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Combining multi-scale surface ERT for fast and robust shallow hydrostratigraphic units delineation at catchment scale

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A reliable understanding of catchment hydrology requires an accurate knowledge of the structure and composition of underlying soil and bedrock. Factors such as the depth and composition of the soil cover, and the weathering and features of the bedrock, all determine the pathways of infiltrating rainfall, the residence times of water in the subsurface and its subsequent interactions with surface water bodies. However, the complexity and spatial variability of the subsurface make its characterisation very challenging. In this context, surface ERT is now a well-established and commonly used method in hydrological studies to grasp the spatial variability of subsurface properties. This technique eventually allows to overcome the limited spatial resolution of the conventional “point-scale” drilling approach. In many cases, though, the subsurface structure is shallow and has to be measured with a precise vertical scale, requiring a small electrode spacing. In these circumstances, ERT measurements remain time-consuming. Contrariwise, when the aim is to carry out large horizontal surveys, a set-up with larger electrode spacing is preferred. In our study, we show that oversized electrode spacing can significantly affect our perception of a shallow subsurface structure by missing important surficial layers (this has already been demonstrated in several studies). More precisely, we document how a thin surficial layer can influence ERT results and cause a resistivity bias, both at the surface and at deeper horizons. First, we simulate a soil / weathered bedrock / fresh bedrock system to identify the resistivity bias produced as a result of electrode spacing. Second, this evidence is documented with a field dataset characterising a slate catchment in Luxembourg. Finally, we introduce a method to improve 2D inversion results for large units of electrode spacing. Our method incorporates interpolated apparent resistivity surficial values based on a limited number of ERT profiles at plot scale and carried out at finer units of electrode spacing. When applied to our field dataset, this combination of multi-scale surface ERT shows significantly improved inversion results. We suggest that our method should be considered to improve the inversion reconstruction for delineating hydrostratigraphic units at catchment scale in a cost-effective and more robust way.