Spatial disaggregation of a nationwide flood frequency analysis method

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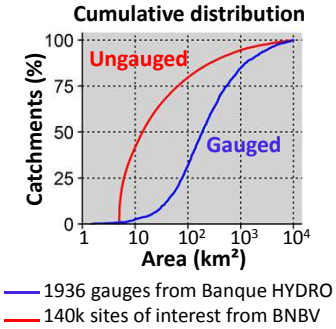
Supported by:

1. Introduction

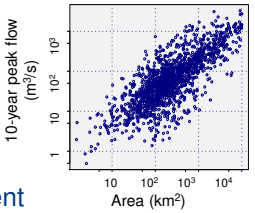
- Flood frequency analysis needed everywhere
  - For prevention plans, protection measures…
  - Problem of **ungauged sites**
- Problem
  - Gauged catchments are generally **large**
  - Operationally, sites of interest can be **small**
- Objective
  - Test **disaggregation** techniques
  - Estimate model parameter at 1km² scale
  - Validate with small catchments



2. Data and methods

- SHYREG[1]
  - Flood frequency analysis method in **France**
  - At-site stochastic **rainfall generator** (fully regionalised)
  - At-site event-based **rainfall-runoff modelling**
    - 1 **single parameter**: responsiveness
  - Empirical frequency analysis (multi-duration)
  - **Quantiles aggregated** to the catchment scale
- Advantages
  - 1km² spatial resolution
  - Considers **rainfall spatial variability**
  - Good **extrapolation** behaviour at gauged[1] and ungauged sites[2]

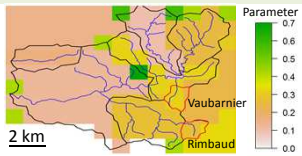
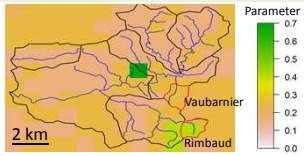
- Test a: whole France
  - **1936 gauged sites**
  - Including 618 catchments of **less than 100 km² used for validation**
  - Local GEV vs simulated 10-year peak flow



- Test b: the Réal Collobrier catchment

- 8 gauges in 70 km²
- Well-known
- Mediterranean basin
- 2 validation catchments
  - Vaubarnier (1 km²)
  - Rimbaud (1 km²)

3. Results

Disaggregation	Test a: R^2	Test b: Values of the parameter	Discussion
No disaggregation ▪ Catchment-by-catchment calibration ▪ Homogenous parameter ▪ Regionalisation required for ungauged estimation (regression and IDW)	$R^2 = 0.52$	Calibr. / Validation Whole basin: 0.15 / n/a Rimbaud: **0.52** / 0.34 Vaubarnier: 0.13 / 0.26	▪ Rimbaud has a **higher value** ▪ Nested catchments are considered independently ▪ Regionalisation can induce **upstream-downstream inconsistences**
Semi-distributed calibration ▪ Calibration by sub-catchment ▪ Regionalisation required for estimation in non-nested ungauged catchment	$R^2 = 0.54$		▪ The spatial variability depends on the sample of gauged catchments ▪ Rimbaud's behaviour not captured ▪ Upstream-Downstream tendency ?
Cell regression ▪ At each cell the parameter is determined by regression with descriptors ▪ The regression coefficients are calibrated against observed flows	$R^2 = 0.54$		▪ Rimbaud's behaviour not captured ▪ Only a limited number of descriptor can be used ▪ The variation of the parameter is controlled by the variation of the descriptor
Cell classification ▪ Each cell is classified according to land use, drainage density, hydrogeology ▪ Each class is associated with a calibrated parameter value	$R^2 = 0.53$		▪ **Rimbaud's behaviour captured** ▪ Cell classification allows sharp variation of the parameters

4. Conclusion

- Overall performances are little affected
  - Locally the differences can be high
  - High impact on the estimation at small ungauged sites
- Results suggest to develop the cell classification method
  - Ability to introduce sharp spatial variations
  - More adapted to categorical data
- A priori knowledge is required
  - There is a high equifinality in the spatial distribution of model parameter inside a gauged catchment.
  - This spatial distribution should be constrained with an a priori knowledge
- Future work
  - Study more well gauged catchments
  - Study the impact of the different cell classes
  - Try different level of a priori information
  - Merge semi-distributed and cell classification methods

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References:

(1) Arnaud, P., Cantet, P., and Aubert, Y (2016) Relevance of an at-site flood frequency analysis method for extreme events based on stochastic simulation of hourly rainfall. *Hydrological Sciences Journal*: 61(1), 36-49

(2) Odry, J. and Arnaud, P. (2017). Comparison of Flood Frequency Analysis Methods for Ungauged Catchments in France. *Geosciences*: 7, 88.

To know more about SHYREG:

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