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Predictive performance of flood frequency analysis approaches: a national comparison based on an extensive French dataset

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An abundance of approaches

• Local estimation of a distribution
• Regional implementations
• Continuous simulation approaches

Objectives

Compare the predictive performance of FFA implementations

Introduction: Flood Frequency Analysis (FFA)

Importance of FFA in engineering

Central in risk assessment and management:

• Design of civil engineering structures
• Foundation of risk assessments

• Inundation maps

Results: comparison of FFA implementations in France

Competing teams

The local league: using at-site data only

1. Gumbel distribution (LOC_GUM)
2. GEV distribution (LOC_GEV)
3. A continuous simulation approach: SHYPRE [2]

The regional league: estimation at ungauged sites

Hydro-eco-regions

1. Gumbel distribution (REG_GUM)
2. GEV distribution (REG_GEV)
3. SHYREG, regionalized version of SHYPRE

The local-regional league: at-site estimation using regional information

1. Gumbel distribution (L+R_GUM)
2. GEV distribution (L+R_GEV)

Bayesian approach, prior = regional, likelihood = local [4]

Application: FFA implementations in France

A data-based comparison framework [1]

Spirit of the game

General principles

Focus is on predictive (as opposed to descriptive) performance

To verify implementation

Would you rather build a dam that will withstand future floods, or one that would withstand past floods?

Should be applicable to any FFA family (local, regional, mixed local-regional, continuous simulation)

Complements (but not replaces):

Monte-Carlo evaluations

The truth is known, but how realistic is the Monte-Carlo setup?

Statistical testing

Tests not available for all implementations

General-purpose tests exist, but they assume known parameters!

Rules of the game

Compute on validation data:

N_v: number of exceedances of the estimated T-year flood

FF: non-exceedance probability of the largest observation

For a reliable implementation:

N_v > Bin(a,1/T), pr(FF ≤ z) ≥ 0

Repeat on many sites ...

... and evaluate adequacy with the theoretical distribution

Note: due to the discrete nature, a “randomness” test is required for N_v.

Trend in over-/under estimation

Tendency to overestimate/predict failures

2076 stations, 20 years + Catchment size: 10-2000 km²

Validation data identical for all implementations

Bayesian approach, prior = regional, likelihood = local [4]

Conclusions

Main conclusions

• Two winners: SHYPRE and L+R_GEV
• The reliability of regional implementations is in general quite poor
• Purely local estimation of a GEV distribution is dangerous

Using more information...

• In general, purely local implementations are not sufficiently reliable
• Benefit of additional information: rainfall (SHYPRE) or regional (L+R_GEV)
• Perspective: combine more diverse sources of information

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Marked regional differences

Mediterranean area

Oceania

No evidence that GUM is inappropriate

All implementations fairly reliable

Reliability is poor for all implementations

SHYPRE is the most reliable

Especially GEV: for 20% of stations, what is considered as “impossible” actually occurs in validation!

SHYPRE ~ L+R_GEV

Slight over-estimation for

No evidence that GUM is inappropriate

All implementations similar

SHYPRE ~ L+R_GEV

GUM clearly inappropriate

SHYPRE ~ L+R_GEV

100

FF

N

n

T

z

pr

T

1

n

(1)


