to Grosio plant

Natural condition



Real condition



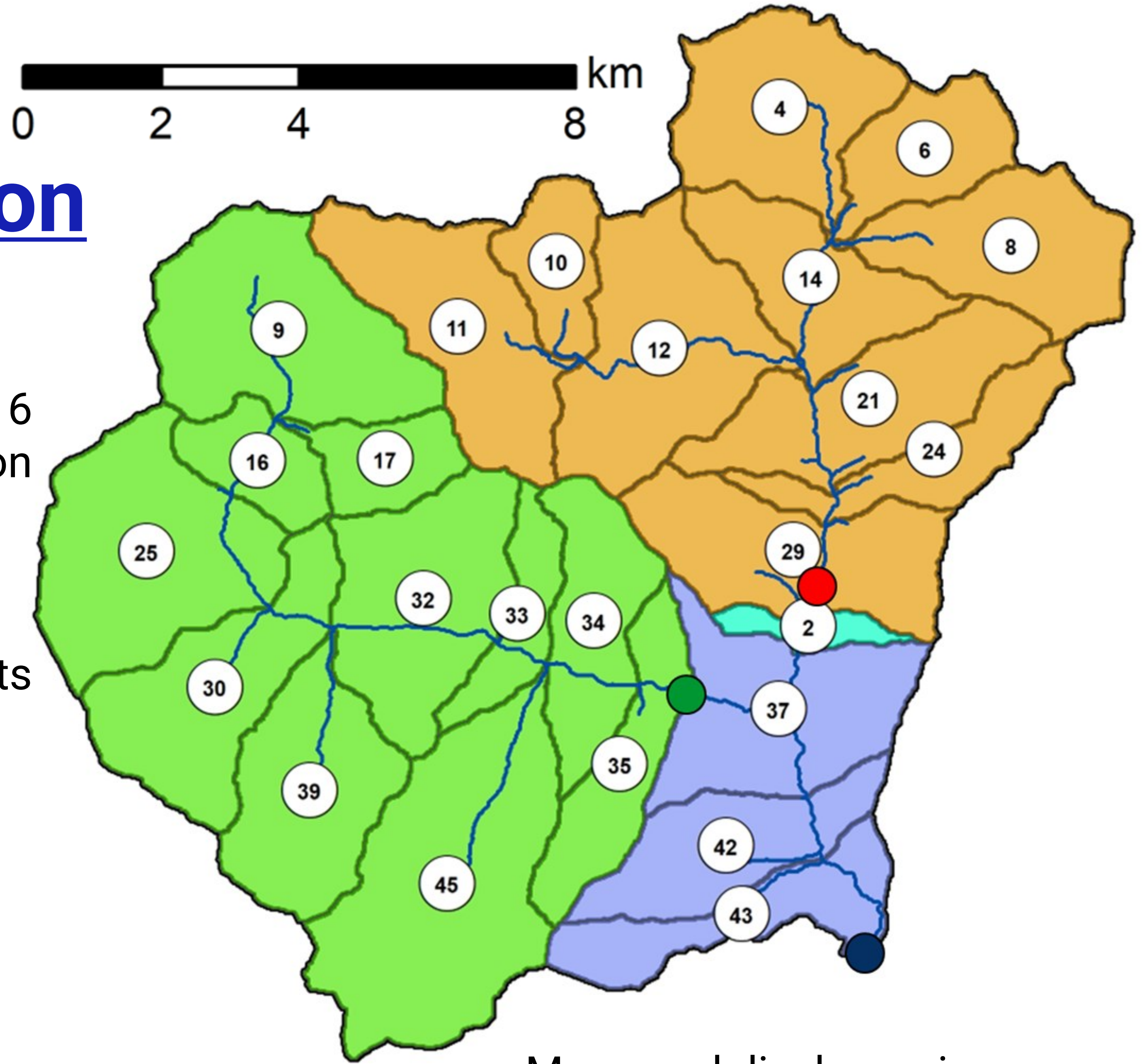
The model and Calibration

First approach

→ Trial&Error + LUCa Calibration (2011-2016 calibration period / 2016 – 2020 validation period)

Second approach

→ Trial&Error + LUCa calibration on eight events (2-3 months each)



Fusino dam

Grosotto → Measured discharge ✓

Sacco → Captured discharge + MEF ✓

Eita → Captured discharge ✗

Sensitivity analysis

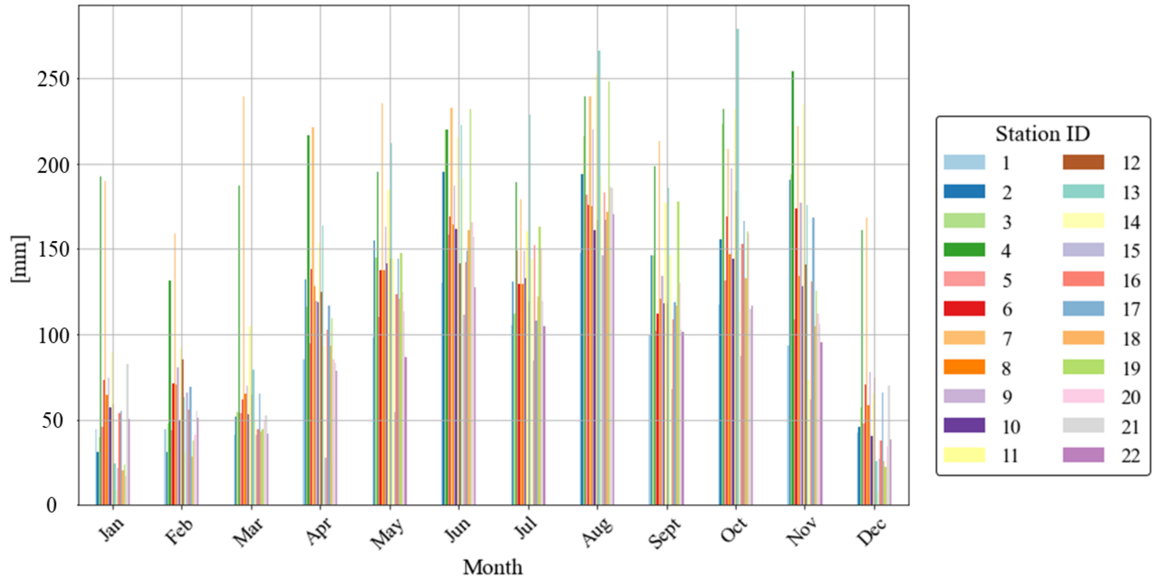
Measured discharge in Grosotto

Captured discharge in Sacco penstock

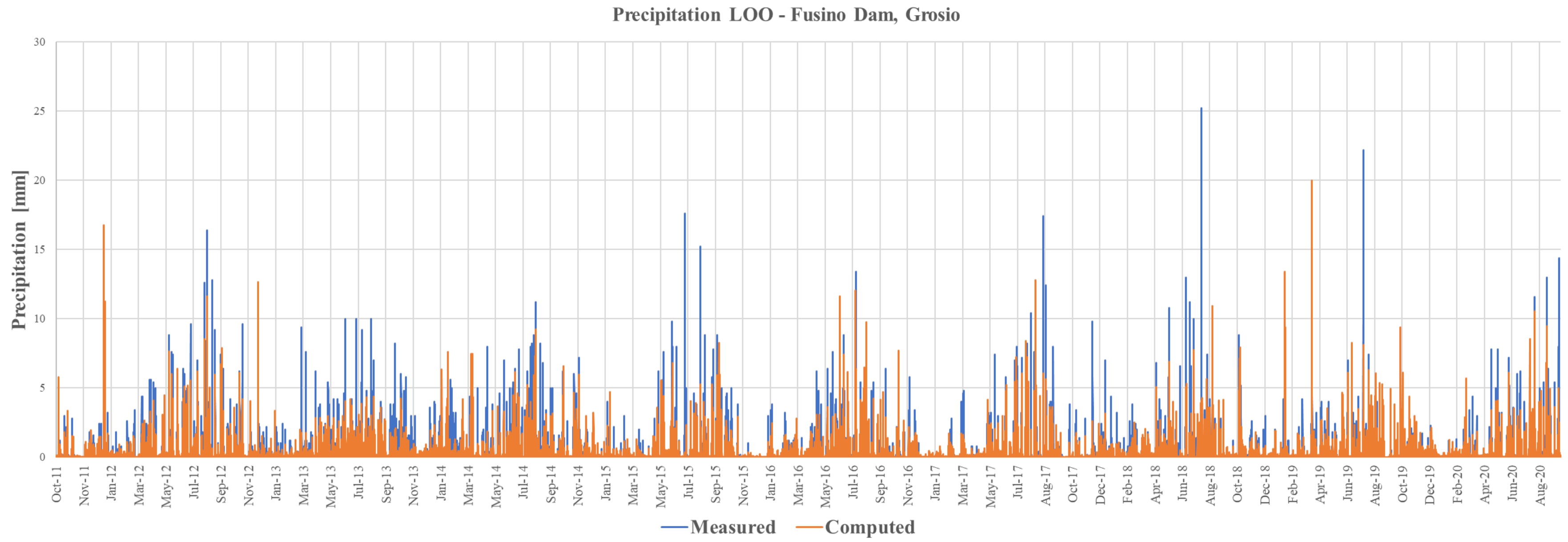
Captured discharge in Eita penstock

Preliminary results

Precipitation → Period from 01-10-2011 to 30-09-2020



1- Bormio, Frodolfo
2- Valdidentro, Arnoga
3- Passo del Bernina
4- Eita
5- Valdisotto, Arginone
6- Poschiavo/Robbia
7- Malghera
8- Grosio, Fusino Dam
9- Monno
10- Tirano, M. Masuccio
11- Aprica
12- Edolo, Ist. Meneghini
13- Edolo, Pantano Avio
14- Livigno, la Vallaccia
15- Livigno, P. Foscagno
16- Ponte di Legno
17- Teglio, S. Giacomo
18- Valdidentro, Cancano
19- Valdisotto, Oga
20- Valfurva, S. Caterina
21- Buffalora
22- S. Maria/Val Mustair



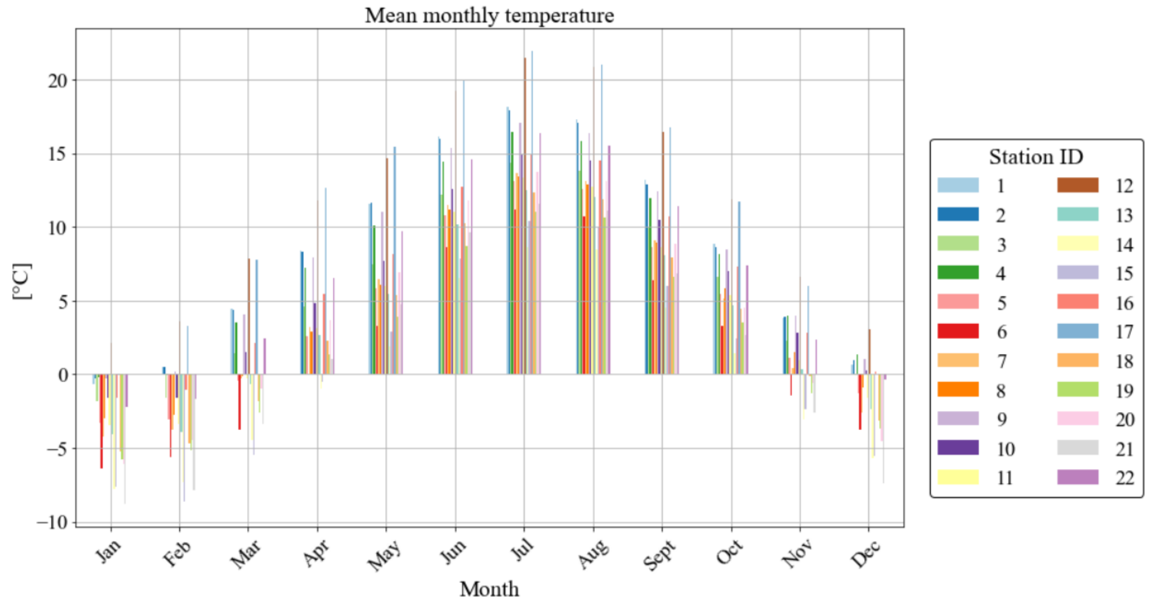
Reference station – Grosio, Fusino Dam

LOO – Leave One Out

Hourly mean: Obs = 0.12 mm; Sim = 0.15 mm

NSE = 0.34

Temperature → Period from 01-10-2011 to 30-09-2020



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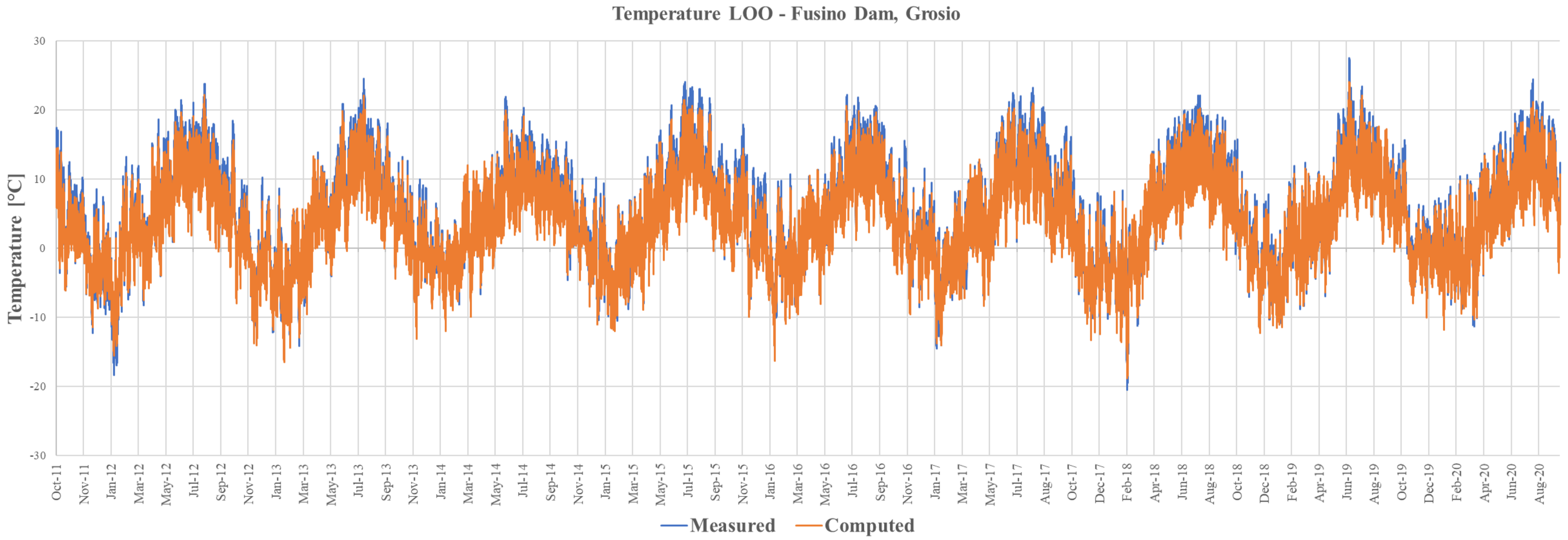


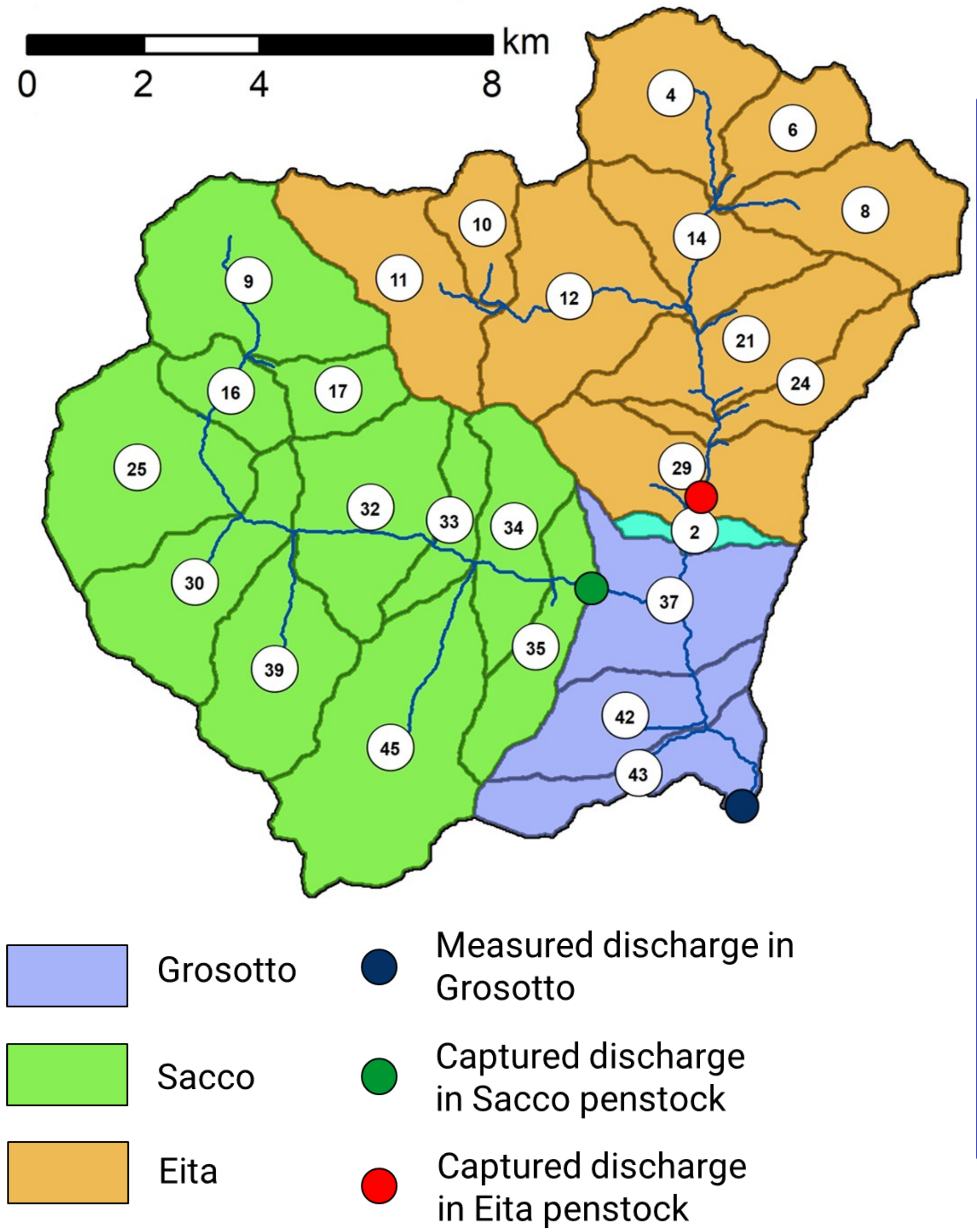
Reference station – Grosio, Fusino Dam

LOO – Leave One Out

Hourly mean: Obs = 4.7 °C; Sim = 3.6°C

NSE = 0.93

Preliminary results

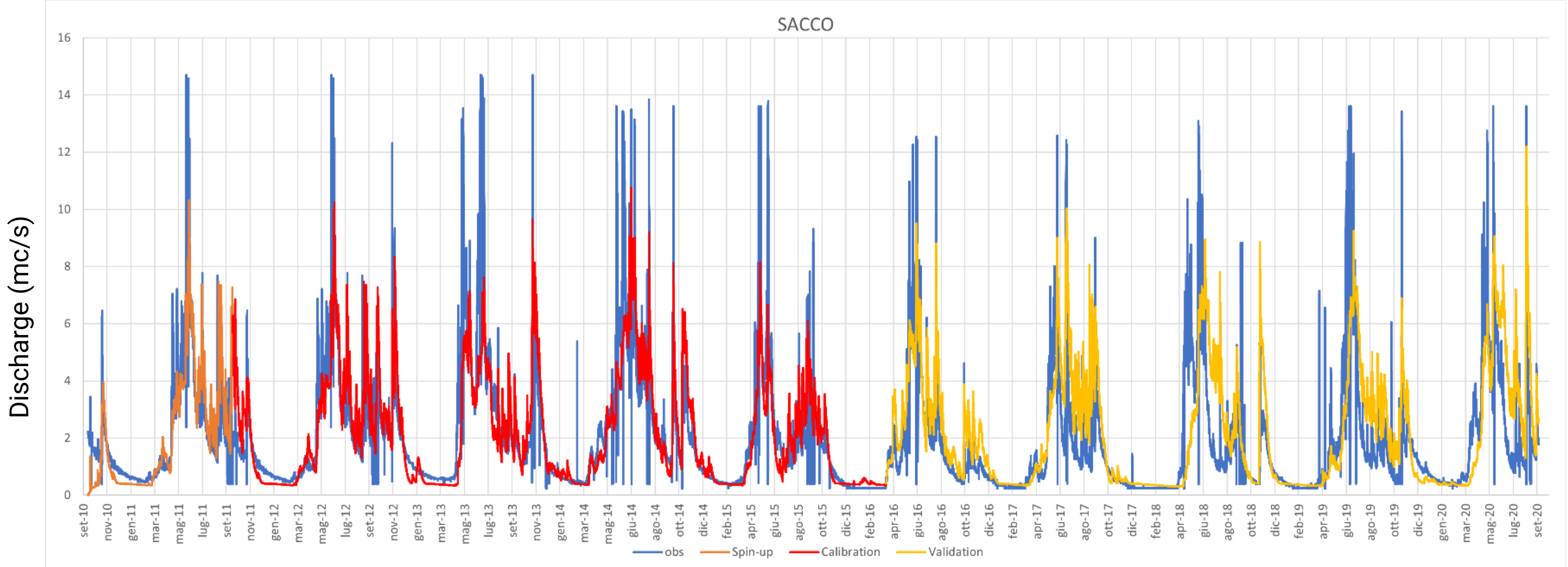


I approach

Sacco → Period from **01-10-2010** to **30-09-2020**

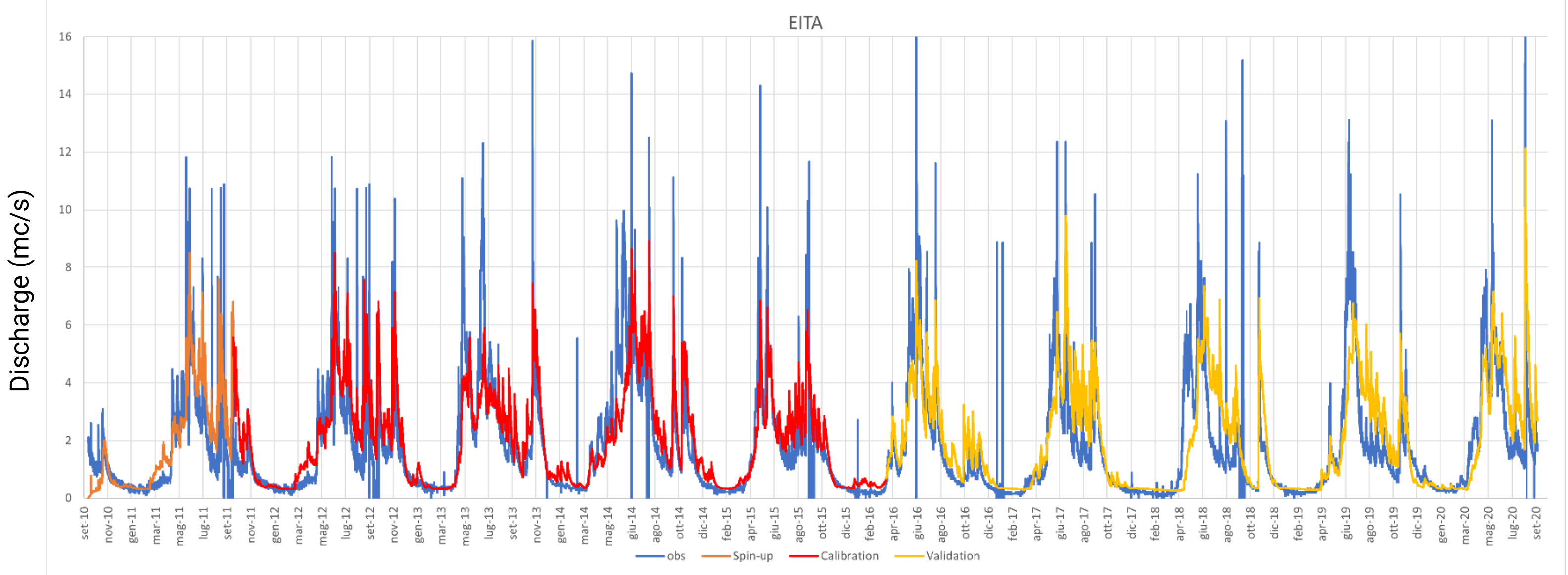
NSE		hourly	daily	Log_h
Calibration	01/10/2011 01/04/2016	0.64	0.67	0.75
Validation	01/04/2016 30/09/2020	0.48	0.50	0.64

May-Oct MEF = 0.406 m^3s^{-1}
Nov-Apr MEF = 0.266 m^3s^{-1}



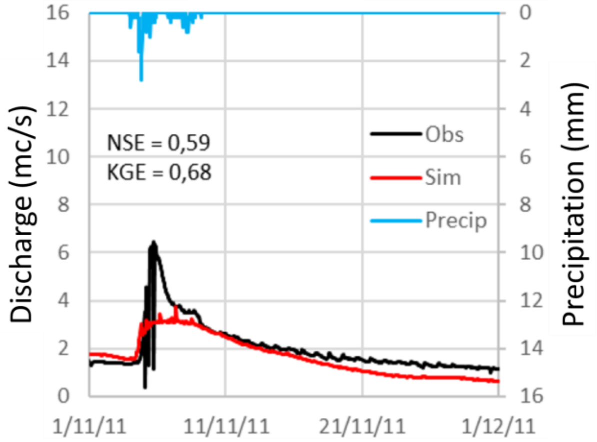
Eita → Period from **01-10-2010** to **30-09-2020**

NSE		hourly	daily	Log_h
Calibration	01/10/2011 01/04/2016	0.66	0.67	0.78
Validation	01/04/2016 30/09/2020	0.63	0.64	0.76



Sensitivity analysis → **Captured discharge in Eita penstock (from 01-10-2011 to 30-09-2020) < Computed discharge**

Preliminary results

EVENT 1


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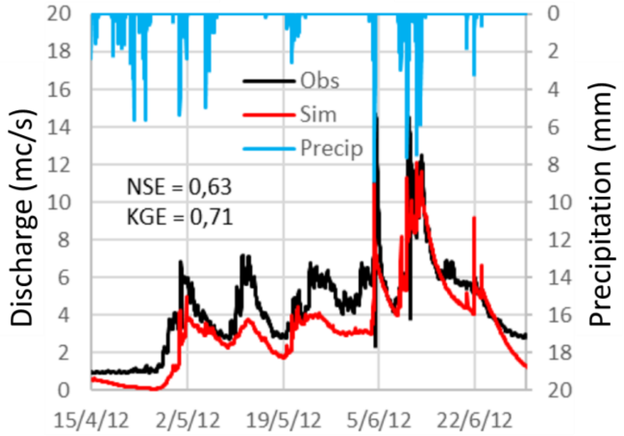

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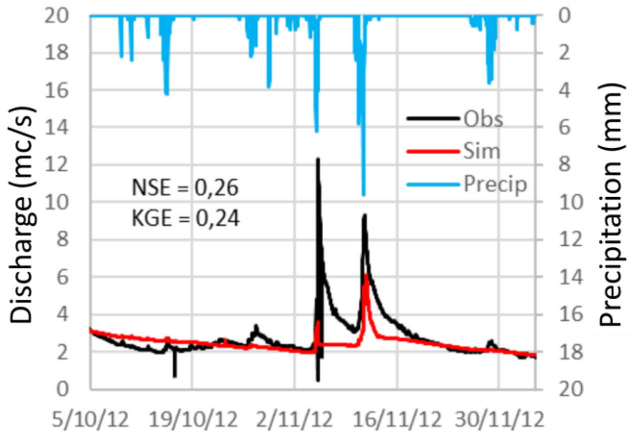
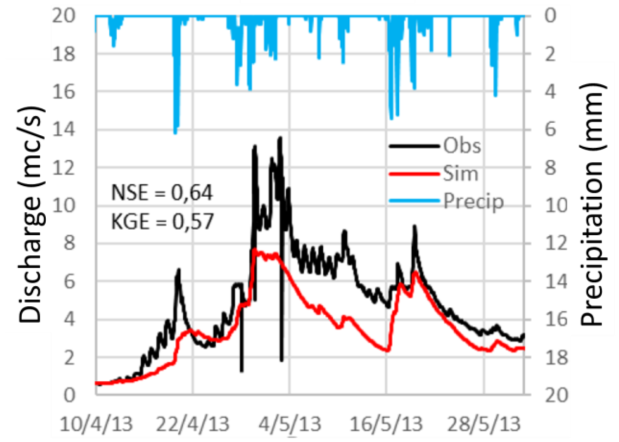
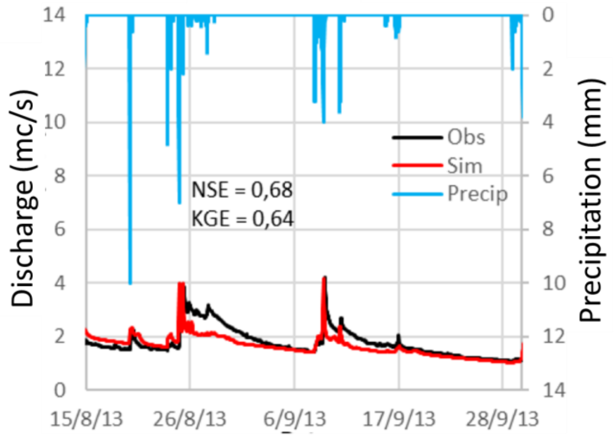
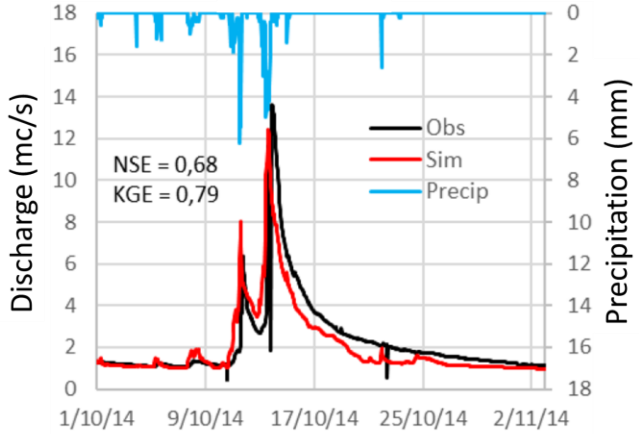
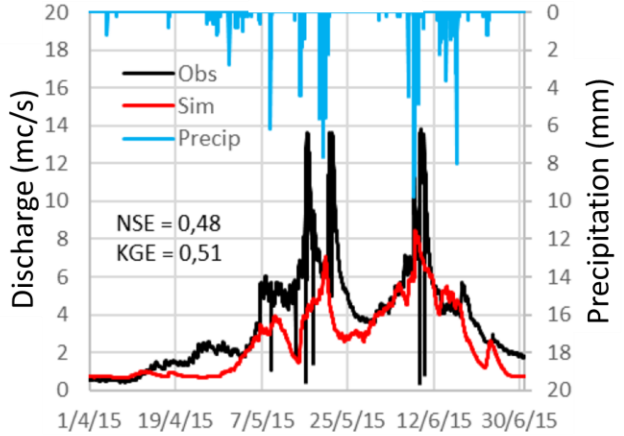
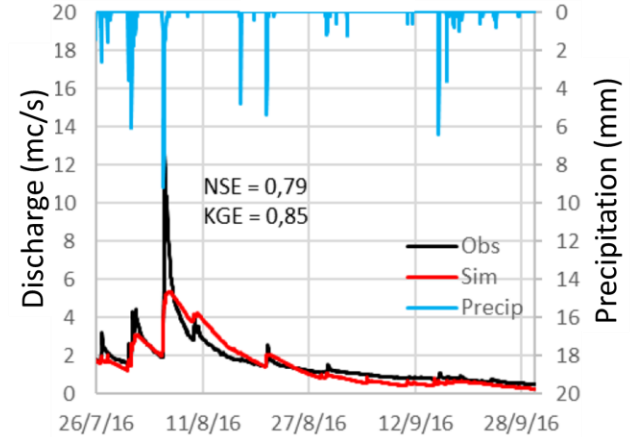


EVENT 4


EVENT 5


EVENT 6


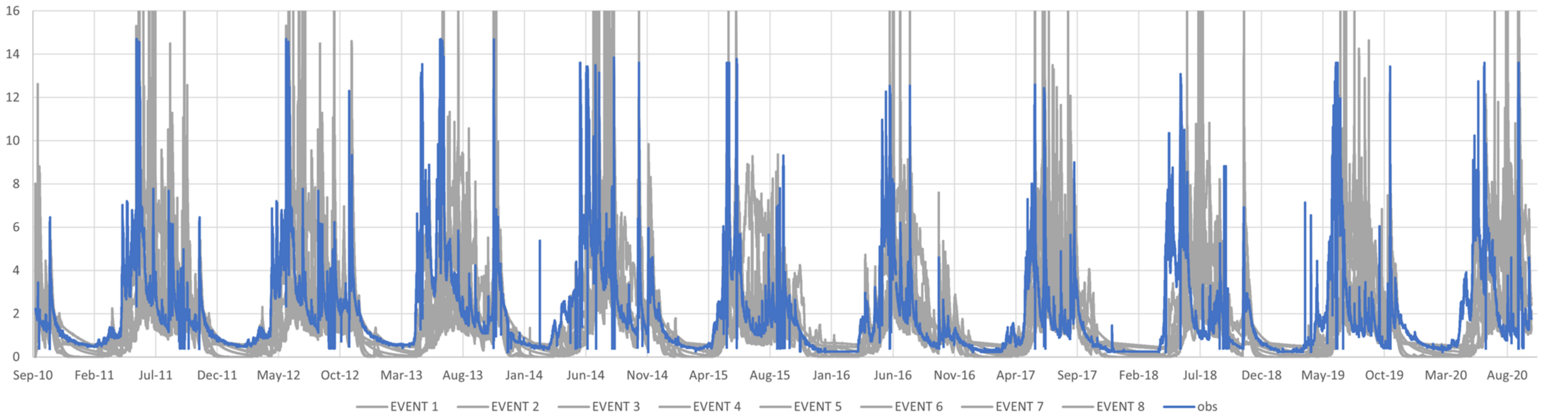
EVENT 7


EVENT 8


SACCO BASIN

	Calibration	01/10/2011 01/04/2016	01/04/2016 30/09/2020
	NSE		
Event 1	0.59	0.10	-0.44
Event 2	0.63	0.39	-0.29
Event 3	0.26	0.05	0.07
Event 4	0.64	0.52	0.34
Event 5	0.68	-0.07	-0.18
Event 6	0.68	0.17	0.16
Event 7	0.48	-0.11	-0.76
Event 8	0.79	0.03	0.05

II approach

Event ensemble


Concluding remarks

KRIGING on Precipitation and Temperature →
Quality of interpolation not comparable to hourly scale, in fact P and T have different spatial/temporal variability

First calibration approach (multi-year interval) →
Overall satisfactory results, spatial transfer of parameters is robust

Second calibration approach (2-3 months events) →
The variability from event to event is extremely high. Only the ensemble manages to reproduce the variability of the observed discharge

Thanks for the attention

References:

- **A2A S.p.A**. Pdg Valgrosina, **2010**.
- **Bancheri**, M. A Flexible Approach to the Estimation of Water Budgets and Its Connection to the Travel Time Theory. Ph.D. Thesis, University of Trento, Trento, Italy, **2017**.
- **Formetta**, G.; Antonello, A.; Franceschi, S.; David, O.; Rigon, R. Hydrological modelling with components: A GIS-based open-source framework. Environ. Model. Softw., **2014**.

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