Understanding and Reducing Uncertainty in Small Watershed Sampling

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Objectives

- **Present background information on uncertainty in flow and water quality data**
- **Briefly describe the <u>D</u>ata <u>U</u>ncertainty <u>E</u>stimation <u>T</u>ool for <u>H</u>ydrology and <u>W</u>ater <u>Q</u>uality (DUET- H/WQ)**
- **Discuss DUET results and personal experience related to uncertainty in small watershed sampling**

"Should it not be required that every… (field and modeling study)… attempt to evaluate the uncertainty in the results?" Beven (2006)

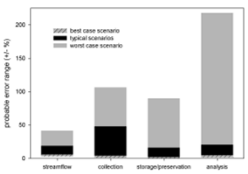
Uncertainty sources

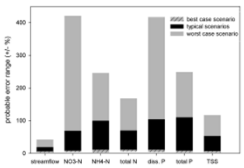
- **<u>discharge measurement</u> - individual Q's, stage-discharge relation, channel conditions**
- **<u>sample collection</u> - EWI vs. grab vs. automated, sampling frequency, location in x-section, discrete vs. composite**
- **<u>sample preservation/storage</u> - pre-processing, preservation, storage duration and conditions**
- **<u>laboratory analysis</u> - reagents, standards, method, instrument, best fit curve**
- **<u>data processing and management</u> - mistakes, missing data**

"The use of uncertainty estimation… (should be)… routine in hydrological and hydraulic science."
Pappenberger, Beven (2006)

DUET- H/WQ

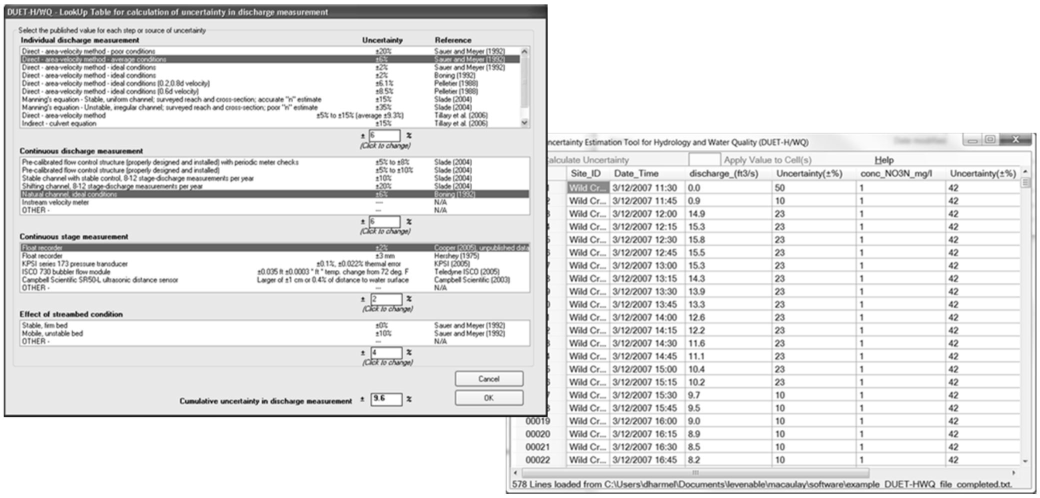
- **Developed uncertainty estimation framework (2006)**
  - **focused on Q, TSS, N, and P data for small watersheds**
  - **listed published uncertainty estimates for four procedural categories**
    - **Q, sample collection, preservation/storage, lab analysis**
  - **estimated uncertainty for arbitrary "data quality" scenarios (best, typical, worst) with RMSE method**





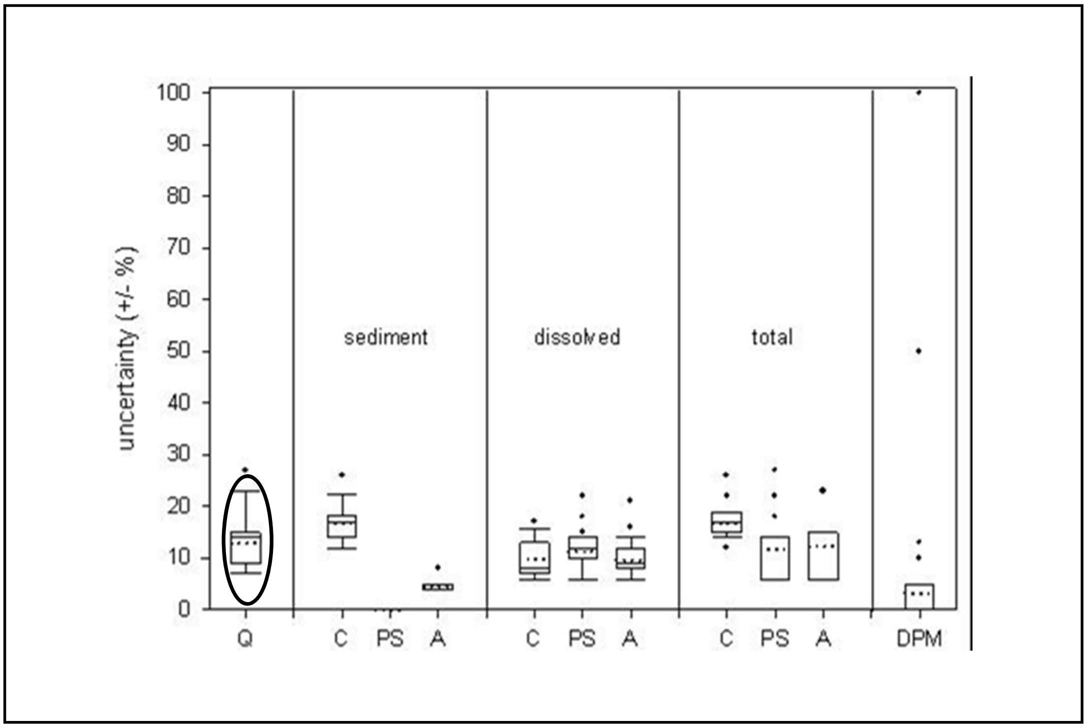
DUET- H/WQ

- **User-friendly enhancement of framework (2009).**
  - **"data processing and management" procedural category**



DUET- H/WQ Application

- **Applied to real-world data from five monitoring projects**
  - **various hydrologic settings, land uses, watershed sizes, and field and laboratory techniques**
  - **131 storm events**
- **Estimated uncertainty:**
  - **contributed by each procedural category**
  - **in individual Q, TSS, NO_3-N, PO_4-P, total N, total P values**



uncertainty (+/- %)
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90
80
70
60
50
40
30
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10
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sediment
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PS
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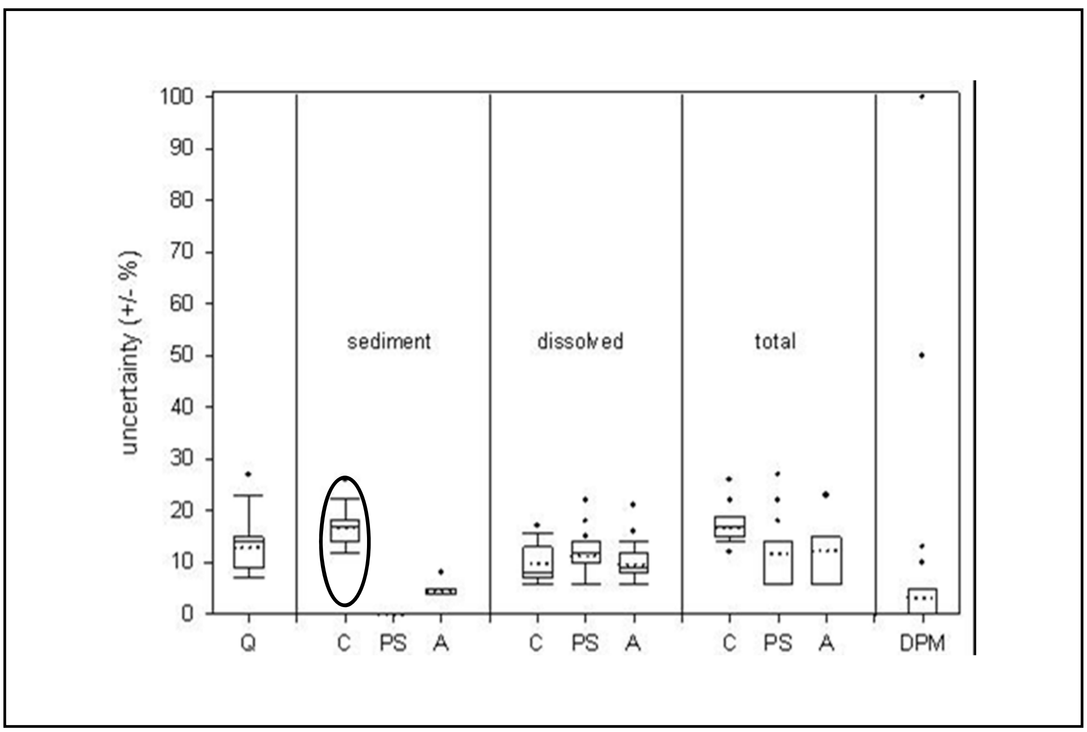

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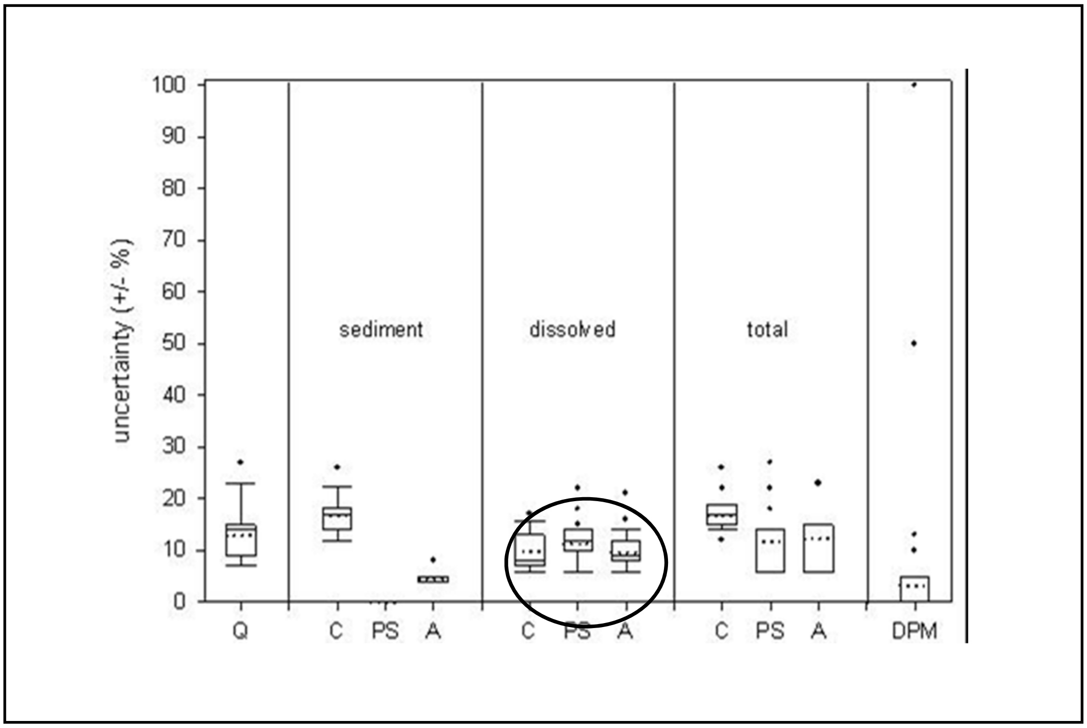
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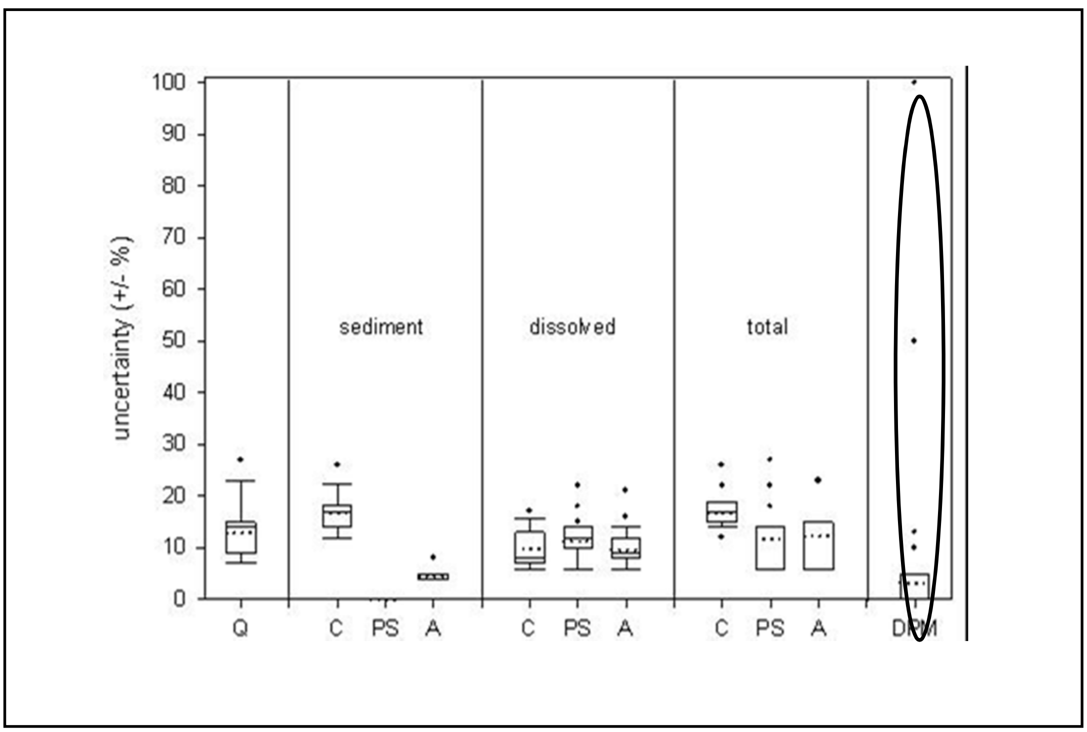
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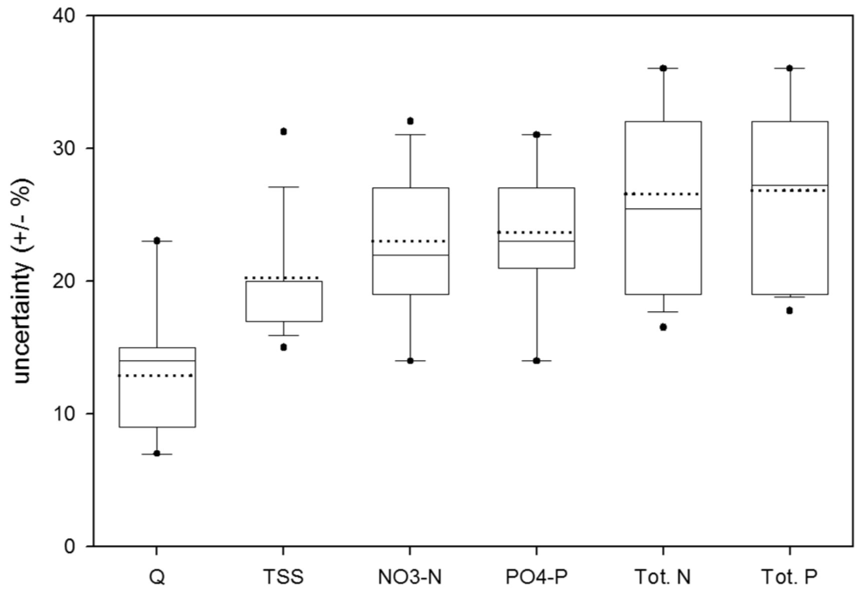


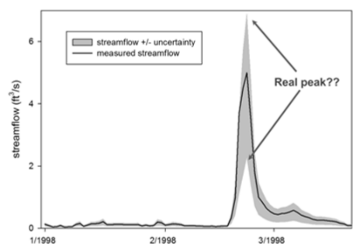
Conclusions

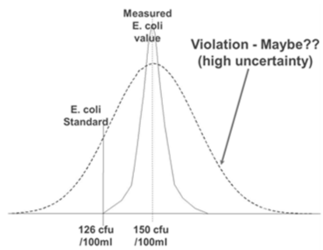
- **Important for water resource professionals to understand that…**
  - **all measured flow and water quality data are uncertain**
  - **uncertainty increases dramatically without dedicated QA/QC; however, QA/QC should:**
    - **realistically address each procedural category**
    - **include uncertainty estimation and reporting to increase "value" of data.**




Conclusions

- **Historically, uncertainty in flow and water quality data has rarely been estimated and included in:**
  - **Research and monitoring**
  - **Data reporting**
  - **Regulation and policy**
  - **Model evaluation**





Conclusions

- **Uncertainty is almost always ignored in spite of:**
  - **pleas for uncertainty analysis**
  - **fact that all measurements are inherently uncertain.**

However, the environmental and socio-economic ramifications of decisions based on these data are too great for the inherent uncertainty to continue to be ignored!!!

Any Questions??

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Includes uncertainty-related pubs (6) and sampling methods-related pubs (10)