ERT and DTS time-lapse for the monitoring of hyporheic zone

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The hyporheic zone (HZ) is the area located beneath and adjacent to rivers and streams, where the interactions between surface water and groundwater take place (Reidy and Clinton, 2004; Westhoff *et al.*, 2011). This complex physical domain allows the transport of several substances (e.g., water, nutrients, and pollution, Boulton *et al.*, 1998) from a stream to the unconfined aquifer below, and vice versa, thus playing a fundamental role in the river ecosystem.
The importance of the hyporheic zone makes its characterization a goal shared by several disciplines, which range from applied geophysics to biogeochemistry, from hydraulics to ecology (Bridge J.W., 2005). Regardless of the field of study, the main aim is always to completely describe the structures and the processes that distinguish this zone. Furthermore, flow and transport models are nowadays key instruments to efficiently characterize the HZ, given their ability of simulating surface water-groundwater exchange phenomena at a local scale (Constantz J., 1998; Bianchin *et al.*, 2010). In order to achieve these common purposes, almost all these disciplines offer many invasive techniques that permit punctual *in situ* surveys and/or sample analysis (Bridge J.W., 2005). The frontier field of HZ characterization stays in applied non-invasive methodologies as Electrical Resistivity Tomography – ERT – and Distributed Temperature Sensing – DTS. ERT is commonly applied in cross-well configuration or with a superficial electrodes deployment (Acworth R.I. and Dasey G.R., 2003; Crook N. *et. al*, 2008). DTS usage in hydro-geophysics has been developing since the last decade, revealing a wide applicability to the typical issues of this field of study. DTS for hydro-geophysics studies is based on Raman scattering and employs heat as tracer and uses a fiber-optic cable to acquire temperature values (Boulton A.J. *et. al* 1998; Anderson M.P., 2005; Selker J.S. *et al.*, 2006; Lane J.W., 2008). We applied both techniques for an alpine river case studies located in Val di Sole, TN, Italy. The collected measurements allow high-resolution characterization of the hyporheic zone, overcoming the critical problem of invasive measurements under riverbeds.
In this work, we present the preliminary results regarding the characterization of the hyporheic zone of the alpine river in Val di Sole (Vermigliana creek), obtained combining ERT (e.g. Fig.1) and DTS time-lapse measurements. The data collection benefits from an innovative instrumentation deployment, which consists of both an ERT multicore cable and a DTS fiber-optic located in two separated boreholes drilled 5m under the watercourse and perpendicular to it. In particular, we present the first year monitoring results and a short time-lapse monitoring experiment.

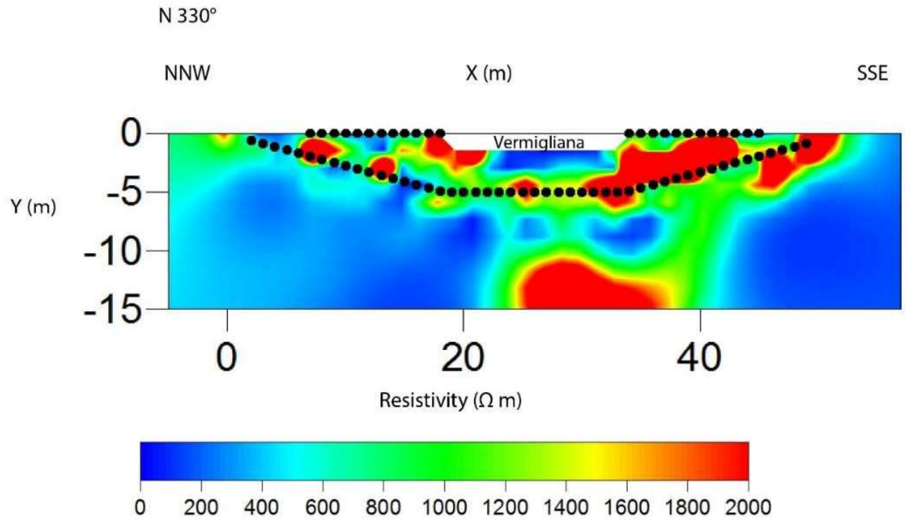

Fig. 1 Example of resistivity cross-section resulting from the ERT survey conducted in Vermiglio. The cross-section is facing downstream. A low resistivity domain is located under the Vermigliana creek, while the riparian zones show, on average, higher resistivity values. The black dots represent the electrodes position both on the levee surface (24 stainless steel electrodes) and inside the perforation drilled under the Vermigliana creek (48 brass electrodes).

These acquisition schemes led to high quality data capable to highlight some of the dynamics taking place in the HZ, which, however, still need to be coupled with a flow and transport model, in order to completely describe the domain of interest.
The site and the results here described are part of the GLOBAQUA Project (Managing the effects of multiple stressors on aquatic ecosystems under water scarcity).

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