Regional Flood Estimation: a Daily Streamflow Approach

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1 Introduction

- **Flood estimation at ungauged sites: Regional flood frequency analysis**
  - **Classical approaches → prior aggregation of regional information**
  - **Proposed approach → regional information in the estimated streamflows**

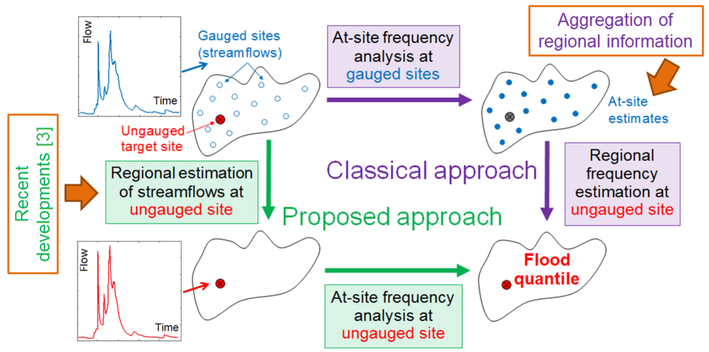

Fig. 1. Classical vs. proposed regional flood frequency approach

2 Case Study

- **151 sites in Quebec, Canada (Fig. 2)**
- **Hydrological variables to study (specific spring flood quantiles)**
  - **10- and 100-year return period (T) quantile**
- **Descriptors available**
  - **Catchment area**
  - **Catchment area slope**
  - **Fraction of catchment controlled by lakes**
  - **Annual mean total precipitation**
  - **Annual mean degree-days below 0°C**
  - **… Additional descriptors**

Analysis using 5 descriptors

Analysis using 14 descriptors

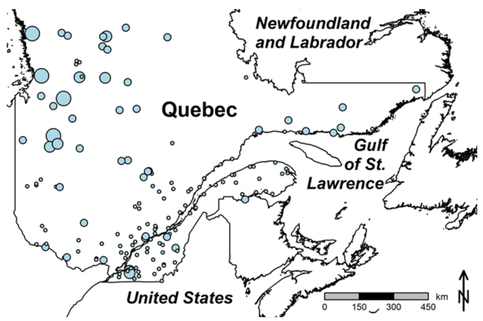

Fig. 2. Location of the studied sites

3 Methodology & Results

Destination (ungauged) site

(i) Regional estimation of daily streamflow series (based on [3])

Extraction of **maximum peak flow series**

(ii) Local estimation of flood quantiles

(iii) Assessment & Comparison with classical approaches

i Regional estimation of daily streamflow series

a) FDC at the ungauged site & transfer procedure

Flow-duration-curve (FDC) based approach

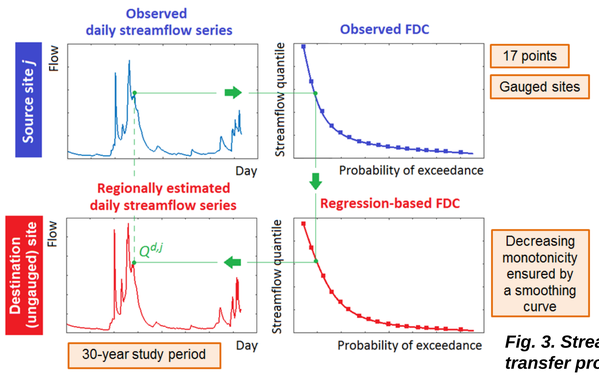

Fig. 3. Streamflow transfer procedure

b) Source sites

The transfer procedure in "(a)" is repeated for each selected source site

4 source sites & their weights based on geographical distance

$$Q^d = \sum_{j=1}^{N} w_j Q^{d,j} \Big/ \sum_{j=1}^{N} w_j, \quad \text{with } j = 1, \ldots, N \text{ and } N = 4$$

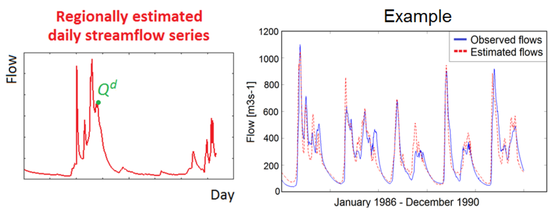

Fig. 4. Estimated streamflow series

c) Estimated streamflow length

By a Jackknife procedure

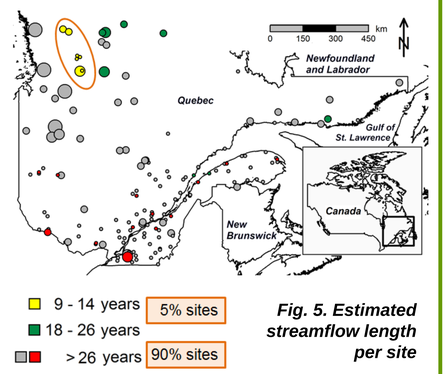

Fig. 5. Estimated streamflow length per site

ii Local estimation of flood quantiles

a) Extraction of maximum spring peak flow series

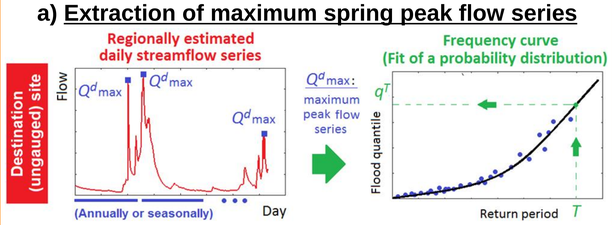

Fig. 6. Flood quantile estimation scheme

b) Selection of distributions for quantile estimation

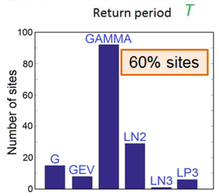

Fig. 7. Distributions selected

iii Assessment & Comparison with classical approaches

a) Performance assessment

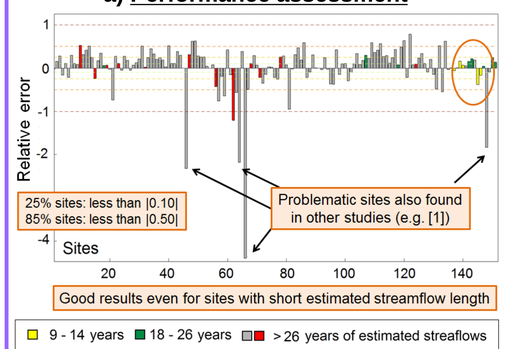

Fig. 8. Relative error for the T=100 quantile

b) Performance assessment & Comparison

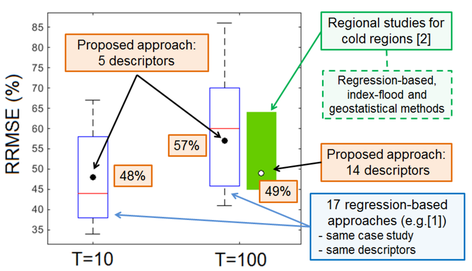

Fig. 9. Relative root mean square error (RRMSE): proposed vs. classical approaches

4 Conclusions

- **Comparable results to classical regional approaches with additional benefits:**
  - **Provide the whole daily streamflow series at the ungauged site where all the regional information is included**
  - **Seasonal/annual, specific/absolute quantile estimate for any return period without redoing the regional analysis**
- **The "ungauged" site is transformed into gauged: any local analysis may be done (e.g. low flow / multivariate)**
- **Simple and flexible procedure**

Acknowledgements

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Main references

[1] Chokmani, K. & Ouarda, T.B.M.J., 2004, Physical space-based kriging for regional flood frequency estimation at ungauged sites, Water Resour. Res., 40, W12514

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[3] Shu, C. & Ouarda, T.B.M.J., 2012, Improved methods for daily streamflow estimates at ungauged sites, Water Resour. Res., 48, W02523