Climate change impacts on extreme rainfalls, discharges and floods in Mediterranean catchments: Application to the Orbieu.

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Mediterranean Floods

- Major source of damages in France (Ricard et al., 2012; Gaume et al., 2016)
- From 2001 to 2015 (BD CATNAT)
  - 201 deaths
  - 800 M€/year
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Climate change

‘Mediterranean change are ... hotspot ... when you look at extreme seasonal precipitation’ Diffenbaugh and Giorgi, 2012

‘The water-holding capacity of soil will affect possible changes in soil moisture deficits’ IPCC, SREX 2012

Projected changes seasonal changes of heavy precipitation for 2071-2100 compared to 1971-2000, for RCP8.5. Figure from Jacob et al., 2013
How does climate change will affect precipitation, discharges and floods in Mediterranean mesoscale catchments?

- Create an operational tool for the WSP France
- Develop a methodology of local estimation according to the EU directive on flood risks
- Assessment of the precipitation change uncertainties
- Assessment of the hydrological modelling uncertainties
- Assessment of the future soil humidity uncertainties
Case study: Orbieu catchment

- Important issues for SPC, SMMAR and SCHAPI
- Ø structures on the river
- Area: 780 km², Length: 72 km
- Robust data from 2005-2017

Luc-sur-Orbieu bridge in Aude catchment, 14/02/2017
Observed data: February 2017 in Orbieu catchment (France)
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Applying quantile-specific change coefficient to the corresponding precipitation event observed in the past period (Colin et al., 2011; Harader, 2015)
Assessment of flow modification with the future precipitation applied to the hydrological model.
Precipitation from CORDEX (Giorgi et al., 2009) simulations at 0.11°:

- **Complex orographic** region (Harader, 2015)

- Precipitation **spatial variability** (Gaume et al., 2004)

- **Added value of 0.11°** for mean (Kotlarski et al., 2014) and extreme precipitation (Prein et al., 2016)

"Evaluation of uncertainties in mean and extreme precipitation under climate changes for northwestern Mediterranean watersheds with high-resolution Med and Euro-CORDEX ensembles" Colmet-Daage Antoine, Sanchez-Gomez Emilia, Ricci Sophie, Llovel Cécile, Borrell Estupina Valérie, Quintana-Seguí Pere, Llasat Maria Carmen, Servat Eric, in review in HESS
Estimated changes in extreme precipitation:

- Increase of extreme precipitation intensity
- 2071-2100: spread mostly positive
- RCP8.5 changes are similar to RCP4.5 changes
Application of the futurisation method with CNRM-CM5_ALADIN5.3 to the Orbieu pluviometers of the February 2017 event:
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![Graph showing precipitation data over time](image-url)
Application of the futurisation method with CNRM-CM5_ALADIN5.3 to the Orbieu pluviometers of the February 2017 event:
Application of the futurisation method with the CORDEX ensemble to the Orbieu pluviometers of the February 2017 event:
Conceptual event-based hydrological model to simulate the Orbieu discharges: SCS-LR

- Calibration/Validation based on Coustau et al., 2012
- Simple implementation in accordance with WSP France demand

**Production**

4 parameters: \( S \) (mm), \( I_a/S \) (ad.), \( \omega \) (ad.), \( ds \) (j⁻¹)

**Rooting**

2 parameters: \( V_0 \) (m/s), \( K_0 \) (ad.)
Soil Humidity strategy:

- CMIP5 models statistically downscalled on SAFRAN grid (Dayon, 2017)
- SIM (SAFRAN-ISBA-MODCOU)
- SWI-Root from MODCOU

\[
\text{SWI-Root} = \frac{W_{\text{Total}} - W_{\text{Wilt}}}{W_{\text{FieldCapacity}} - W_{\text{Wilt}}}
\]

February SWI for Rcp4.5 in 2011-2041

SWI mean = 0.82  SWI max = 1.06  SWI min = 0.55

Initial soil deficit S (mm):

S opt = 77 mm  S mean = 50 mm  S max = 0 mm  S min = 77 mm
Hydrological impact of the futurized precipitation in the Orbieu discharges for the February 2017 event:
Hydrological impact of the futurizated precipitation in the Orbieu discharges for the February 2017 event:

Goals

Futurization Method

Future Rainfall

Future flows

Conclusion
Method:

- Estimation of the statistical counterpart of past events of precipitation considered by the stakeholders

CC impacts on extreme precipitation:

- Extreme precipitation intensity is projected to increase for both RCP scenarios
- Precipitation changes have an important spatial variability
- Climate model variability considered

Future precipitation impact on discharges:

- Different soil humidity scenarios are considered and impact strongly the response
- With a saturated soil, the pick of discharges can increase twice

Coming soon:

- Assess the global uncertainties on the hydrological impacts
- The methodology have been applied to the Lez catchment. A comparison between the two catchment can validate the methodology for other catchments.
- Compare and validate the use of the SCS-LR model with a physical based model
Thanks for your attention.
Observed data: February 2017 in Orbieu catchment (France)
30 year of daily precipitation to define quantiles

SAFRAN
Durand et al. (1993)
Quintana-Segui et al. (2008)
Characterisation of the past observed rainfall event within the quantile ranked precipitation re-analysis.
Simulated data from CORDEX regional climate models:
Computation of the change coefficient function for all quantiles ranks.
Applying quantile-specific change coefficient to the corresponding precipitation event observed in the past period (Colin et al., 2011; Harader, 2015)
Assessment of flow modification with the future precipitation applied to the hydrological model