UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO
DIPARTIMENTO DI SCIENZE AGRO-AMBIENTALI E TERRITORIALI

IRSA CNR
Istituto di Ricerca sulle Acque
CONSIGLIO NAZIONALE DELLE RICERCHE

Simulating streamflow in a temporary karst river system

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Session HS2.1.3
Zero flow: hydrology and biogeochemistry of intermittent and ephemeral streams

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1. Background and Aims
2. Study Area
3. Materials and methods
4. Ongoing results
5. Conclusions

Background and aims

Most of the basins in the Mediterranean Region cease flow for some time of the year, hence are defined as non-perennial rivers (i.e. temporary rivers, intermittent rivers, ephemeral streams, episodic streams).

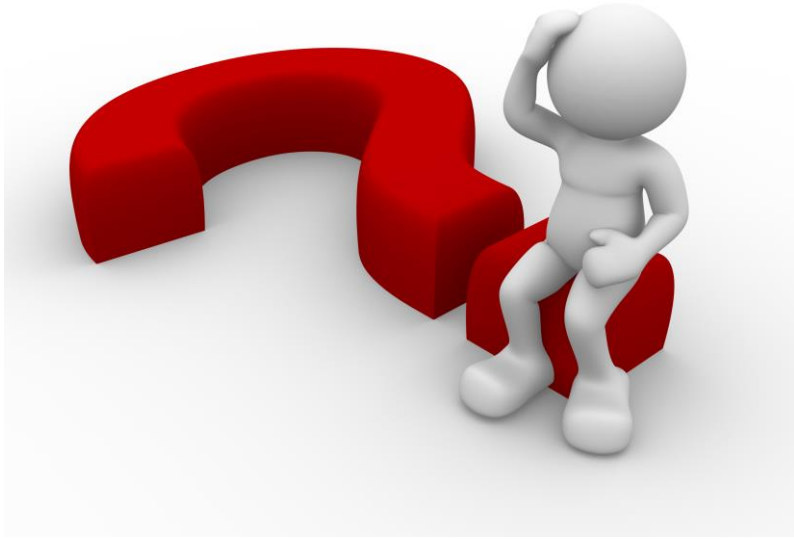
Factor influencing flow regime:

- Spatial gradient in rainfall and temperature
- Lithology and geological features (i.e. limestone, sinkhole)
- Anthropic pressure (i.e. water treatment plants, water abstractions)

Background and aims

Problems:

- Data of land use, soil and slope not homogeneous
- limited time series of streamflow due to the reduced investments in monitoring intermittent river
- Climate stations not well distributed in the basin
- Presence of several gaps in weather time series



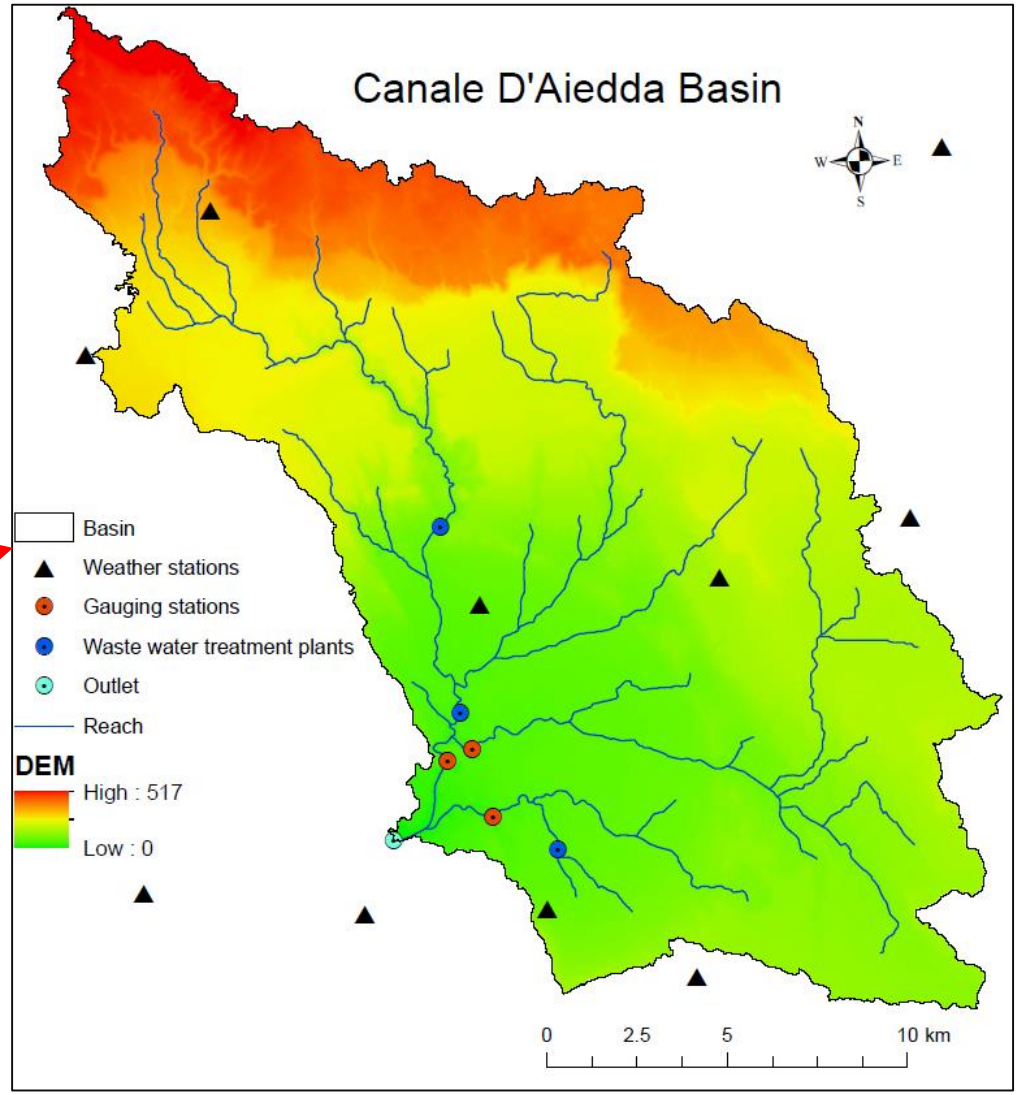
In such a complex environment, the hydrological and water quality model set up and run may be challenging.

Aims:

- Set up SWAT model in a karst temporary Mediterranean basin characterized by paucity of data
- Define problem-solving in simulating hydrology with a particular attention to zero flow periods

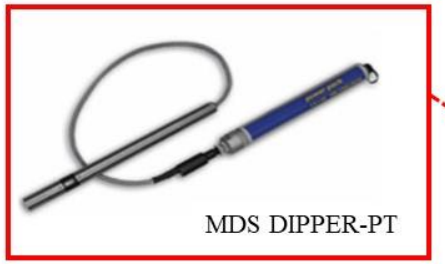
Study area

Morphological characteristics	Canale d'Aiedda basin
Drainage area	360 km^2
Main channel length (km)	29 km
Mean elevation (m a.s.l.)	131 m (a.s.l.)
Maximum elevation (m a.s.l.)	381 m (a.s.l.)
Minimum elevation (m a.s.l.)	0 m (a.s.l.)
Mean watershed slope (%)	4.70%
Mean slope of the main channel (%)	0.84%



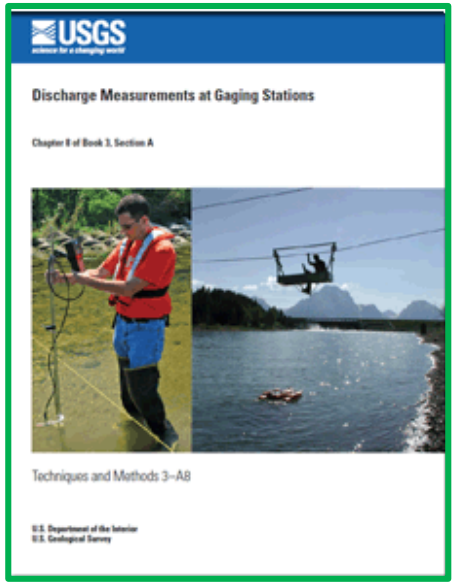
The Canale D'Aiedda (Puglia, Italy) is a temporary karst river basin

Study area – monitoring equipment

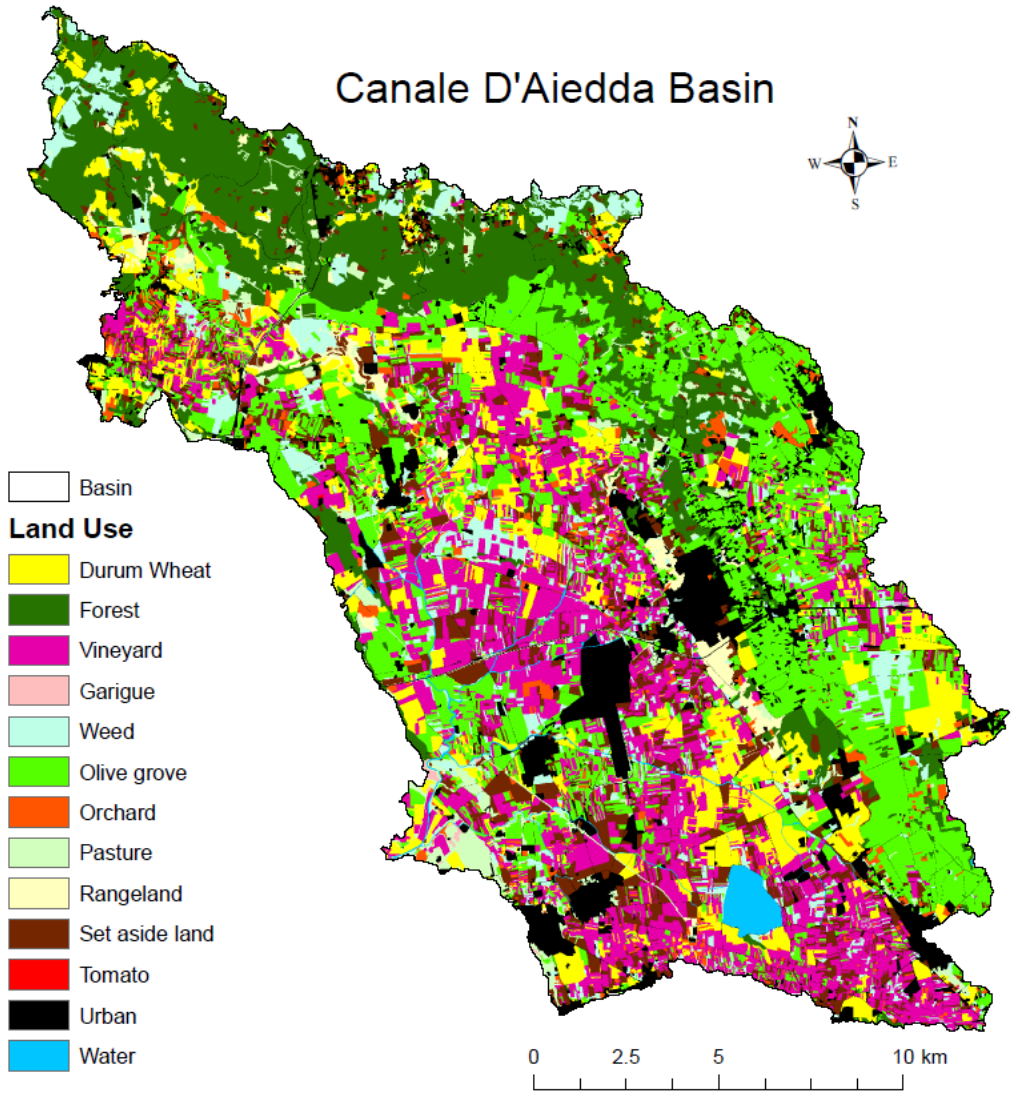


Components of flow gauge station

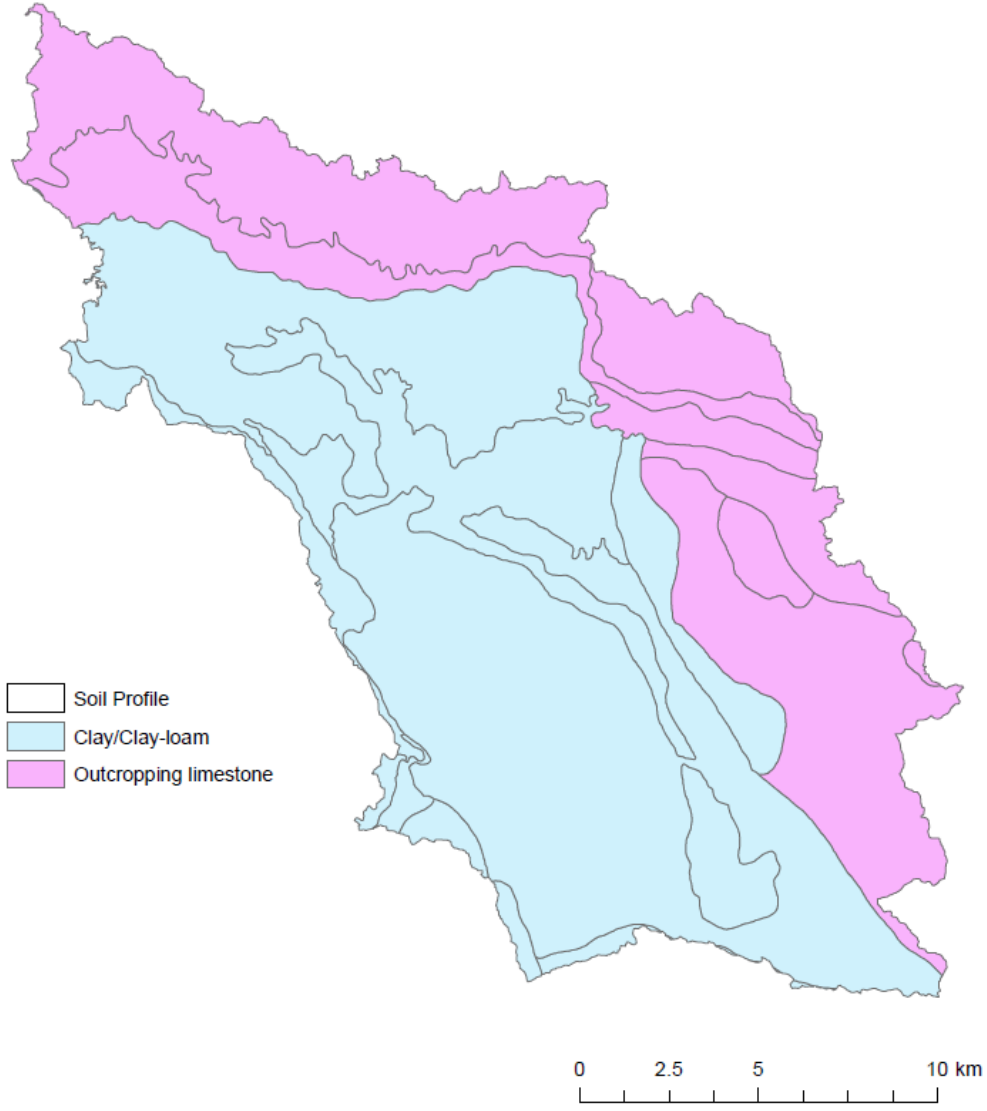
A) Fluvial graduated auction
B) Water stage and temperature sensors
C) Sensor case (MDS DIPPER-PT)
D) Closing cap
E) USB cable
F) Laptop



Study area



Main Land uses of the basin

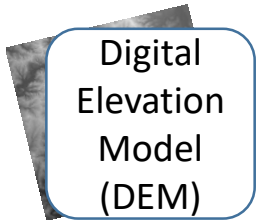


Areas with outcropping limestone (purple) and areas with clay soils

Methodology

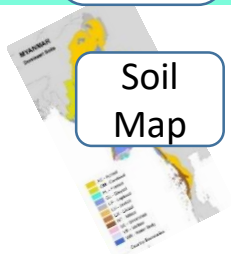
The Soil and Water Assessment Tool (SWAT) considering two different set up solution:

1. All the basin area was considered
2. The area with outcropping limestone was cut off with a mask



Digital Elevation Model (DEM)

Land Cover Map

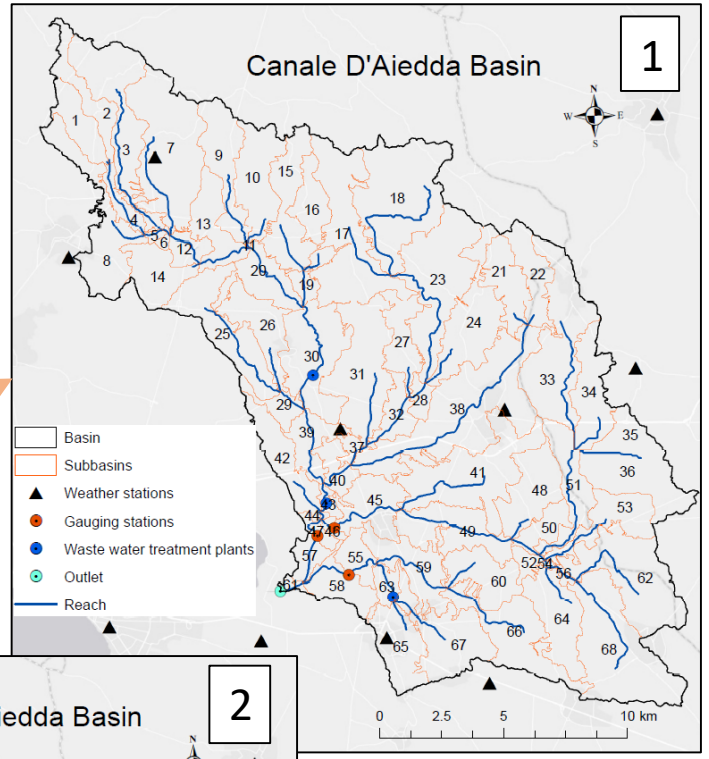


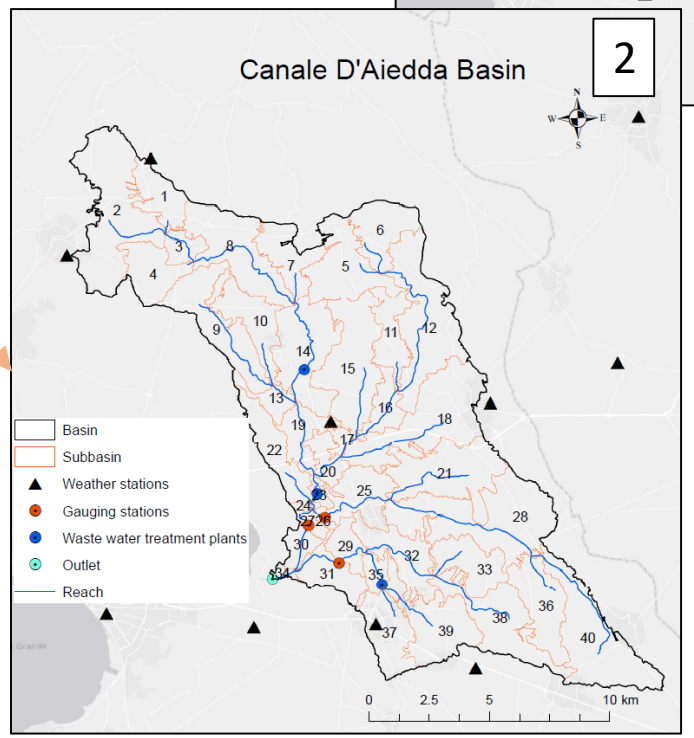
Soil Map

SWAT Soil & Water Assessment Tool

SWAT Model Set up

ArcGIS ESRI





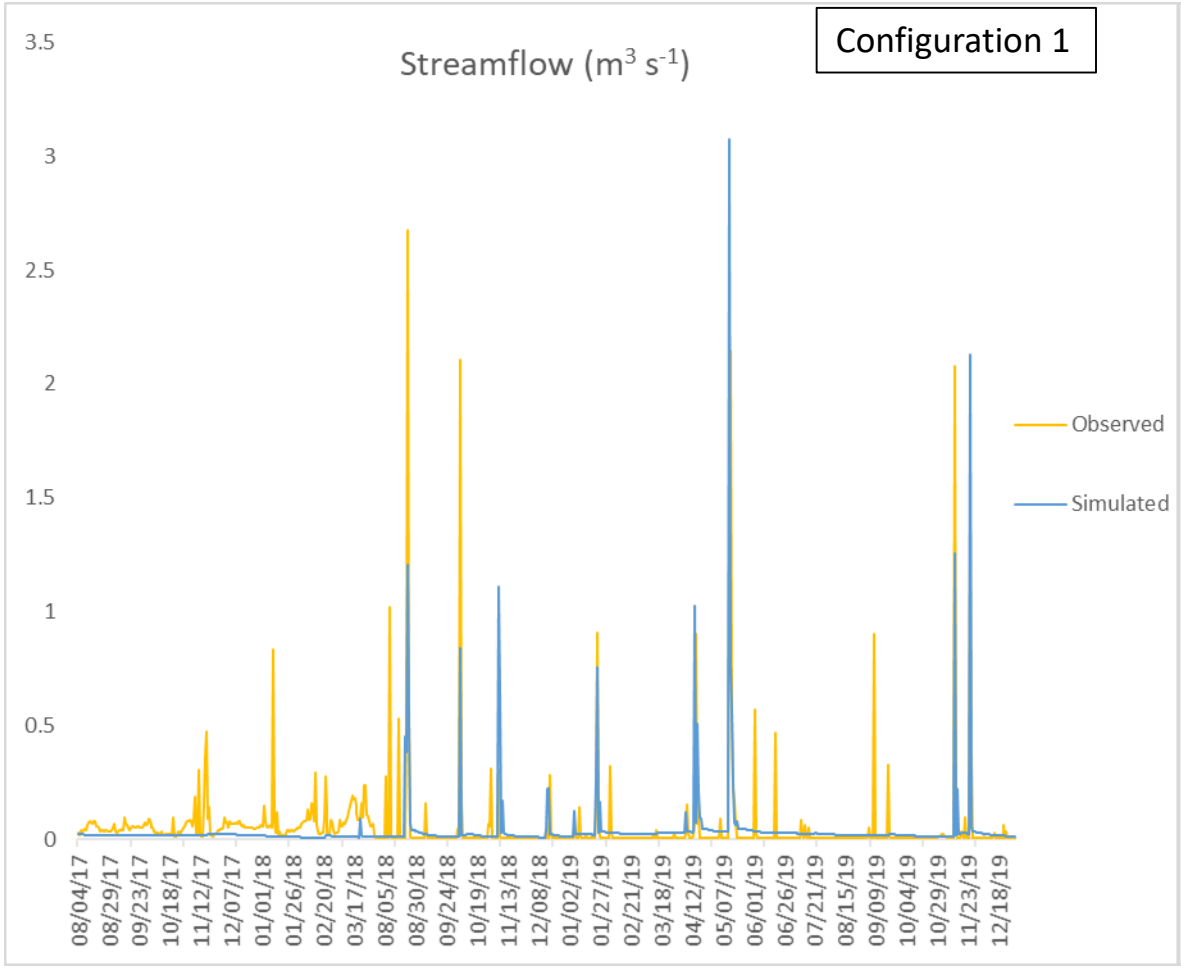
Observed Discharge

Calibration

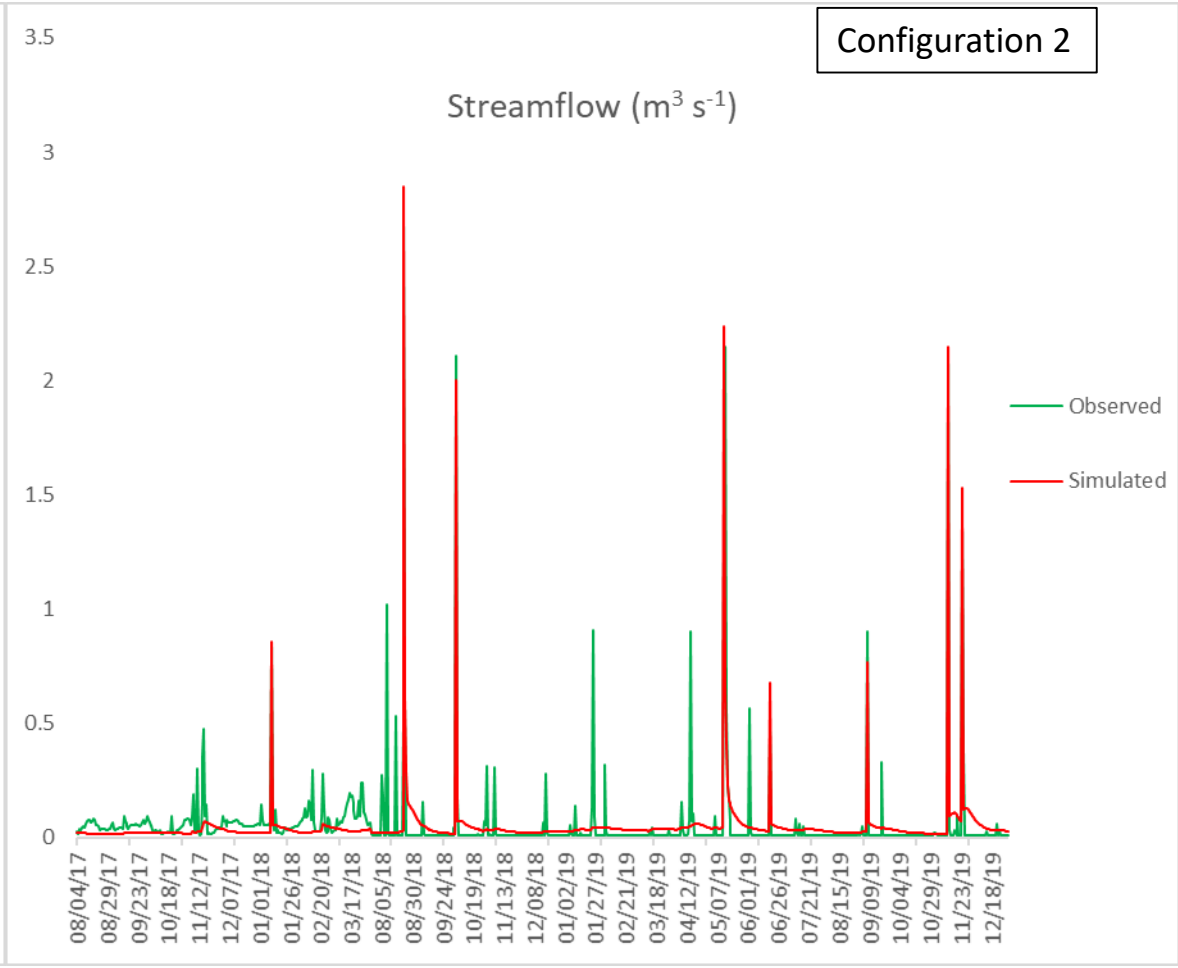
Methodology – data used to set up and calibrate the model

Data	Source	Resolution
Digital Terrain Model	Puglia Region (http://www.sit.puglia.it)	8 × 8 m
Land use map	Puglia Region (http://www.sit.puglia.it)	1:5000
	National Agricultural Census (http://censimentoagricoltura.istat.it/index.php?id=73)	–
Soil map and database	Puglia Region (2001)	1:100000
	JRC-ESDAC (https://esdac.jrc.ec.europa.eu/resource-type/datasets)	500 × 500 m
Point sources	Apulian Water Authority (Personal communication) (W1, W2, W3)	
	Puglia Region (http://www.sit.puglia.it) (S1, S2)	
	Regional Agency for Environmental Protection (http://www.arpa.puglia.it/web/guest/depuratori) (W1, W2, W3)	–
	Sampling and chemical analysis of treated effluents (W2, W3)	
Meteorological data	Civil Protection Service - Puglia Region (https://protezionecivile.puglia.it/)	
	Regional Agency for Irrigation and Forestry Activities (http://www.agrometeopuglia.it/)	Daily 1/1/1997 - 31/12/2019
	National Agency for New Technologies, Energy and Sustainable Economic Development (http://www.solaritaly.enea.it/)	
Gauging station	Department of Agricultural and Environmental Sciences, University of Bari Aldo Moro	Daily 8/2017 - 12/2019
Agricultural practices	Interviews with farmers and agricultural advisors (D'Ambrosio et al., 2019).	–

Ongoing results



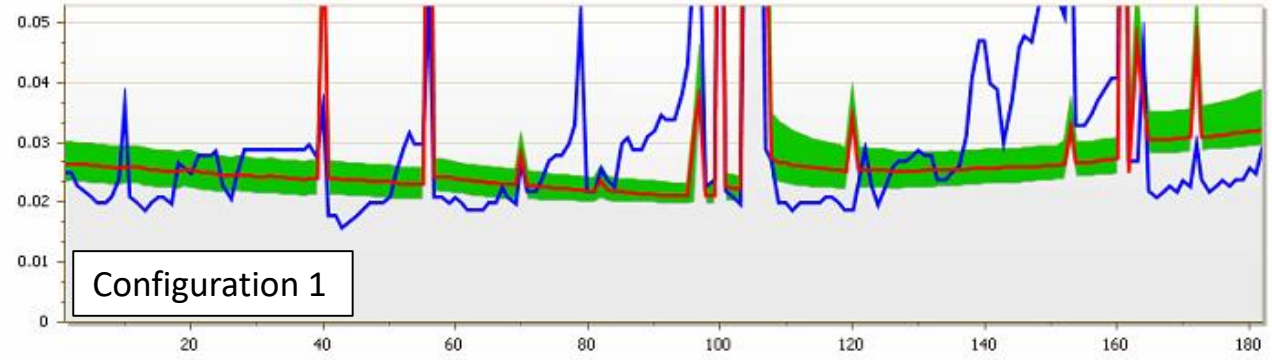
R^2: 0.43
NSE: 0.39
PBIAS: +26.9



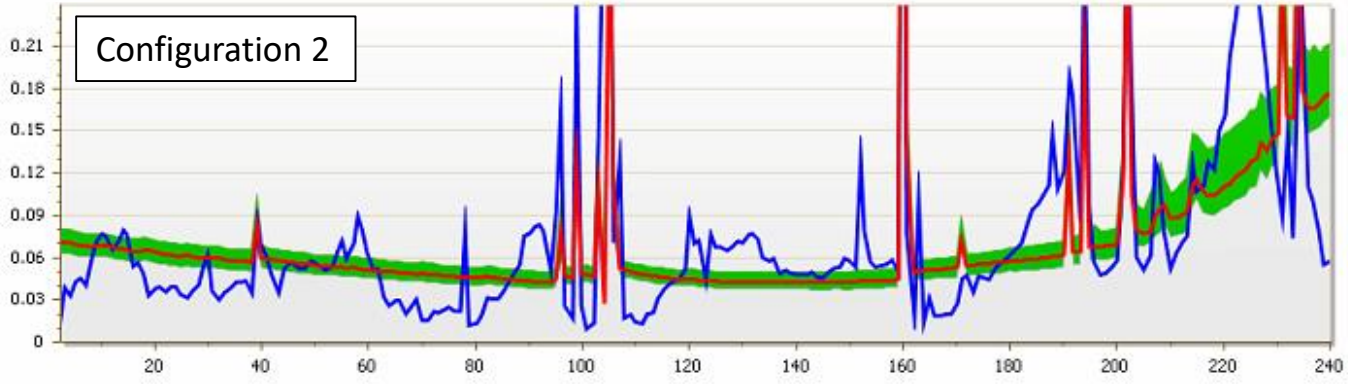
R^2: 0.72
NSE: 0.71
PBIAS: +5.1

Infiltration and transmission losses and soil hydraulic parameters resulted the most relevant in simulating hydrology

Ongoing results

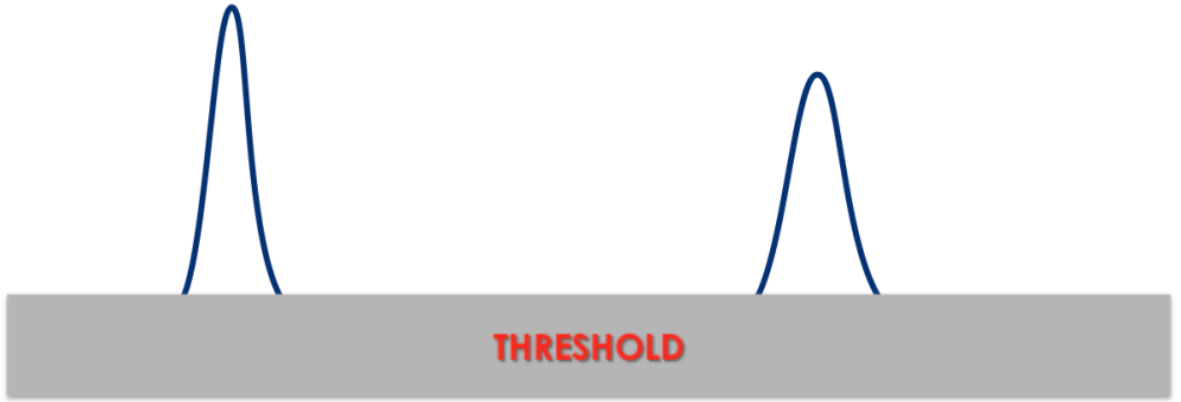


Both simulations (1 and 2) show an asymptotic overestimation in low flow periods when the lowest measured values was 0.008 $m^3 s^{-1}$

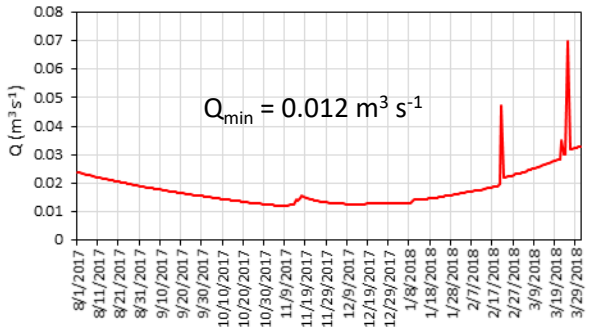


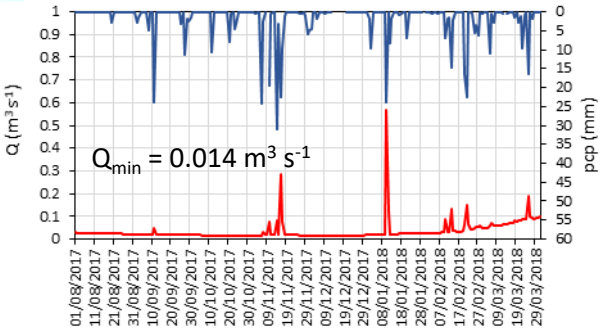
Extreme low flows are affected by large uncertainty.

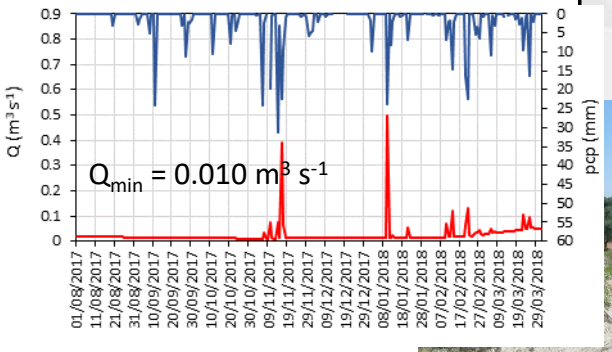
The comparison of measured and modeled flow duration curves and the analysis of pictures of several reaches of the Canale d'Aiedda took in field surveys, lead to identify a "zero flow" threshold used to rectify the simulated streamflow.

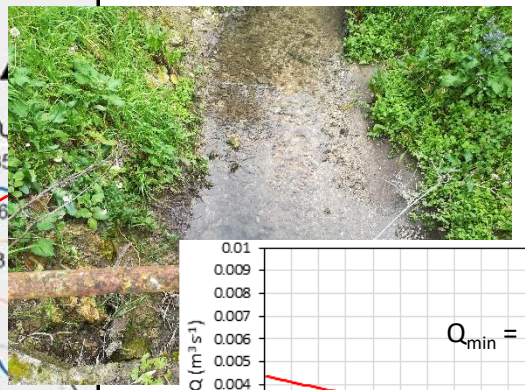


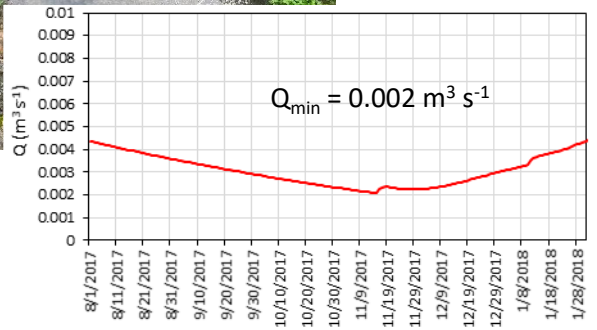
Ongoing results







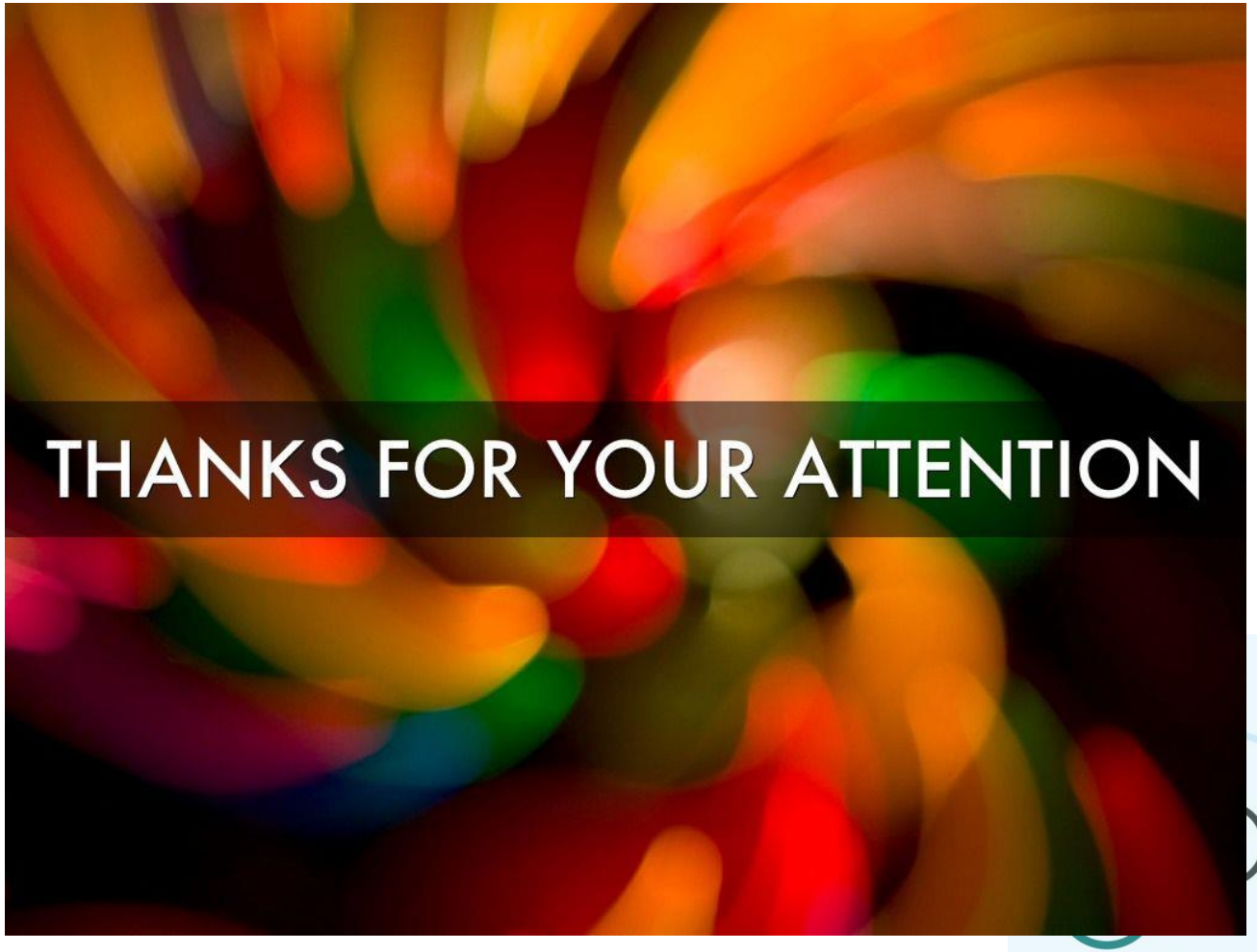




The analysis of the pictures taken in different time period and in different location upstream to the gauging station evidenced that some reaches were intermittent during the year

Conclusions

- The SWAT model is able to simulate daily streamflow with good performances especially considering the configuration without outcropping limestone.
- Unsatisfactory results were obtained for when all the basin area was considered, highlighting that SWAT needs to be further calibrated parameterizing transmission losses and soil hydraulic properties
- Streamflow is affected by uncertainty which lead to overestimate the baseflow
- The hydrograph of calibrated model in upstream river sections does not show an absence of flow in the dry season.
- A procedure was defined to improve the no-flow simulations. A «zero-flow» threshold (actual no flow) was identified for each intermittent reaches through field surveys.
- The simulated streamflow time series was rectified for the dry season based on zero-flow thresholds .



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