Quantifying the Uncertainty in Discharge Data Using Hydraulic Knowledge and Gaugings with their Uncertainty: the BaRatin approach
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To cite this version:
Benjamin Renard, Jérôme Le Coz, L. Bonnifait, F. Branger, R. Le Boursicaud, et al.. Quantifying the Uncertainty in Discharge Data Using Hydraulic Knowledge and Gaugings with their Uncertainty: the BaRatin approach. AGU Fall Meeting, Dec 2014, San Francisco, United States. pp.1, 2014. hal-02600782

HAL Id: hal-02600782
https://hal.inrae.fr/hal-02600782
Submitted on 16 May 2020

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Quantifying the Uncertainty in Discharge Data Using Hydraulic Knowledge and Gaugings with their Uncertainty: the BaRatin* approach


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Dessert: hydrograph + uncertainty

Software tool: BaRatinAGE

BaRatin Advanced Graphical Environment V1.3 freely available (windows platform) just send an email to baratin.dev@irstea.fr V2.0 currently under development:
- multi-platform
- propagation to hydrographs
- improved graphical outputs
- more import/export facilities
- expected release: end of 2015

Impact of discharge uncertainty on hydrologic modelling

Inclusion of uncertainty in gauged stages needs further appraisal
- Non-univocal rating curves: hysteresis, vegetation, rating shifts, etc.
- Model for remnant structural error: alternatives?
- Random vs. systematic errors and their impact on derived quantities (e.g. daily/monthly/annual discharge)
- Impact of discharge uncertainty on water balance analyses
- Impact of discharge uncertainty on hydrologic modelling

Data: gaugings and their uncertainty

Order of magnitude of standard discharge uncertainty for a few gauging methods:

Statistical model

Linking the rating curve with gaugings

Hysteresis modelling

BaRatin Recipe

The basics

Formalisation of the rating curve

The hydraulic control matrix

Segment control

Rectangular weir

Triangular weir

General formula

A versatile rating curve equation

\[ Q(h) = \sum_{r=1}^{N_{\text{magn}}(r)} \left( 1_{r-1,1} \cdot (h) \times \sum_{j=1}^{N_{\text{struct}}(r)} \text{M}(r,j) \times a_j \cdot (h - b_j) \right) \]

\[ \text{computed by continuity for } j > 1 \]

\[ Q(h) = a((h - b)^n) \]

channel control

section control

velocity-area (current-meter): 3.5-7.5%

tracer dilution: 1.5-5%

surface velocity (trader): 5-10%

surface velocity (video): 5-10%

ADCP

2.5-5%

Stage error ~ N(0, w_s)

Stage uncertainty ~ N(0, w_s)

Assumed to be known

Discharge error ~ N(0, w_d)

Uncertainty in observed stage

Uncertainty in observed discharge

Temporal variability (days/month) + structural error (vegetation, moving objects, etc.)

Observed discharge

\[ \text{ADCP} \]

\[ \text{tracer dilution} \]

\[ \text{surface velocity (trader)} \]

\[ \text{surface velocity (video)} \]

\[ \text{velocity-area (current-meter)} \]

\[ \text{ADCP} \]

\[ \text{tracer dilution} \]

\[ \text{surface velocity (trader)} \]

\[ \text{surface velocity (video)} \]

\[ \text{velocity-area (current-meter)} \]

Prior rating curve

MCMC sampling

Bayesian Inference

The blender: Bayes theorem

Combines hydraulic (prior) and information from gaugings with uncertainty (likelihood)

\[ \text{post}(\theta, \gamma_1, \gamma_2 | \tilde{Q}, \tilde{H}) \propto \text{prior}(\theta, \gamma_1, \gamma_2) \times \text{lkh}(\tilde{Q}|\theta, \gamma_1, \gamma_2, \tilde{H}) \]

Conclusion & perspectives

Main properties of BaRatin

A versatile rating curve equation elicited by a hydraulic analysis

Uses informative priors from hydraulic knowledge

Acknowledges uncertainty in gauging

Uncertainty in rating curve and all derived quantities (hydrographs)

Uncertainty decomposition (stage / parametric / structural)

Current and future research

Modelling uncertainty in gauged stages needs further appraisal

Non-univocal rating curves: hysteresis, vegetation, rating shifts, etc.

Model for remnant structural error: alternatives?

Random vs. systematic errors and their impact on derived quantities (e.g. daily/monthly/annual discharge)

Impact of discharge uncertainty on water balance analyses

Impact of discharge uncertainty on hydrologic modelling

Appetizer: parameters + uncertainty

Trace of 10,000 MCMC samples

Scatterplot matrix

Software for improved graphical outputs

More import/export facilities

Expected release: end of 2015

Ask for a demo!

The blender: Bayes theorem

Combines prior hydraulic knowledge + uncertain gaugings

Hysteresis modelling

Impact of rating curve uncertainty on interannual monthly discharge

Software tool: BaRatinAGE

BaRatin Advanced Graphical Environment

V1.3 currently under development:

- multi-platform

- propagation to hydrographs

- improved graphical outputs

- more import/export facilities

- expected release: end of 2015


 incidental uncertainty in spatial uncertain limnigraph

Current & Future research

Conclusion & perspectives

As seen above...

Ask for a demo!