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UNIVERSITÀ DEGLI STUDI DI UDINE

A DISTRIBUTED RAINFALL-RUNOFF MODEL FOR THE INVESTIGATION OF CLIMATE CHANGE EFFECTS ON RIVER FLOODS IN THE EUROPEAN ALPS

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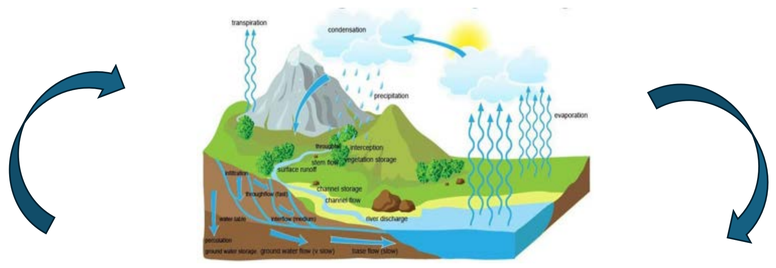
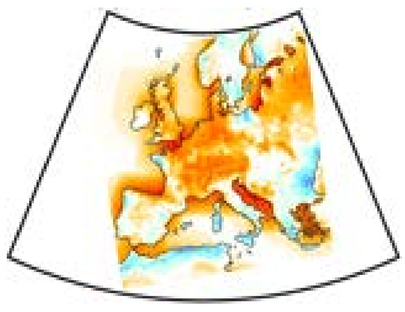
MAPPING EXTREMES CHANGES ON THE EUROPEAN ALPS

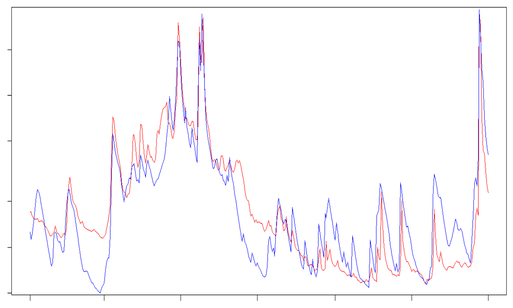
As our climate system climbs through its current warming path, temperature and precipitation are greatly affected also in their extreme. There is a general concern that climate change may affect also the magnitude and frequency of river floods and, therefore, that existing and planned hydraulic structures and flood defenses may become inadequate to provide the required protection level in the future.

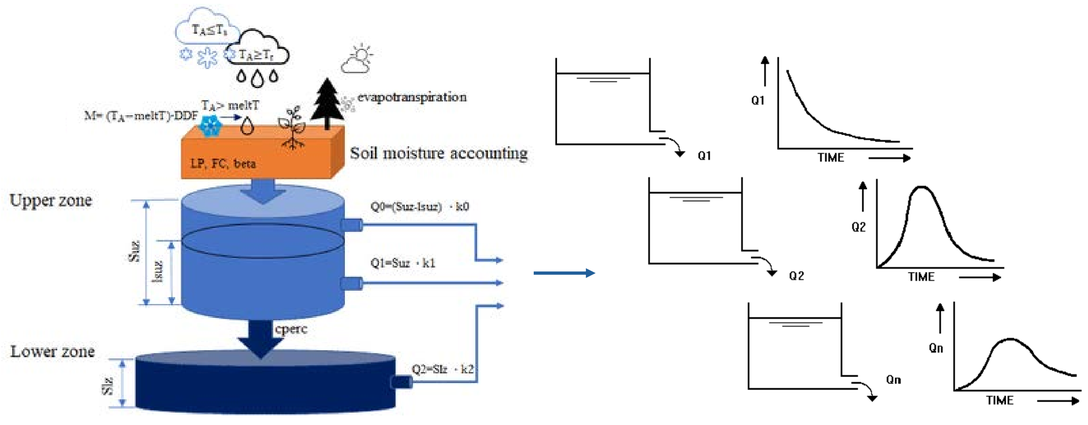
Inside this evolving context, this project aims to assess, under potential climate scenarios, the variations at a regional scale in the intensity and frequency of river floods, how they are related to changes in climate extremes.

To do so, an integrated modelling chain has to be developed, starting from climatic projections, passing through hydrologic modelling, to arrive at the identification of which climate extremes indices are better correlated to river floods indices, and how they will modify due to climate change and the associated uncertainties.





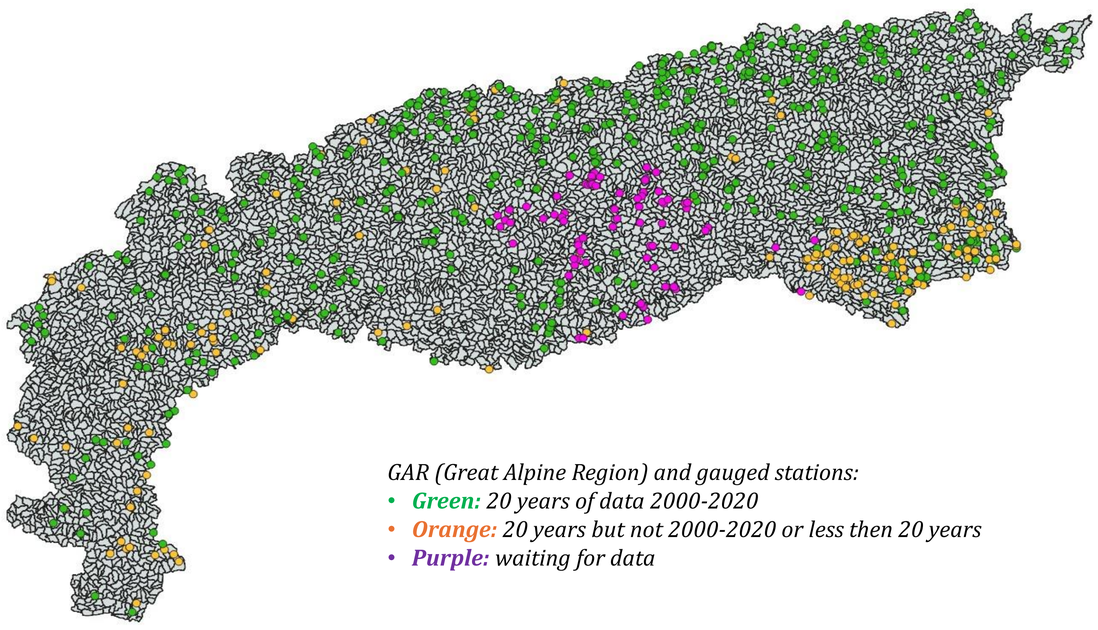




The rainfall-runoff model used for the hydrological module is composed of a generative and a routing routines. The first is performed with the ***TUWmodel [1]***, while the second is implemented through a single ***Nash-Cascade*** (two parameters, *N* and *k_nash*) for the combined contributions of the hillslopes and river runoff. In total the model has 15 parameters:

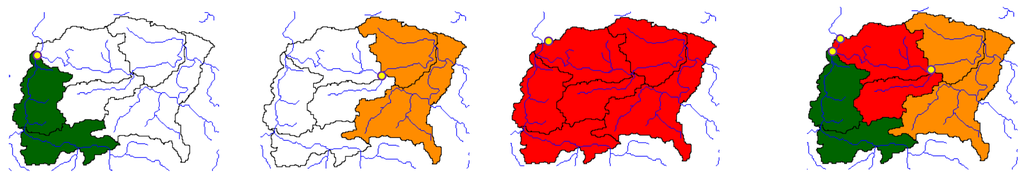
STUDY AREA AND MODEL CALIBRATION

The study area encompasses the entire *GAR* (Great Alpine Region), ranging from France to Slovenia. The sub-basins dataset used to define the hydrological unit of the model has been constructed specifically to garantee that every gauged basin can be correctly attributed to an *UH*.



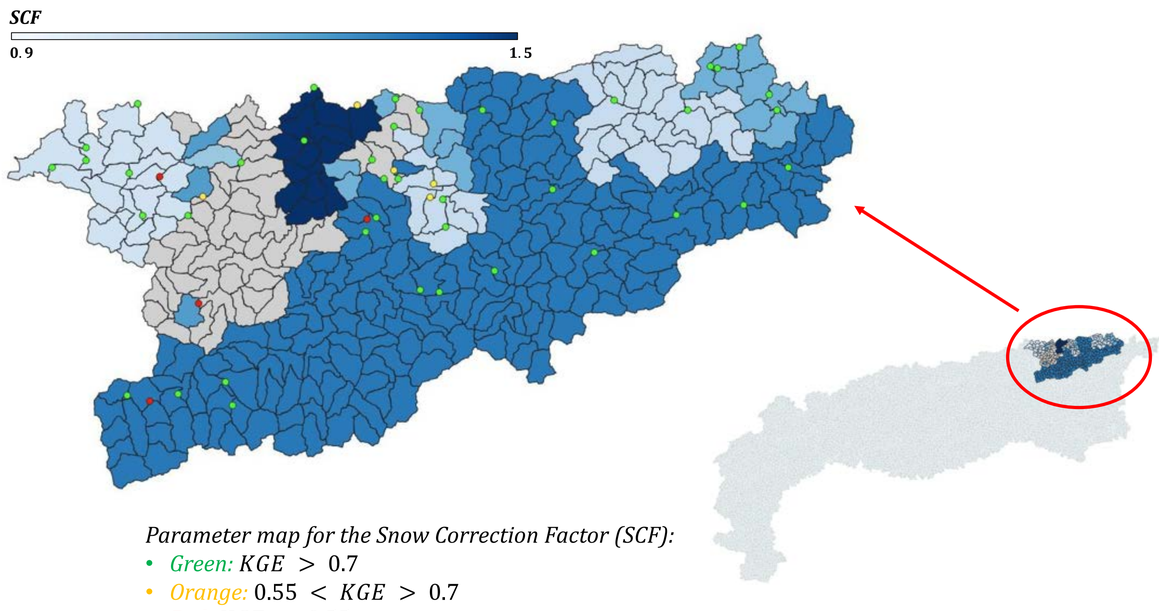
GAR (Great Alpine Region) and gauged stations:
- ***Green:*** *20 years of data 2000-2020*
- ***Orange:*** *20 years but not 2000-2020 or less then 20 years*
- ***Purple:*** *waiting for data*

Two different *modes* are possible in calibration. First an «***independent mode***», in which each gauged basin is calibrated independently from the others: to each sub-basin composing a gauged catchment, are assigned the same parameters. A second «***network mode***», in which each catchment calibration depends from all the already calibrated sub-basins connected upstream.



Example of calibration in «independent» and «network» modes

The calibrations can be conducted sequantially, «composing» step-by-step the parameters' map for the entire region. As input data the *UERRA* dataset (resolution 5.5 km) has been used. Follows an example for Austria for the *SCF* (Snow Correction Factor) and the overall quality of the calibration (quantified by the *KGE*):



Parameter map for the Snow Correction Factor (SCF):
- *Green:* $KGE > 0.7$
- *Orange:* $0.55 < KGE > 0.7$
- *Red:* $KGE < 0.55$

FOLLOWING STEPS MOVING FORWARD

- Finishing the local calibrations on the gauged stations on the period (2010-2019)
- Regionalization by mean of machine learning techniques (***HydroPASS [2]***)
- Spatial and temporal validation of the regionalized model

EVENT IDENTIFICATION AND CLASSIFICATION

- With the validated model simulations, identification of large scale flooding events (magnitude and spatial extension)
- Analyzing the possible correlation between flood indices and climate extreme indices at different resolutions

MAIN REFERENCES:

[1] Merz, R., Blöschl , G. (2004), Regionalisation of catchment model parameters.
[2] Merz, R., Tarasova, L., & Basso, S. (2020), *Parameter's controls of distributed catchment models—How much information is in conventional catchment descriptors?*

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