The Local Polynomial Method: A novel processing tool to quantify surface-subsurface exchange flows using temperature times series and their frequency response

C. Anibas[1], U. Schneidewind[2,3], G. Vandersteen[4], M. Huysmans[1], I. Joris[2], O. Batelaan[5]

[1]Vrije Universiteit Brussel, Department of Hydrology and Hydraulic Engineering, Brussels, Belgium
[2]VITO – Flemish Institute for Technological Research, Environmental Modeling Unit, Mol, Belgium
[3]Ghent University, Department of Soil Management, Gent, Belgium
[4]Vrije Universiteit Brussel, Department of Fundamental Electricity and Instrumentation, Brussels, Belgium
[5]Flinders University, School of the Environment, Adelaide, Australia

The quantification of surface-subsurface exchange flows is important for the assessment of water resources or the investigation of pathways and fate of contaminants and nutrients. Field monitoring in time and space is indispensible for process understanding of hydrological interactions and their variability.

Not only is the complexity of the examined processes- asking for novel data processing and characterization tools, it is also the vastness of acquired information which urges for new solutions. New techniques therefore should be easily applicable, allow fast computation and a flexible output including uncertainties and should use a maximum amount of information for the analysis.

Sensing of temperature profiles in riverbeds in conjunction with numerical and analytical heat transport simulation tools is becoming a standard in the characterization of vertical exchange fluxes. For this type of investigations we propose the application of the Local Polynomial Method (LPM) in conjunction with a Maximum Likelihood Estimator (MLE).

The LPM determines the frequency response function between measured temperatures time series at the water-sediment interface and within the riverbed. Then, a non-linear optimization technique is applied (i.e. a MLE), which allows the determination of the model quality and parameter uncertainty. Finally, the optimized model parameters are transformed from the frequency domain to the time domain where they hold information regarding the vertical exchange flux and thermal soil parameters.

The presented methodology is flexible and fast and is able to create time series of exchange fluxes and their uncertainties. Advantage of LPM In comparison to other methods is that it uses all measured

frequency information for data processing. For the validation of the LPM we compare its results with measurements from conventional techniques like seepage meters, hydraulic head gradients as well as other numerical and analytical heat transport simulation tools.

This abstract is targeting on the following session of the IAHS/IAPSO/IASPEI Joint Assembly in Gothenburg, Sweden, July 2013:

Hw03
Characterizing water quantity and quality: new approaches and future directions

Organiser: IAHS (ICWQ, ICGW, ICSW)
Lead Convener: Kate Heal (UK)
Co-Conveners: Jim Butler (USA), Wouter Buytaert (UK), Chia-Shyun Chen (Taiwan), Peter Dietrich (Gernany), Catherine Gonzalez (France)

Description: Data for water quantity and quality investigations are vital for all areas of hydrology, from monitoring and assessing water resources and understanding their response to environmental change, to better characterizing the complexity of surface and subsurface hydrologic systems, to model calibration and testing, and, ultimately, to improving process understanding. There is currently a high demand for evaluation of water quality monitoring strategies to meet the requirements of legislation, for more effective systems to remediate water contamination, and for better strategies to assess the future prospects for highly stressed hydrologic systems. New characterization approaches are clearly needed if we are to meet these ever increasing societal demands and expectations. Over the last decade, the development and deployment is increasing of novel low-cost and/or widely distributed and continuously monitoring sensors for water quantity and quality, for example smart sensor networks, "labs-on-a-chip", and distributed temperatures sensing technology. The widespread adoption and use of such monitoring and investigative techniques requires validation of the new techniques compared to existing methods, e.g., comparison of different strategies for water sampling, comparison of biological and chemical monitoring techniques for water quality, and comparison of results from investigations using new and conventional approaches. Advances in data processing and assimilation may also be required to manage, process and assimilate the large volumes of data generated by widespread deployment of continuously monitoring sensors and application of the new generation of high-resolution characterization approaches (e.g., direct-push techniques for assessment of shallow groundwater systems). The aim of this workshop is to share good practice and experience of novel characterization techniques for water quantity and quality investigations. Papers are invited on the following topics:

- Applications of novel characterization techniques for water quantity or quality: examples of the application of novel monitoring and investigative techniques, such as in water resource management, identifying sources of pollution, design of remediation systems, targeting pollution control strategies and reducing pollutant loads; validation of novel characterization techniques compared to existing approaches.
- Data processing and assimilation to support novel characterization techniques for water quantity or quality: how can the large quantities of data generated by these techniques be managed, processed and assimilated into databases and models?
- Novel sensors or tools for water quantity or quality investigations: descriptions of novel sensors and tools and their advantages and limitations.

- What does the future hold for the characterization of hydrologic systems? discussion of promising sensors, tools, and approaches that are under development.

In addition to traditional sessions with oral presentations, we plan to organise a more interactive "show and tell" session during this workshop at which presenters would give a more hands-on demonstration of novel characterization techniques.

Review: All submitted abstracts will be reviewed by the Convenors

Invited speakers: To be posted