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Potential flow regime alterations under climate change in an intermittent river system

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Objective

Analyse the potential impacts of future climate scenarios on water balance and flow regime in a basin with a temporary river system.

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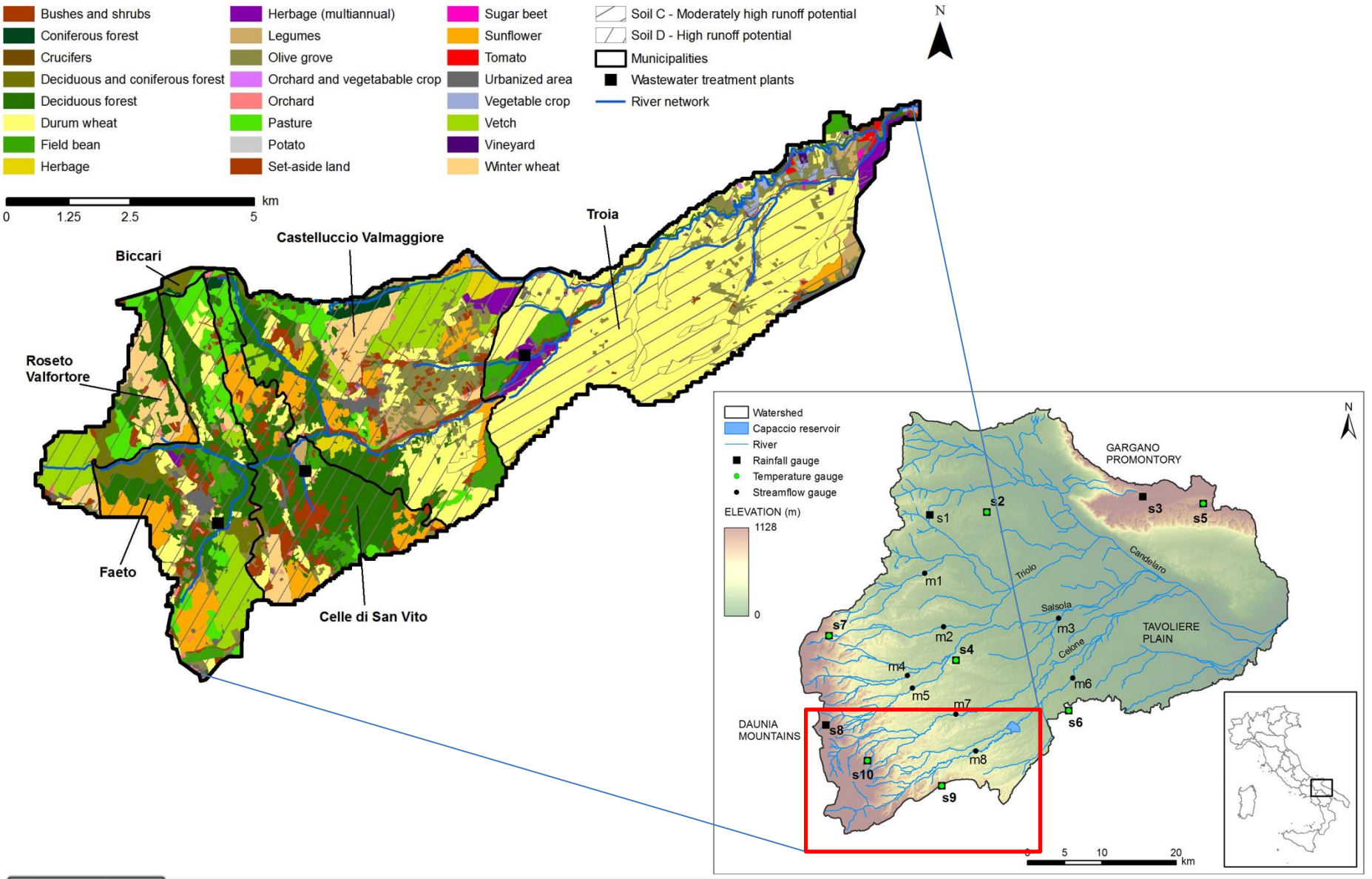
The Celone River Basin



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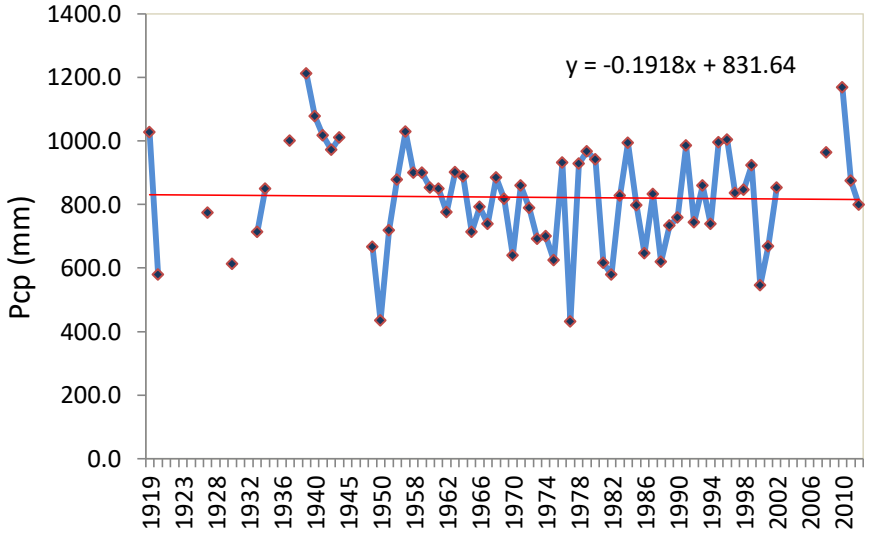
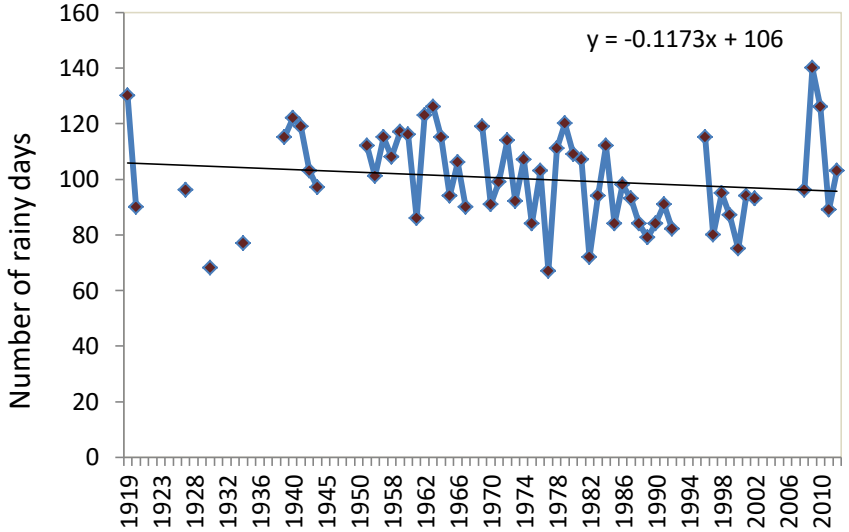
Climate change over the last decades

Since 1919 it has been recorded:

- **a very slight decrease in annual rainfall**
- **a decrease in the number of rainy days**





Data Source:
Civil Protection Service, Apulia Region
Gauging station: Faeto (866 m a.s.l.)

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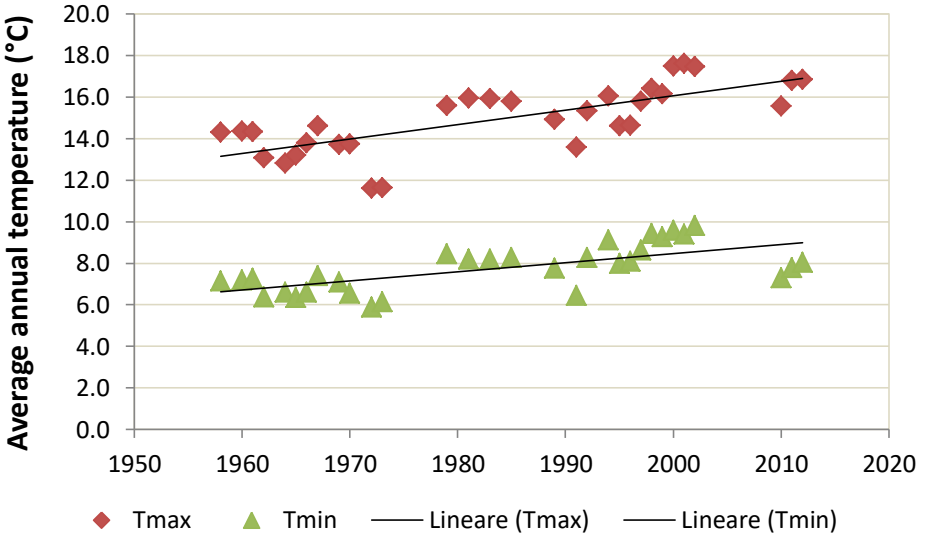
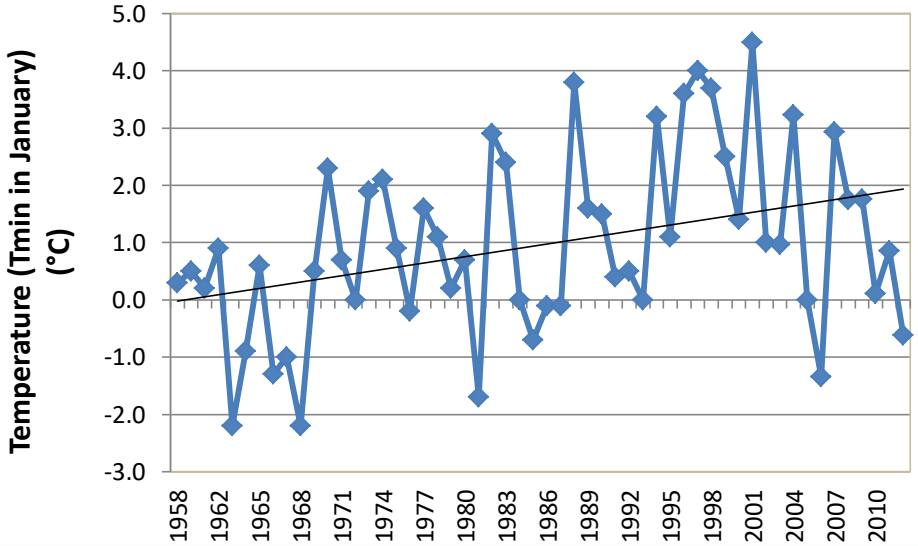
Climate change over the last decades

Since 1954 it has been recorded:

- **Increase of temperature**
- **Increase of minimum temperature in winter**
- **Reduction of precipitation falling as snow**





Data Source:
Civil Protection Service, Apulia region
Gauging station: Faeto (866 m a.s.l.)

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...in the past


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Future climate scenarios and data

- **Data resolution 25-km** (source: FP6 ENSEMBLES Project)

- **A1B storyline** (balanced emphasis on all energy sources)

Combination of GCM and RCMs were used:

- **KNMI_RACMO_ECHAM5**
- **SMHI_RCA_ECHAM5**
- **MPI_REMO_ECHAM5**

Baseline 1980–2009
Future scenarios 2030–2059.

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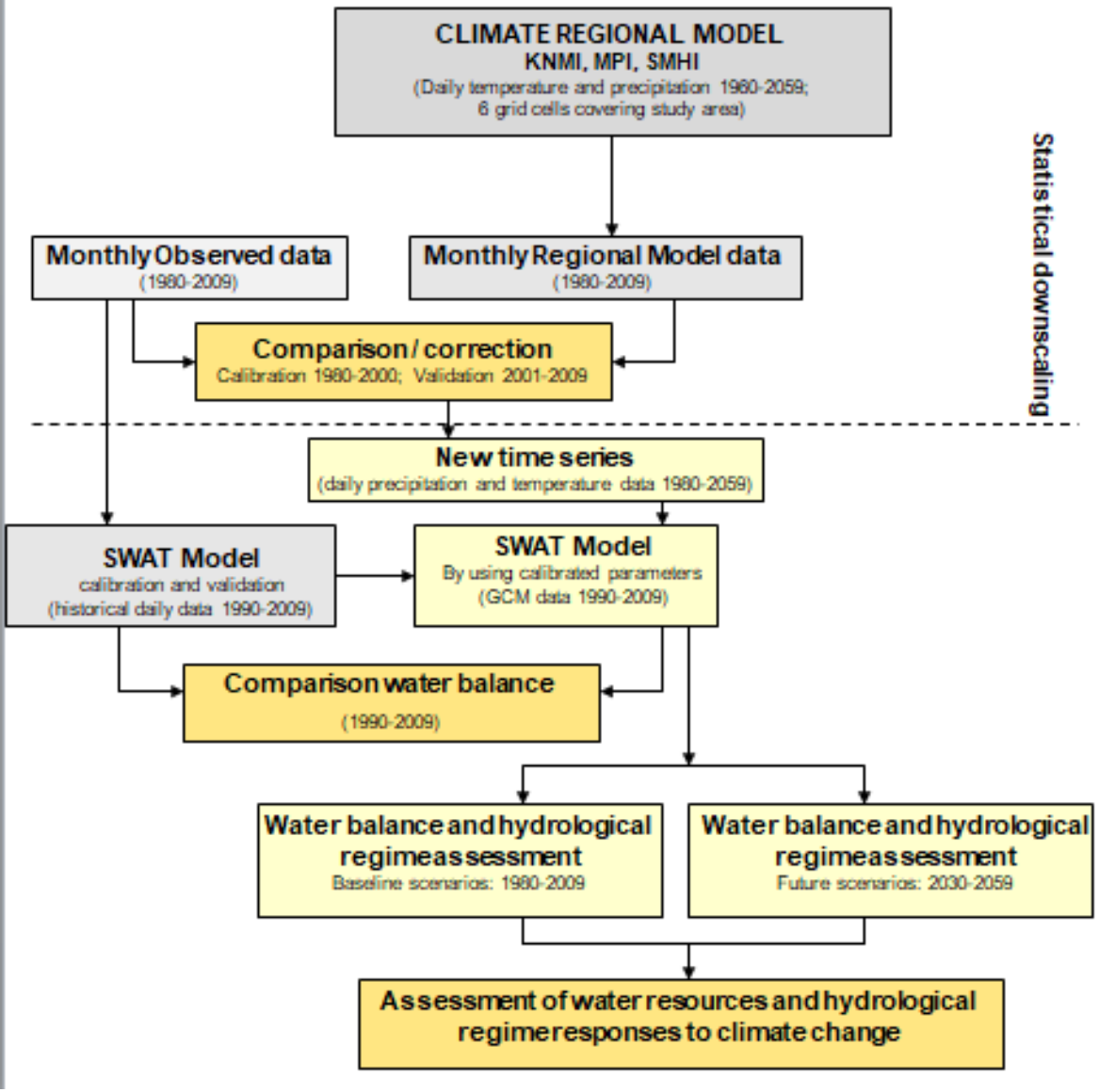
Schematic overview of methodology



No land use changes were assumed for the future.

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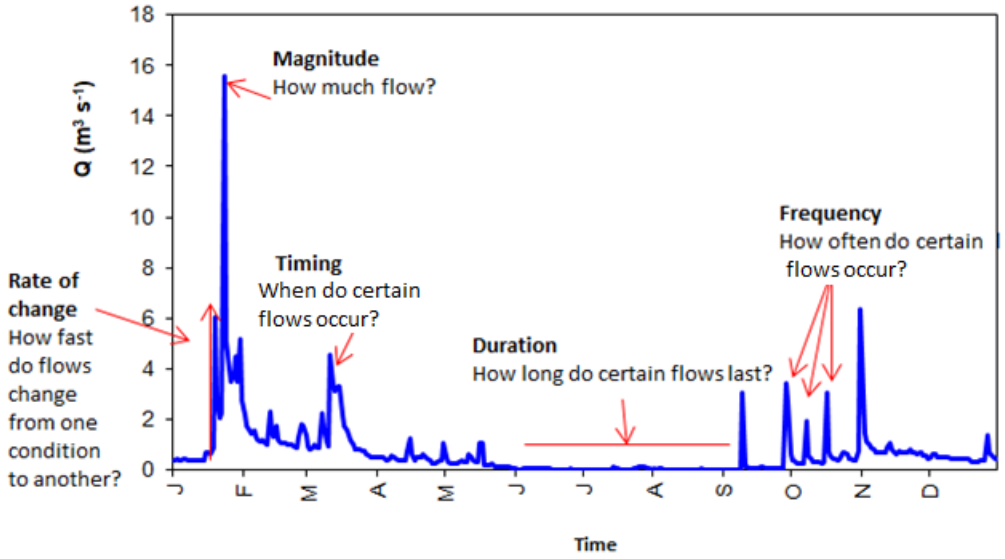
Assessing flow regime alterations

Flow regime was characterized by using
Indicators of Hydrological Alterations (IHAs)
computed using 30 y of daily streamflow data

The Range of Variability Approach was used to assess the diverge between the current and the future hydrological regime



For each IHA, the RVA divides the full range of preimpact variability into three categories (the lower range, the target range, and the upper range) and computes the frequency with which the "postimpact" values of the IHA parameters fall within each category.

For each IHA, the frequency change between the post-impact and pre-period in the target range is the degree of alteration

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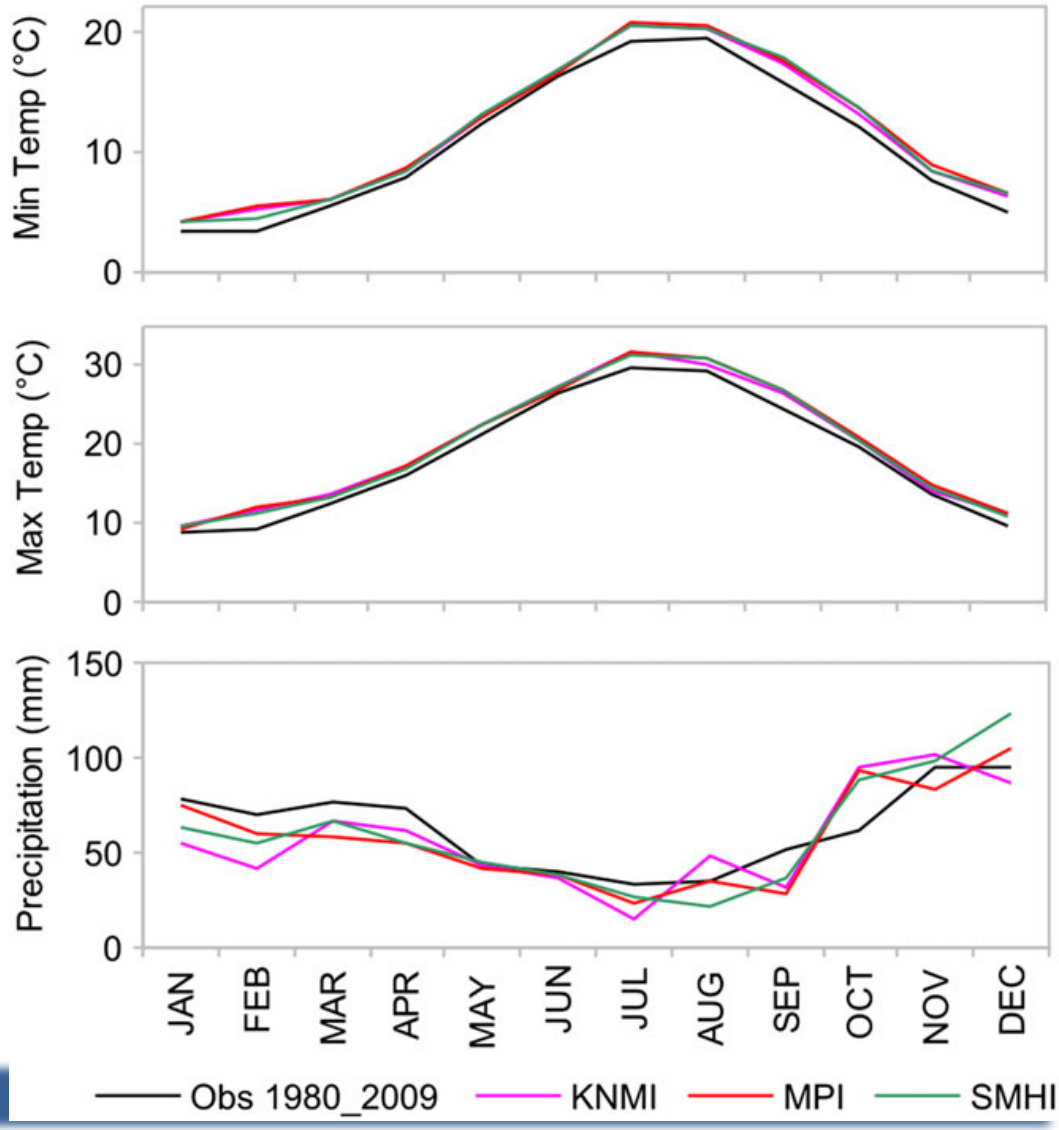
Comparing historical measured data and downscaled climatic data for the future scenario

Increase of temperature:
max TMP varies between 0.5–2.4 °C (highest in September for the MPI)

Min TMP between 0.3–2.1 °C (highest in February).

Decrease in annual precipitation with a major decrease from January to May

Different distribution through the year



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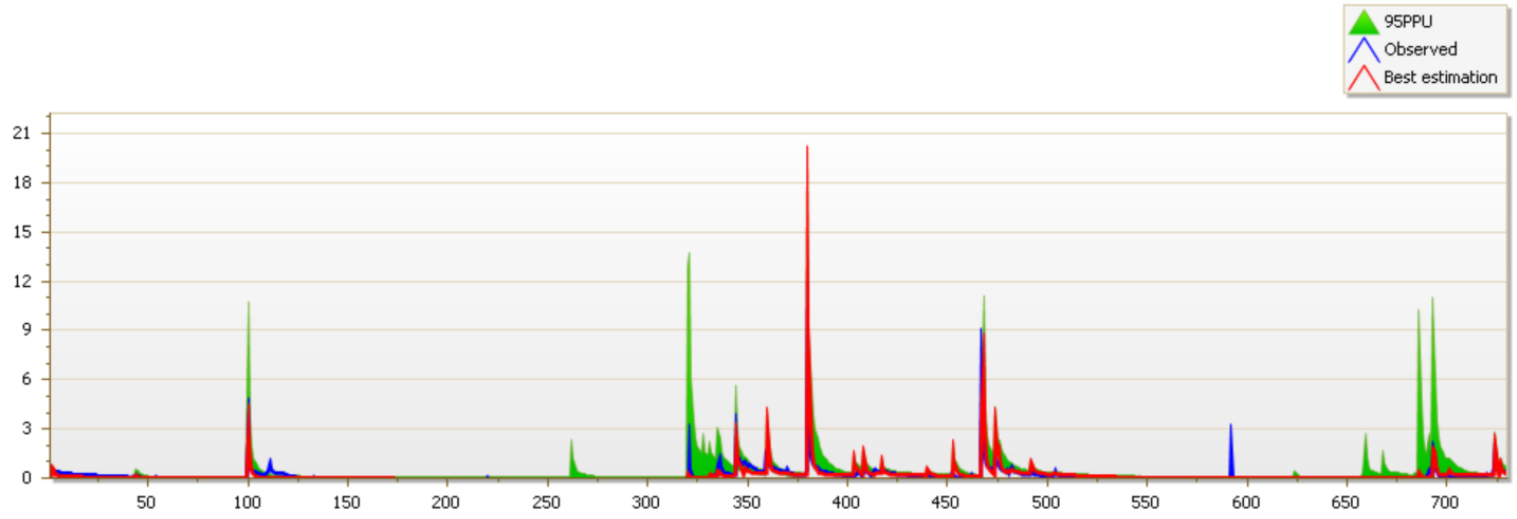
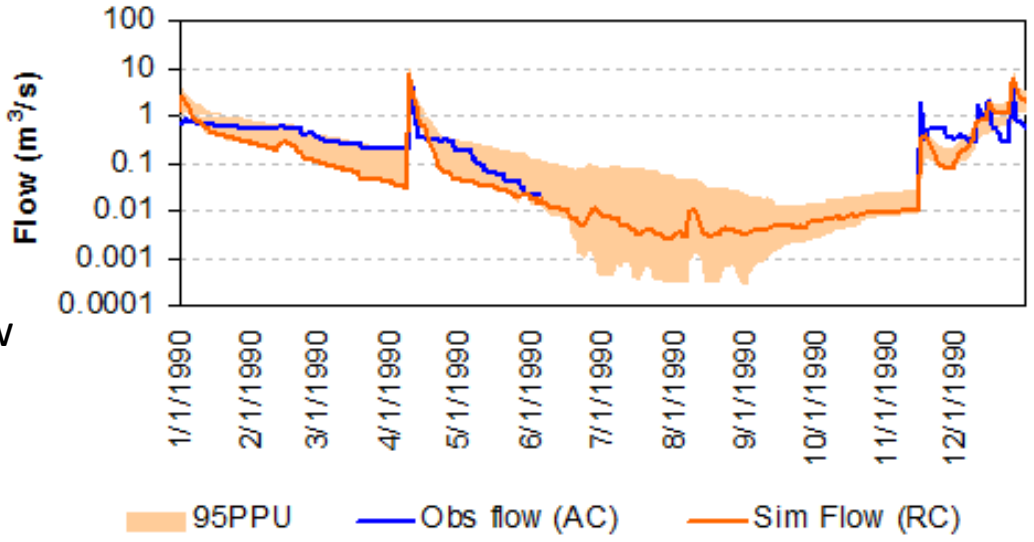
SWAT model calibration and validation



Model performances are satisfactory
NSE = 0.51; PBIAS = 24%;
RSR = 0.70; R2= 0.83.

Model results are affected by uncertainty, especially the extreme low flow conditions



De Girolamo et al., 2015a; 2015b
De Girolamo et al., 2017a; 2017b

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Average effect of climate change on water balance

	Current scenarios GCM_RCMs (baseline 1980-2009)			Future scenarios GCM_RCMs (2030-2059)		
	MPI	KNMI	SMHI	MPI	KNMI	SMHI
Rainfall (mm/y)	741	792	738	699	753	719
Differences in rainfall (%)				-6	-5	-3
Snowmelt (mm)	45	42	12	18	16	4
Diff in snowmelt (%)				-60	-63	-65
PET Potential Evap. (mm/y)	968	967	964	1015	1012	1009
Diff in PET (%)				5	5	5
Et Actual Evap. (mm)	459	463	474	460	459	460
Diff in Et				0	-1	-3
TWY Total Water yield (mm)	155	178	138	126	160	135
Diff in TWY (mm)				-19	-10	-2

Reduction of the total inflow into the *Capaccio* reservoir from 8% (KNMI) to 9% (MPI)

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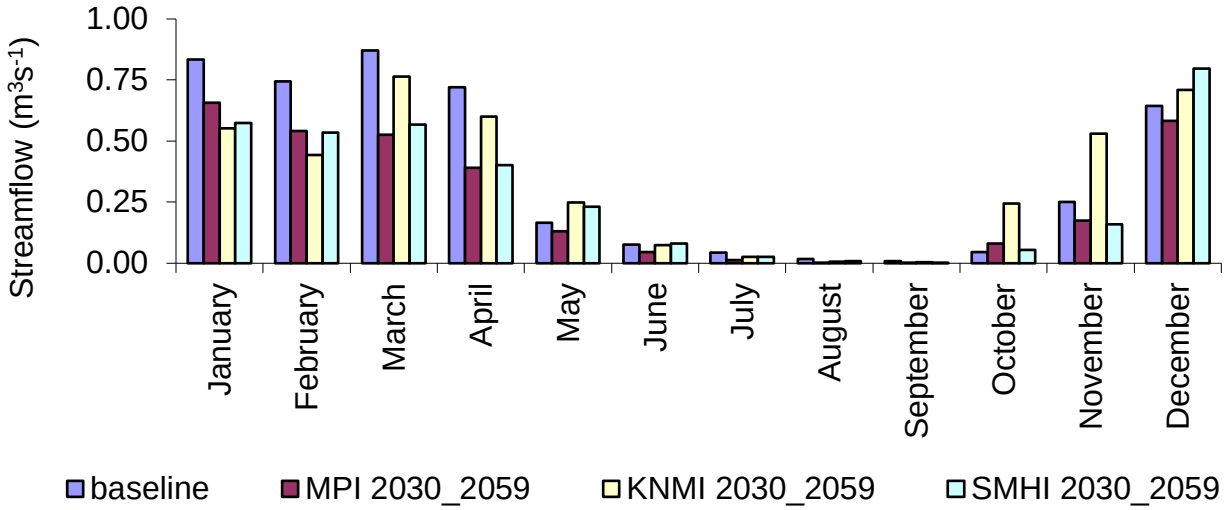
Climate change impact on hydrological regime

MPI resulted the worst scenario in terms of reduction of water resources



High level of alteration for mean monthly flow is expected:

- increase in the frequency of high values for mean monthly flow in July and August
- Reduction of monthly mean flow from January to September

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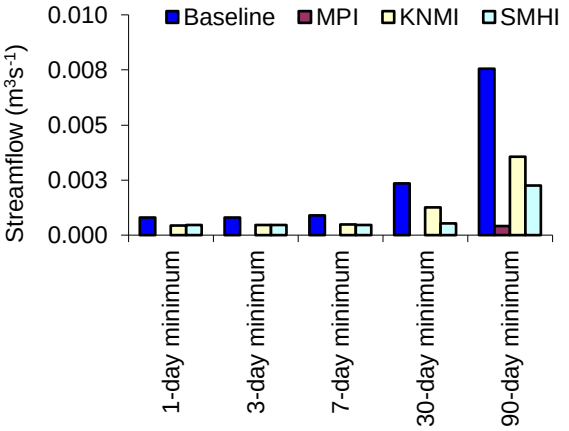
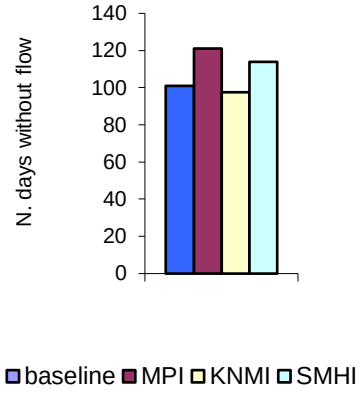
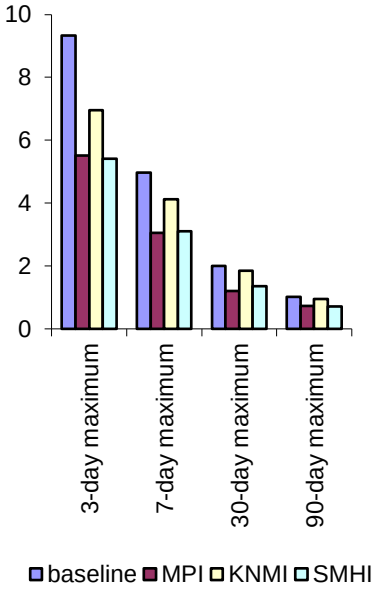
Climate change impact on hydrological regime







- **Shift of the flow regime towards drier conditions**
- **Extension of the period with an absence of flow**
- **Exacerbation of extreme low flow conditions**
- **Decrease in both high and low-flow magnitudes for various time duration** (90-day minimum flow and 90- and 30-day maximum flow)
- **Earlier data of minimum**

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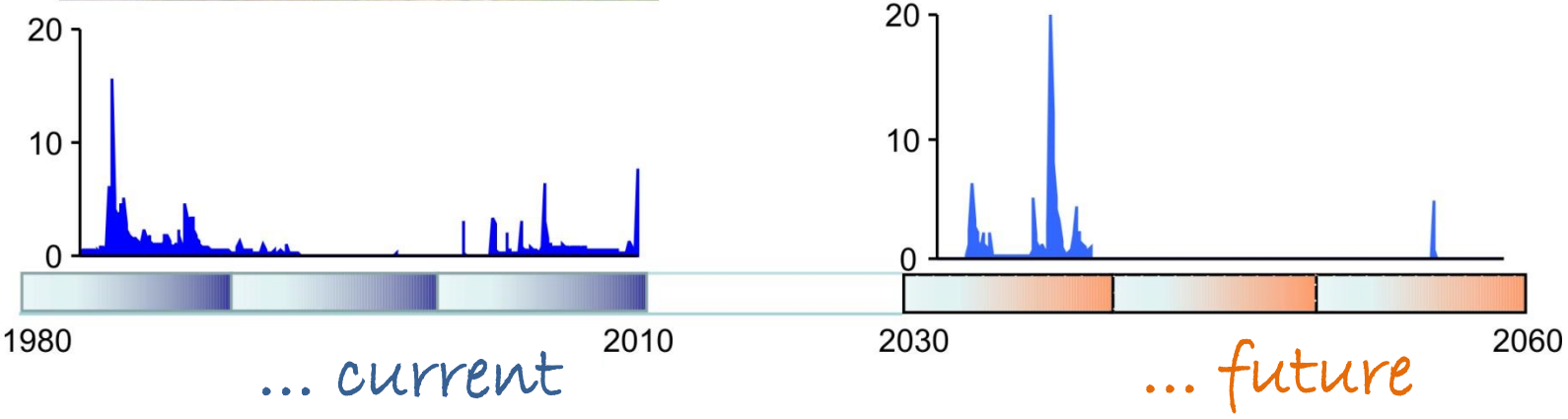

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Conclusions

CC will bring:

- **reduction of water resource availability**
- **alterations in the hydrological regime**
- **the reduction of current water inflow in the Capaccio reservoir will need a revision of the water release downstream the dam and adaptive adjustments of the environmental flow**
- **flow regime alterations influence biological elements that greatly affect the assignment of ecological status and the interpretation of biological data (WFD, DM Ambiente n. 260, 2010)**
- **exacerbation of the competition for water resource uses**
- **new management options and mitigation measures are needed urgently**

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GRAZIE!

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