Dipartimento delle Culture Europee e del Mediterraneo
ARCHITETTURA, AMBIENTE PATRIMONI CULTURALI

UNIVERSITA' DEGLI STUDI DELLA BASILICATA

DERIVATION OF FLOW RATING-CURVES IN DATA-SCARCE ENVIRONMENTS

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WMO HydroHub

WMO

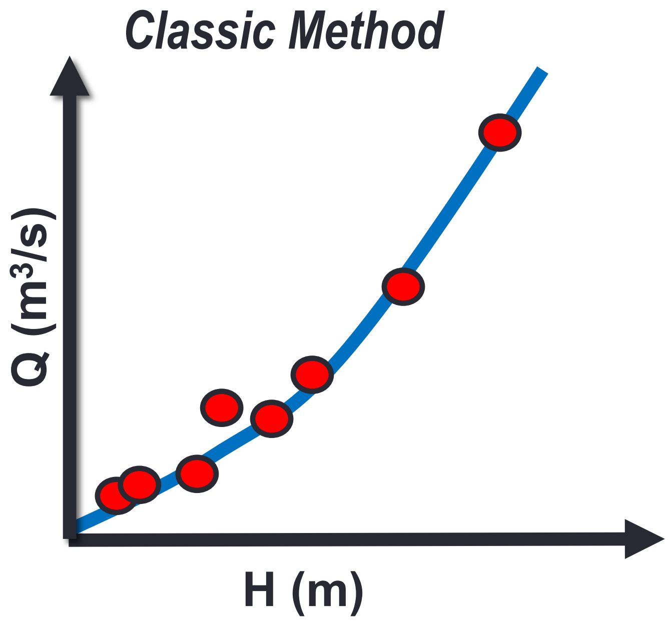
MOXXI Measurements & Observations in the 21st Century
Working Group - International Association of Hydrological Sciences

IAHS-MOXXI & CandHy, WMO HydroHub, CUAHSI Joint Conference, New York 11-12 March 2019

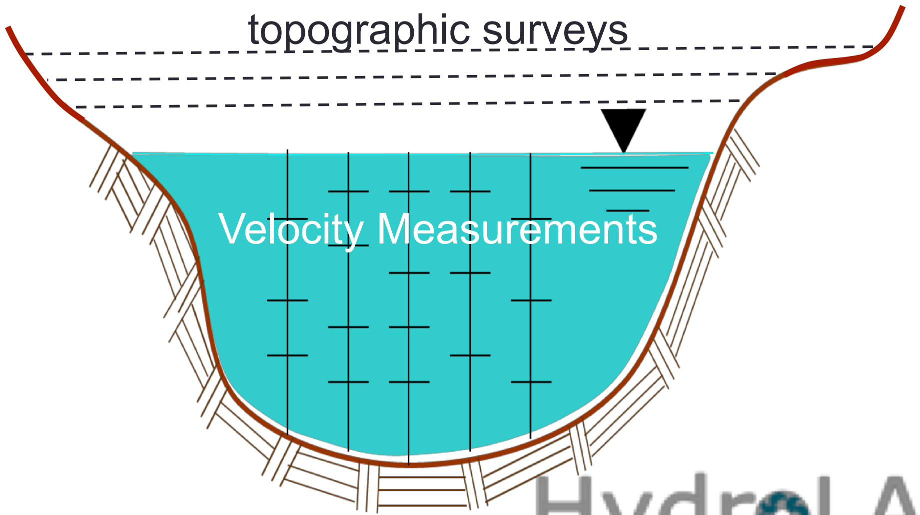
The Use of Discharge DATA: FRCs

FRCs are generally obtained using curve fitting methods with river stage (*H*) and discharge (*Q*) observations.

The most common equation is:

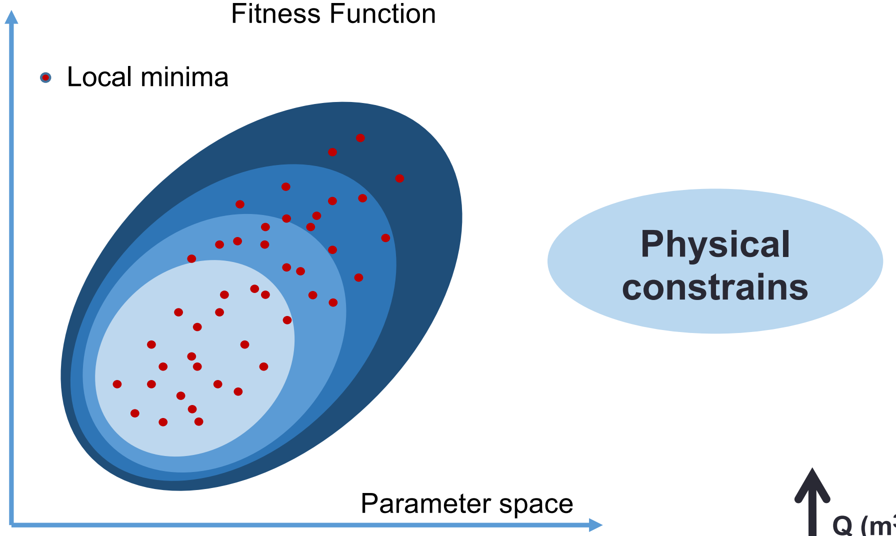


$$Q = \alpha(H - h_0)^{\beta}$$

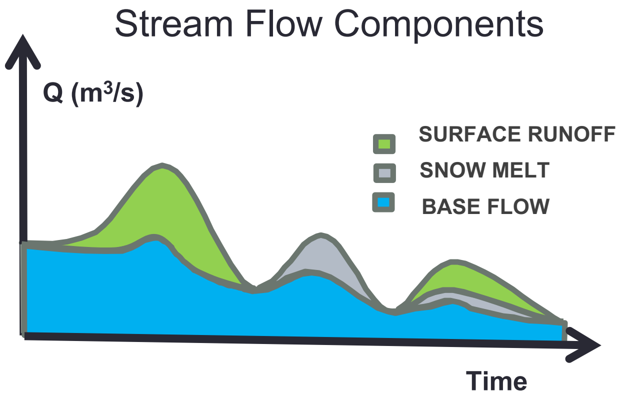


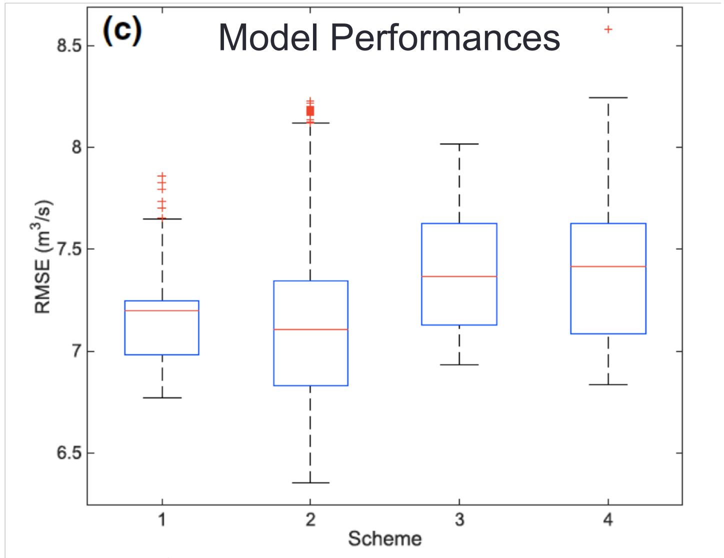
The Key Idea

Decomposing the parameter calibration according to the existing processes leads to more reliable model calibrations.



Impact of physical information on the parameter space domain





Including physical info

Manfreda et al. (HP - 2018)

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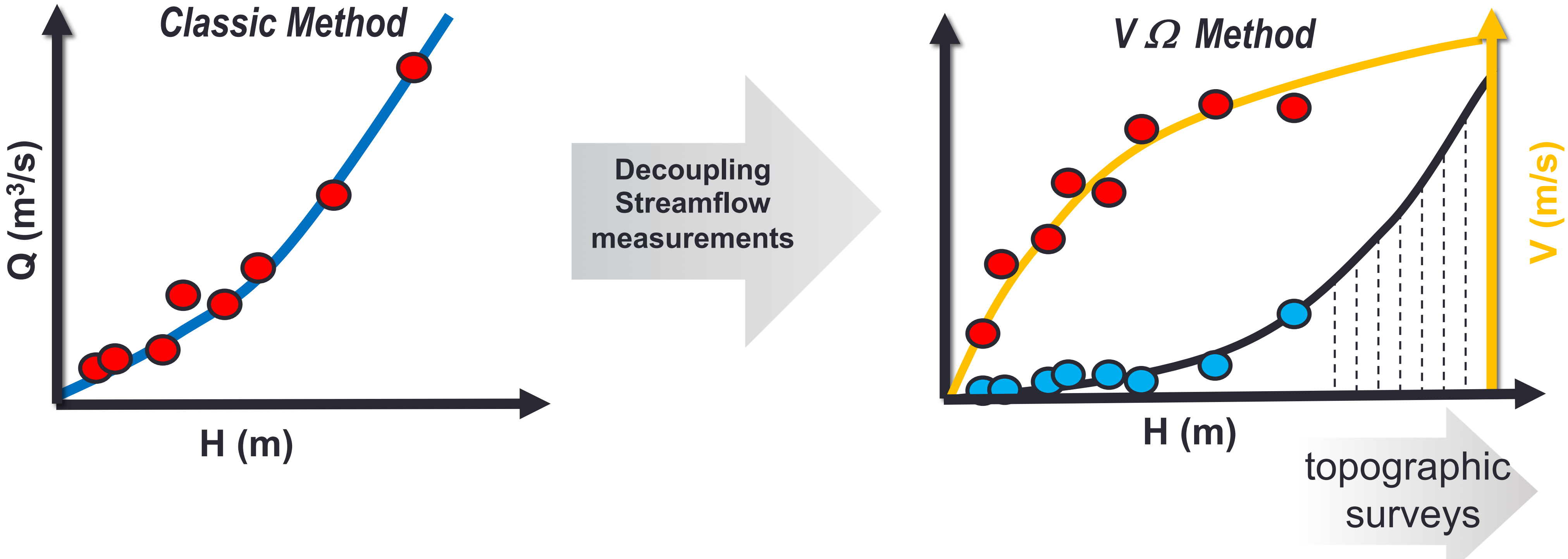
The V Ω Method

The flow rating curve can be obtained as the product of two functions:

$Q = V(H-h_0)\ \Omega\ (H-h_0)$



Manfreda (JH - 2018)

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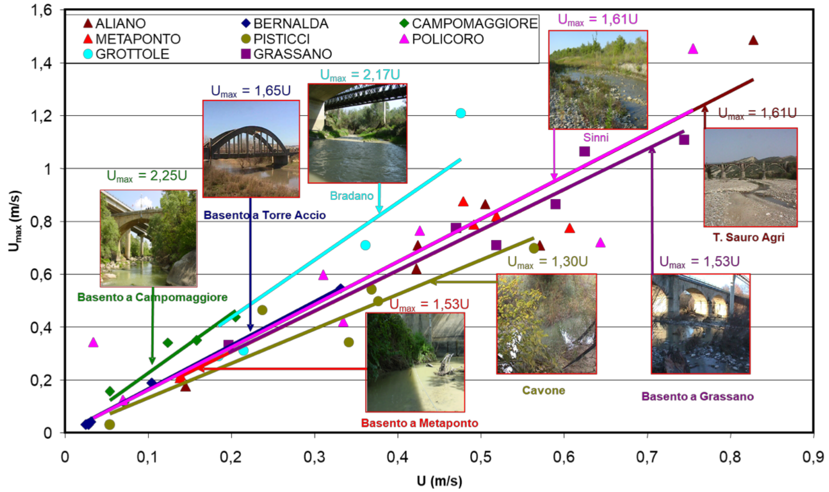
No-contact equipments

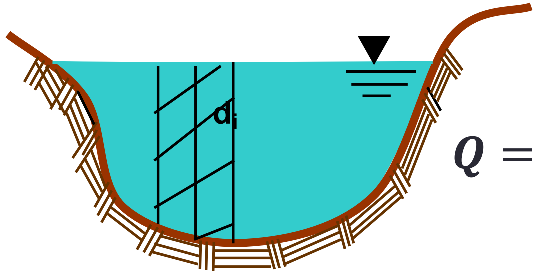
$$\Phi(M) = \frac{U}{U_{max}} = \frac{e^M}{(e^M - 1)} - \frac{1}{M}$$

Optic/thermal sensors	Radar sensors



Advantages

1) High spatial and temporal resolution
2) Relatively low costs
3) Applicable inaccessible sections



$$Q = V(h - h_0)\Omega(h - h_0)$$

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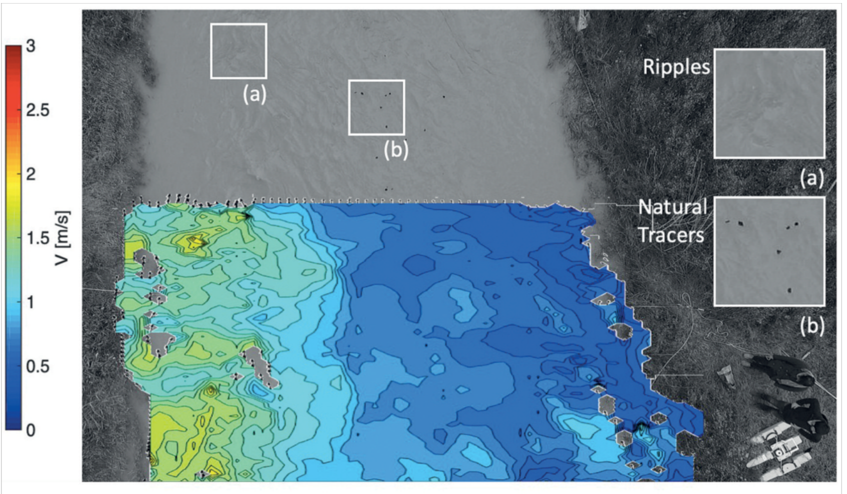
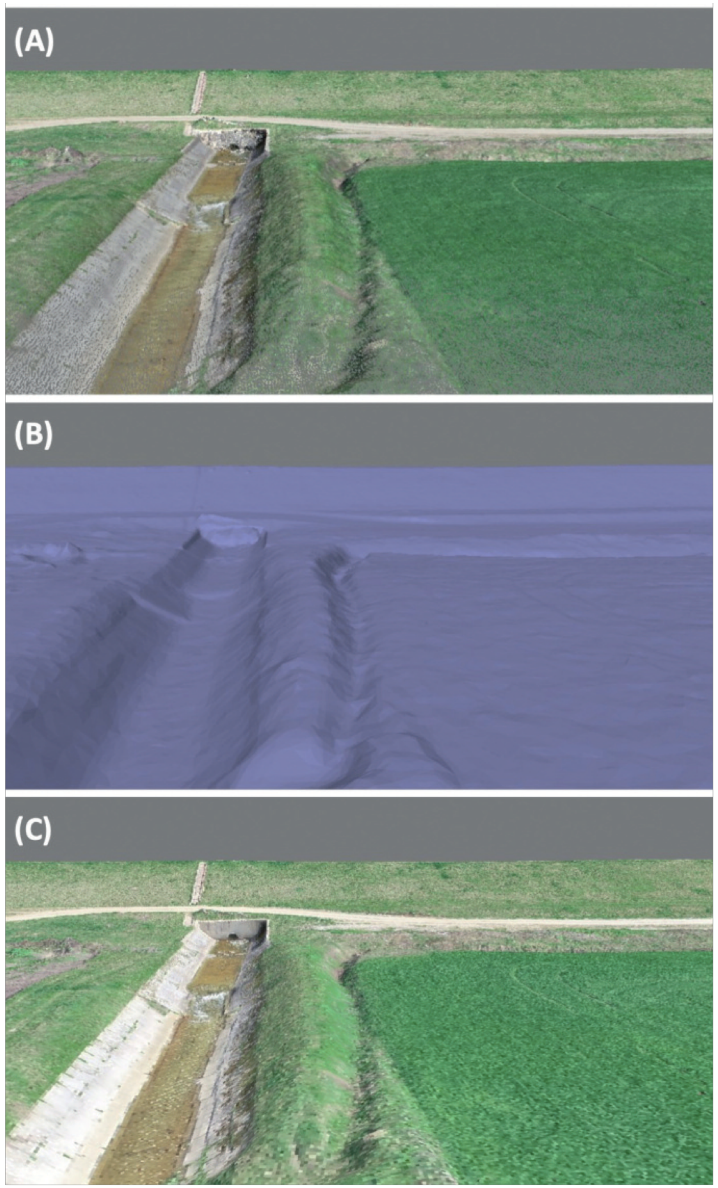
UAS Surveys

UAS can help to provide good quality data regarding both morphology and flow velocity.

- SfM allow to improve accuracy of topographic surveys with low cost equipment (Manfreda el al., DRONES - 2019);
- Image velocimetry generates stream flow velocity measurements of high quality;

2-D flow velocity field derived using an optical camera mounted on a quadcopter hovering the Bradano river (southern Italy).





McCabe and Manfreda (2019)

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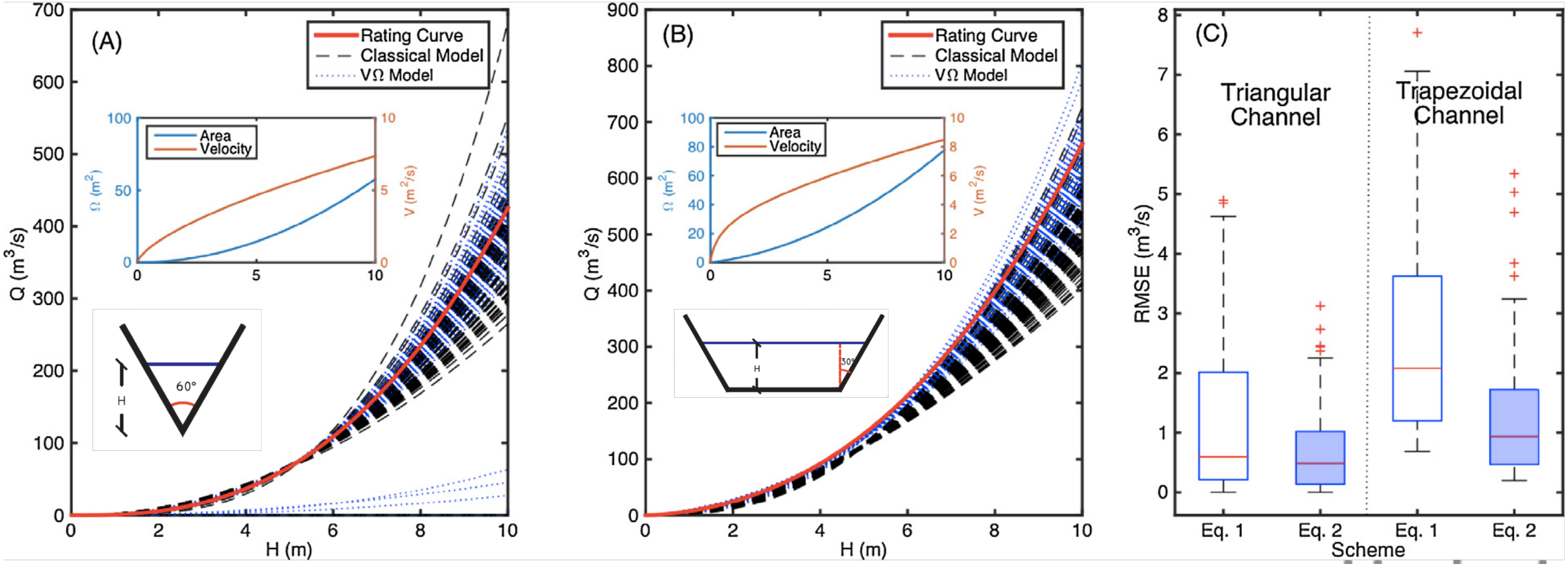
Numerical experiment

FRCs derived applying the two explored methodologies in a triangular cross-section and trapezoidal cross-section.



Manfreda (JH - 2018)

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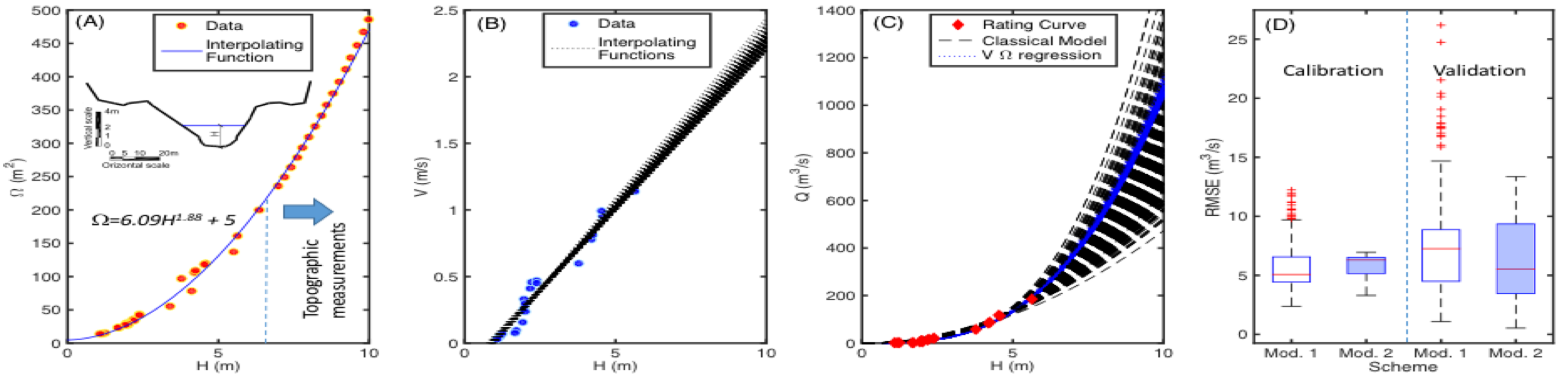
Comparison of the two methods

- FRCs derived with different permutation of the same dataset;
- Comparison is made on the calibration dataset and on the data excluded from the calibration.



Manfreda (JH - 2018)

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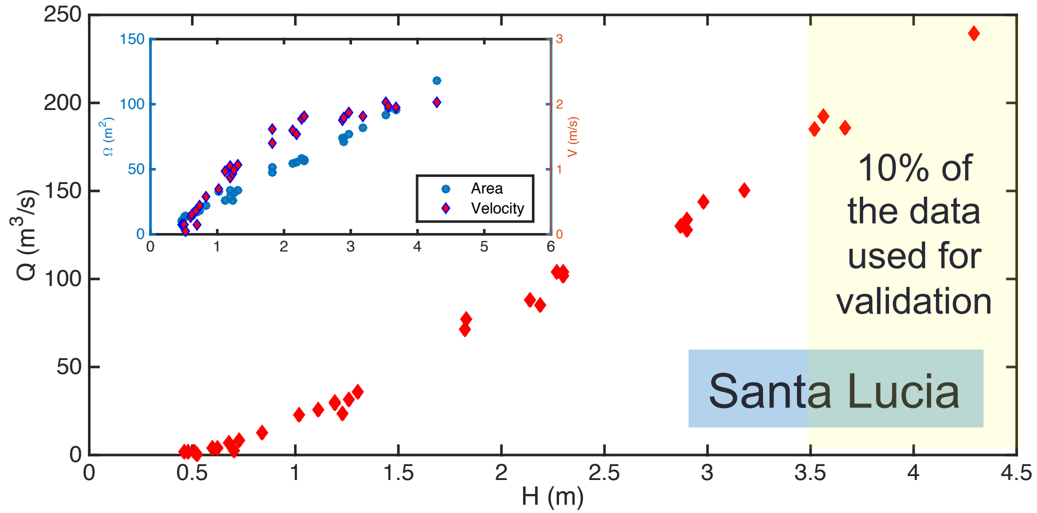
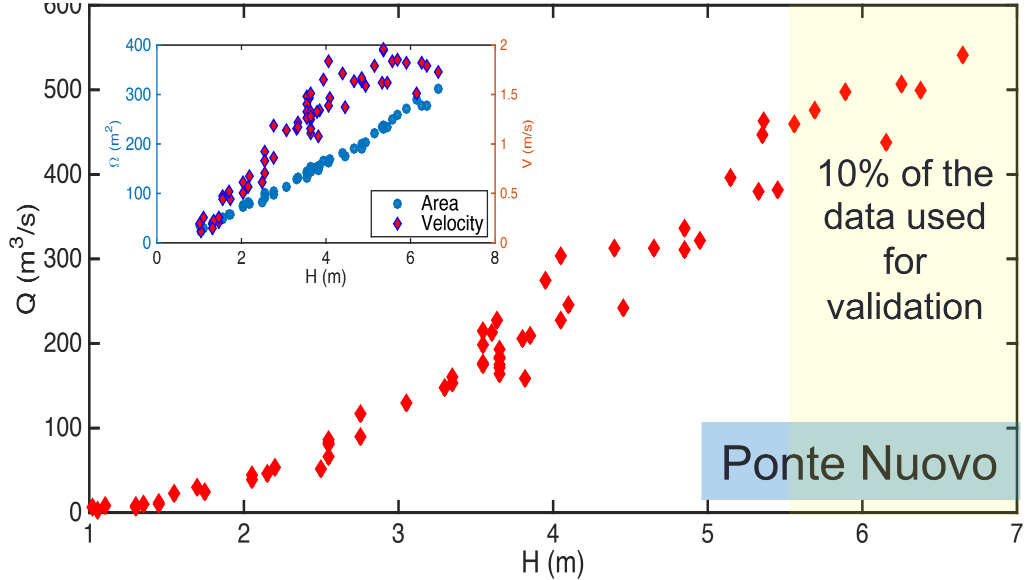
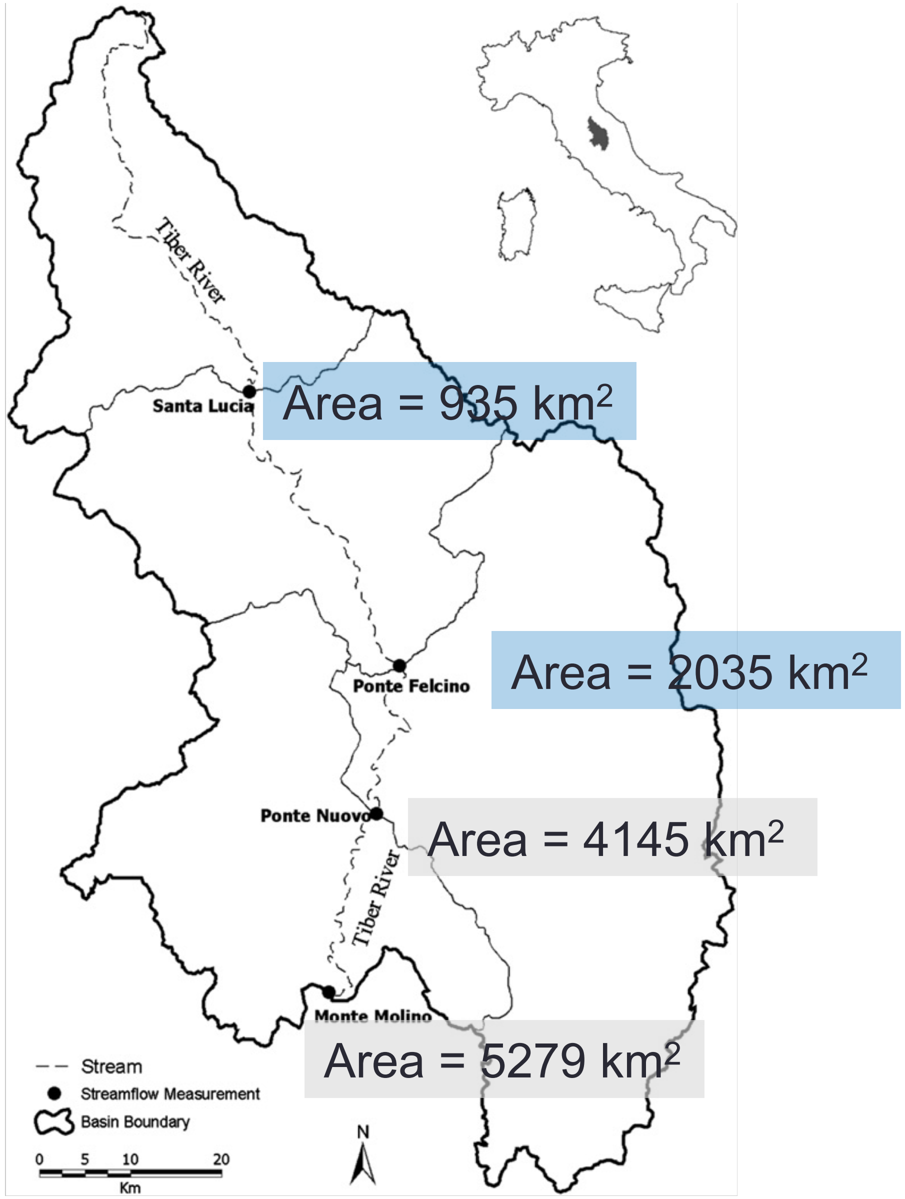
Stream flow measurements on theTiber River





In most of the cases etreme floods are the most difficult data to collect. Therefore, analysis were carried out exploiting only the values with an exceedance probability lower than 90%.

Data gently provided by T. Moramarco and S. Barbetta



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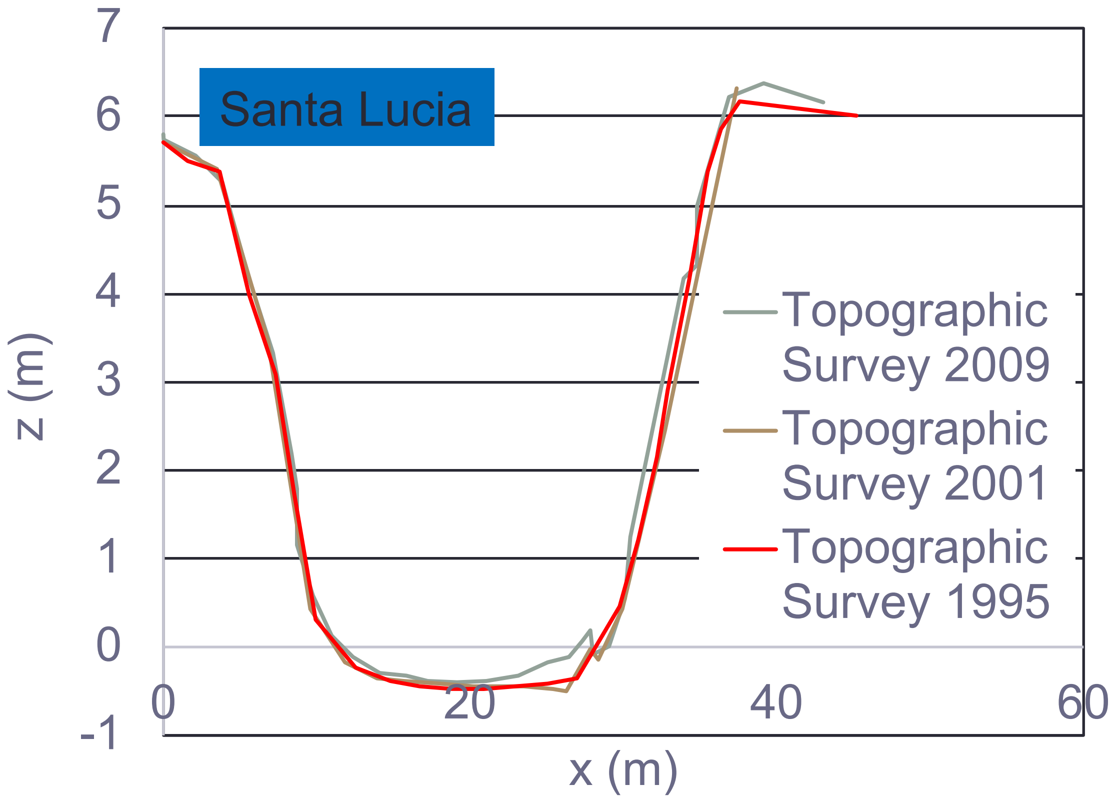
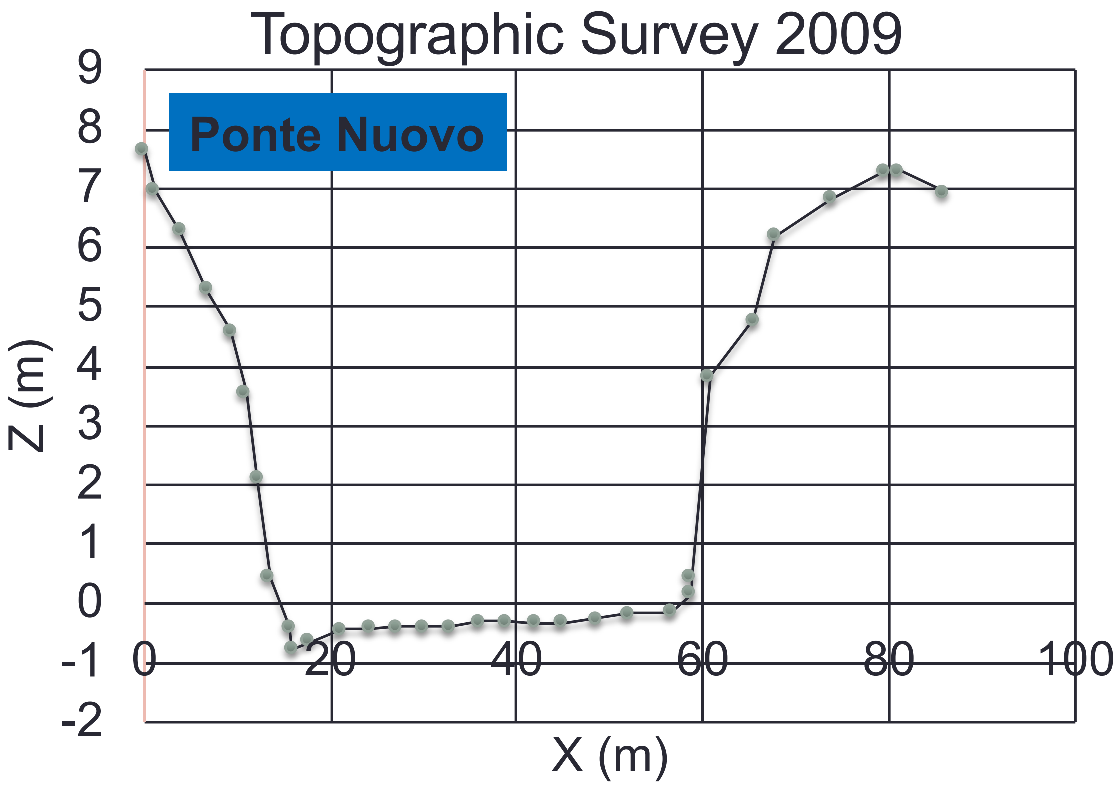
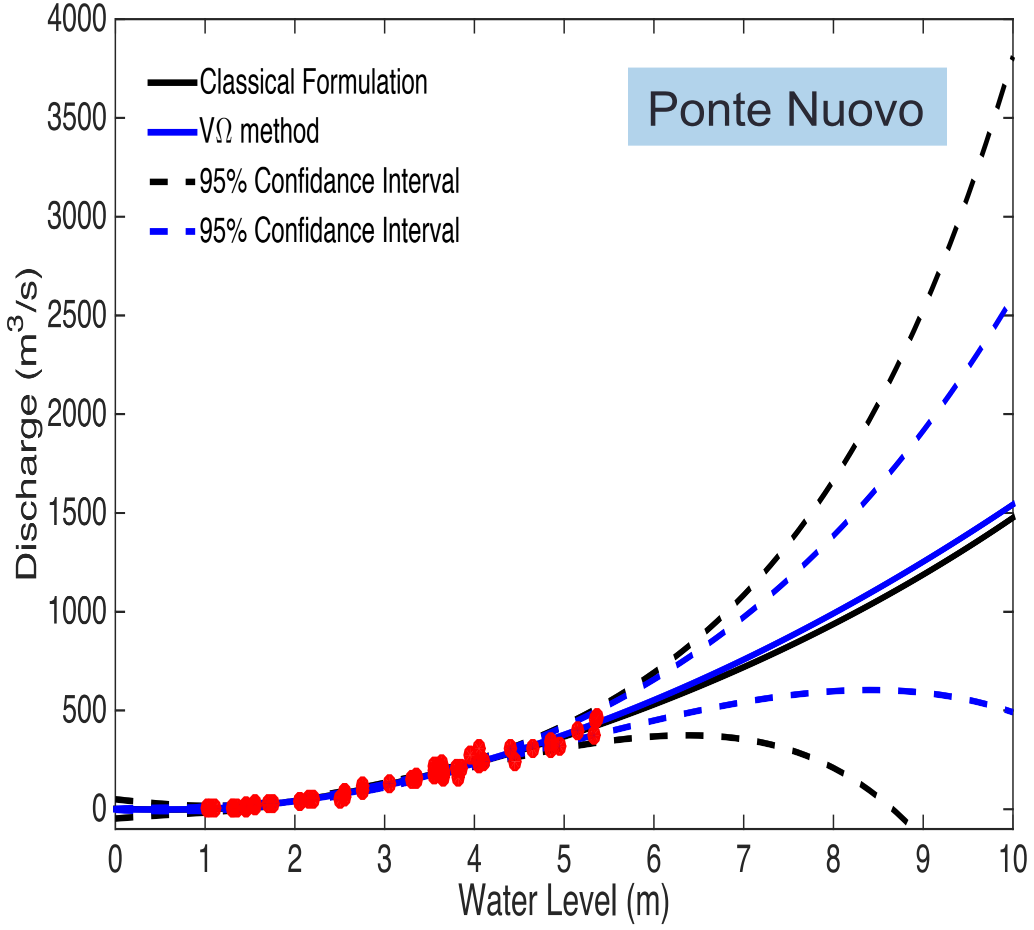
Topographic Surveys

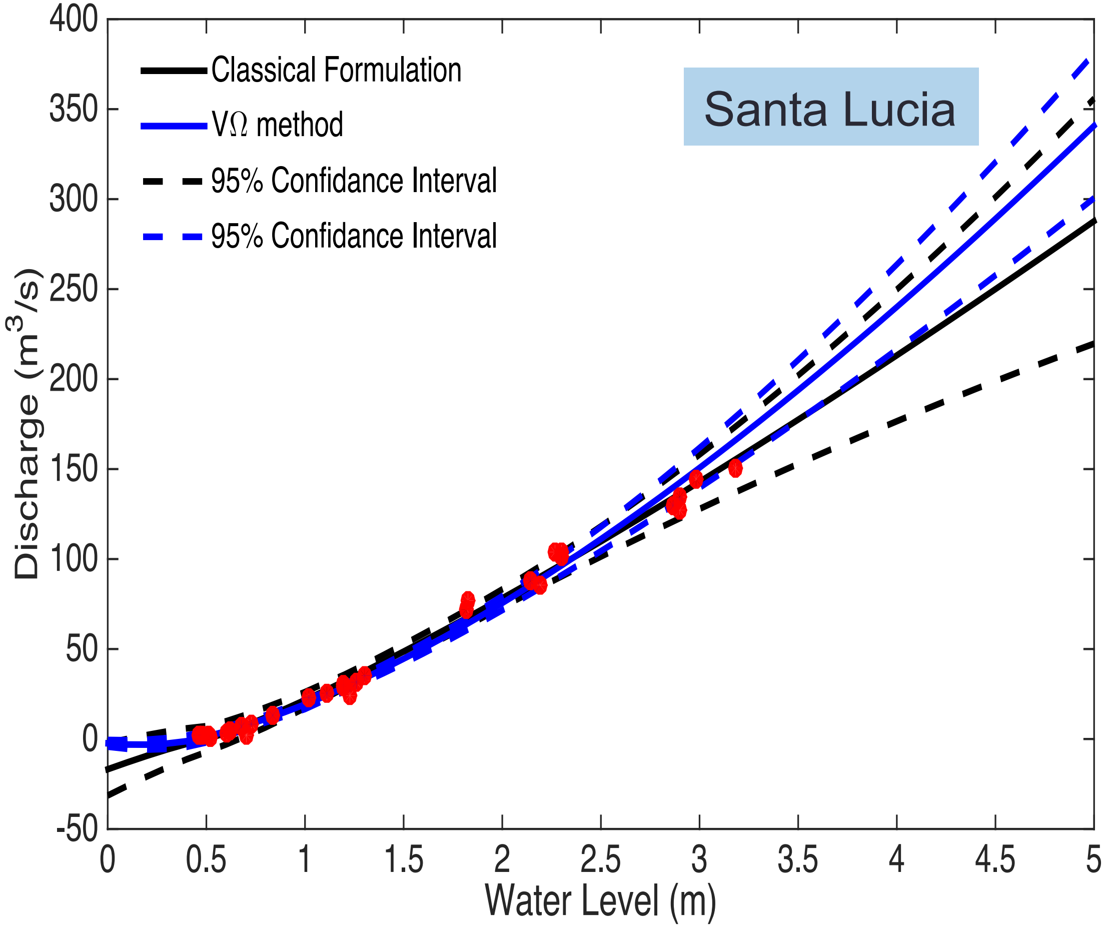
Cross sections show a relative stability troughout time.





Comparison of the two methods for the derivation of the FRCs





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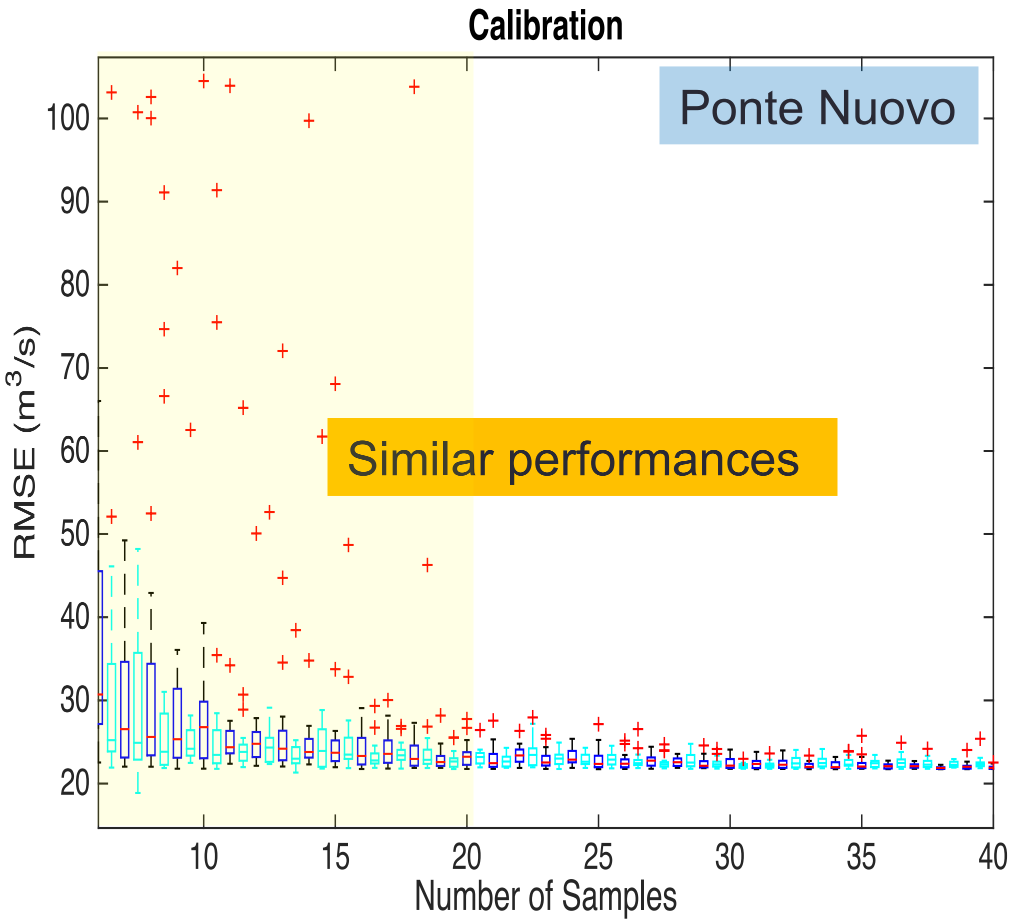
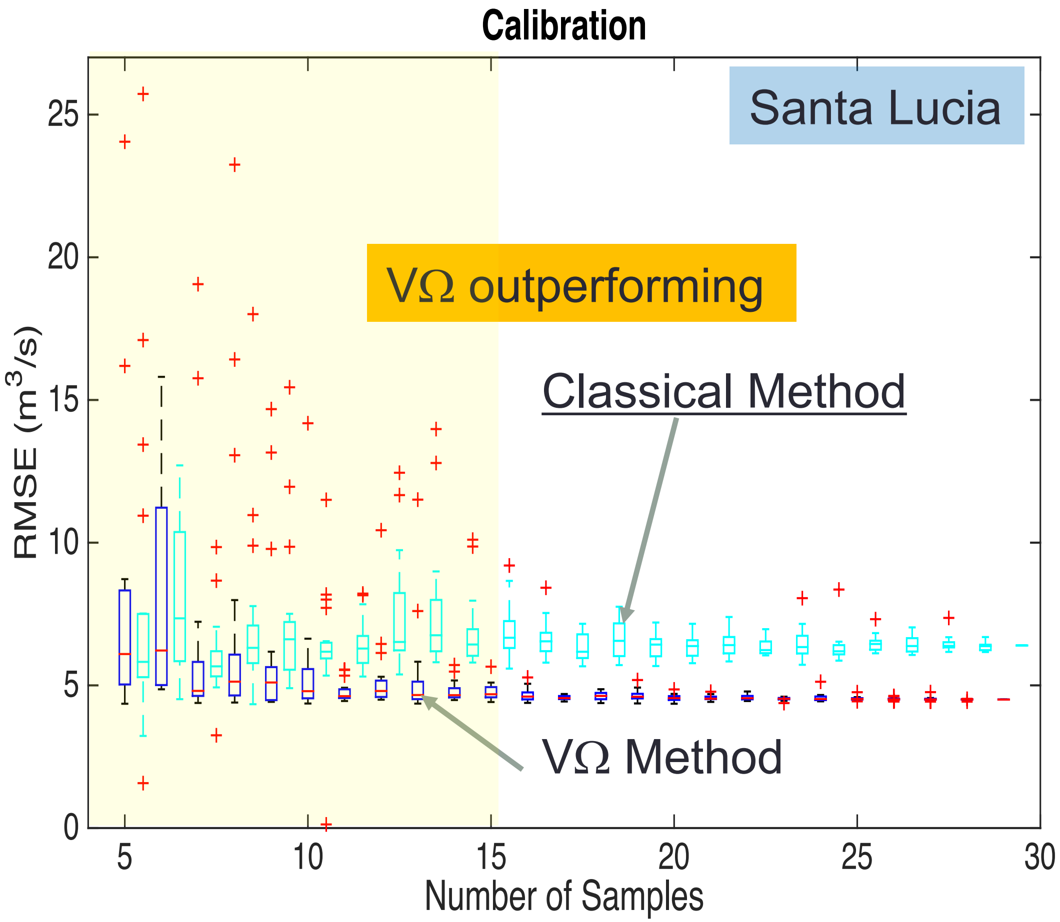
RMSE vs Number of Samples





Performances of both methods seems relatively stable when more than 20/15 samples are available.

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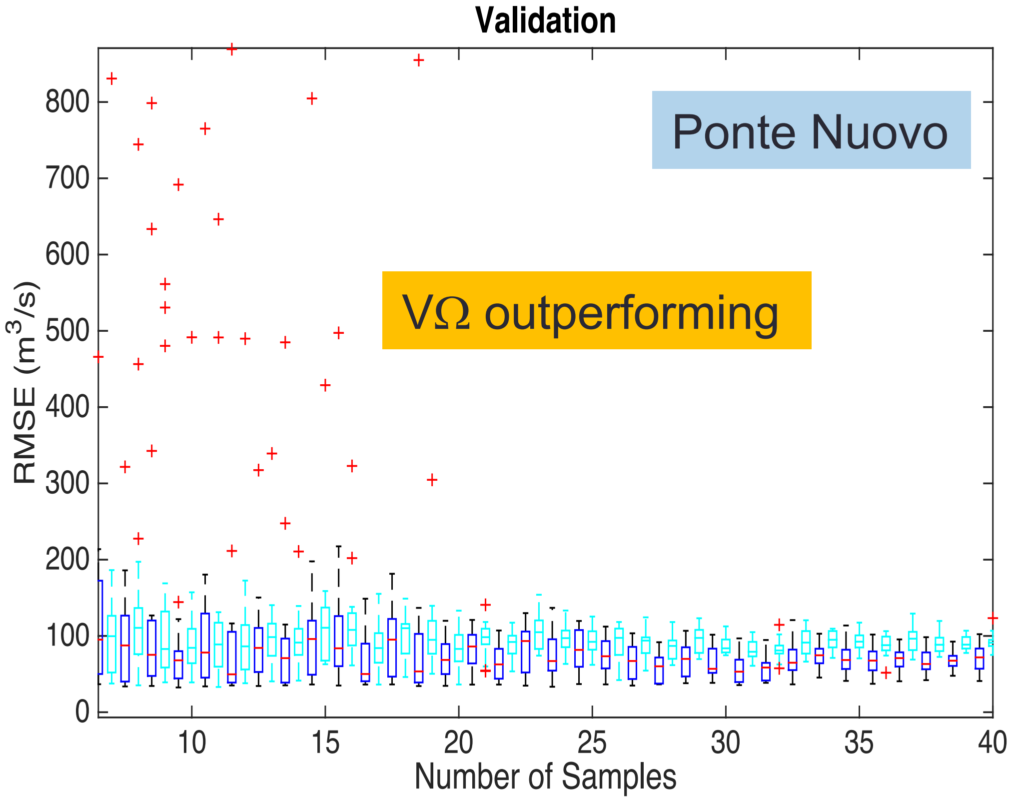
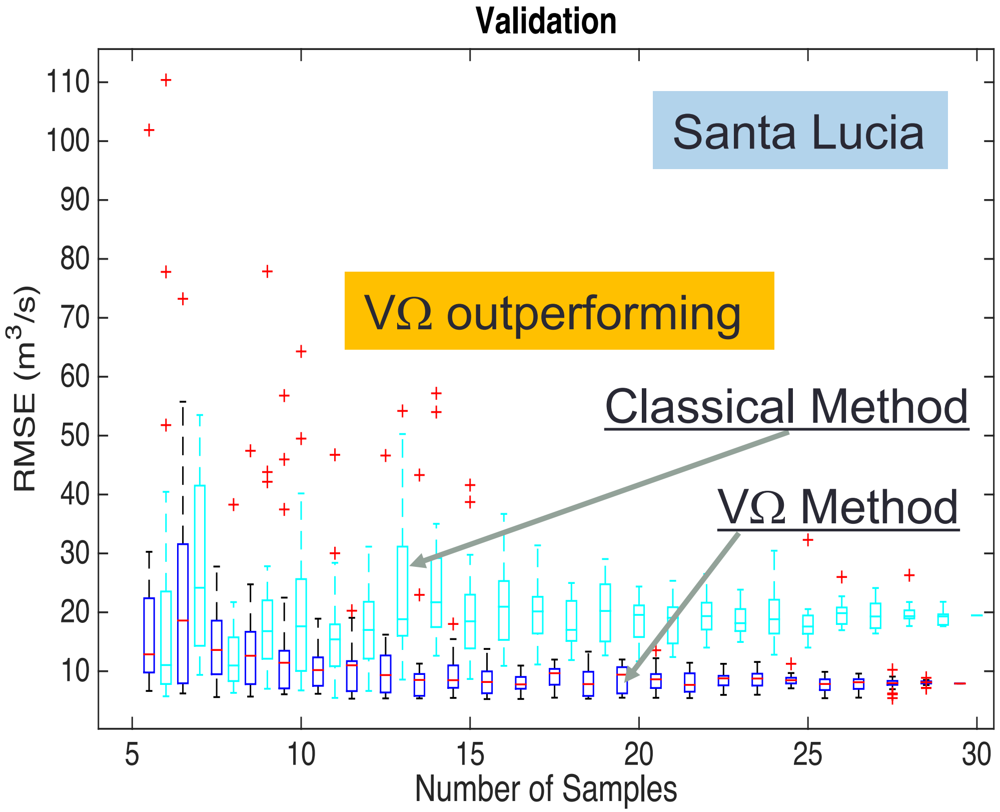
RMSE in validation vs Number of Samples

Discharge measurements exceeding the 90% of exceedance probability have been excluded from the calibration and used only for the validation.





Performances of the VΩ method are always better than the one of the classical method.

Conclusion

- The proposed methodology represents a suitable alternative for the derivation of FRCs, allowing exploitation of the available information about the characteristics of river cross-section geometry.
- $V\Omega$ method may not represent the optimal regression function during the calibration, but it improves the performances of FRCs during the validation.
- The $V\Omega$ method reduces uncertainty associated to FRCs especially for the higher discharge values.

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Related Publications

- McCabe and Manfreda, ***Emerging earth observing platforms offer new insights into hydrological processes***, Hydrolink, 2019.
- Manfreda, Dvorak, Mullerova, Herban, Vuono, Arranz Justel, Perks, ***Assessing the Accuracy of Digital Surface Models Derived from Optical Imagery Acquired with Unmanned Aerial Systems***, Drones, 2019.
- Manfreda, ***On the derivation of flow rating-curves in data-scarce environments***, Journal of Hydrology, 2018.
- Dal Sasso, Pizarro, Samela, Mita, and Manfreda, ***Exploring the optimal experimental setup for surface flow velocity measurements using PTV***, Environmental Monitoring and Assessment, 2018.
- Manfreda, McCabe, Miller, Lucas, Pajuelo Madrigal, Mallinis, Ben-Dor, Helman, Estes, Ciraolo, Müllerová, Tauro, De Lima, De Lima, Frances, Caylor, Kohv, Maltese, ***On the Use of Unmanned Aerial Systems for Environmental Monitoring***, Remote Sensing, 2018.

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Thanks…