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Analysis of the active length dynamics on intermittent streams using water presence sensors

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Headwater streams are important for their hydrological function and for their significant contribution to the riverine ecosystems. Nevertheless their study has always been challenging because of the ephemeral and intermittent nature of those streams. Maps representing the active part of the river network are usually drawn after field surveys performed under different hydrologic conditions, which enable an objective evaluation of the temporal changes in the length of the active network. This method is useful to describe seasonal variations of the stream length, but has significant limitations when it comes to the description of event-based changes of the flowing network, provided that visual inspections of entire catchments are highly time-consuming. In this work, electrical resistance (ER) sensors were used to analyze event-based active network dynamics along some of the tributaries of an Alpine creek in northern Italy. Current intensity values were collected every 5 minutes by the sensors and a threshold electrical signal was identified to distinguish between wet and dry status of the reaches where the probes were placed. A statistical analysis revealed a good correlation among the mean current intensity recorded, the exceedance probability of the threshold and the persistency of the nodes. Data collected by the sensors were also interpolated in space along the network to obtain a sequence of maps of the active and dry parts of the stream network. From each map the wet length (L) of the watercourse was derived and linked to the corresponding discharge (Q) at the outlet of the catchment. Small and intense precipitation events had different effects on the variations of Q and L: the network length was found to be more sensitive than discharge to small precipitation inputs; relevant stream flow variations were instead observed only during significant events that originated the largest changes in the active network length. This heterogeneous behaviour negatively affected the quality of the fitting of empirical discharges vs. wet length data through a power law model. Water presence sensors provide an opportunity to study in depth the spatiotemporal dynamics of the active length of intermittent streams and link such dynamics to the relevant hydrological drivers.