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Hillslope to stream coupling revealed by time-lapse georadar: case study of Capetinga watershed in Brazilian Savanna

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The hillslope-stream connectivity, an important contributor to streamflow generation and surface water quality, depends both on the surface networks and the subsurface structure. The connectivity is dynamic and affected by certain processes (meteorological events) and local site conditions and it may have coupled or decoupled accordingly. Compared to factors affecting the surface networks such as vegetation or slope, subsurface connectivity is challenging to assess because of the limited availability of direct observations. In this context, the present study explored the potential of time-lapse ground-penetrating radar to quantify this connectivity together with in situ soil moisture measurements at a small hillslope in Capetinga stream, Brasilia, Brazil. The study period covers the dry and wetting periods from August 2015 to February 2016.

Geophysical surveys were conducted using 200 MHz and 400 MHz antennas with the approximate depths of investigation 4m and 9m respectively, covering an area of approximately 200 m^2 in the considered watershed. Data were acquired along five parallel profiles and one orthogonal profile to the Capetinga stream. At different locations on these profiles, the soil moisture was estimated at different depths using gravimetric and time-domain reflectometry probes to compare both direct and indirect data. This configuration allowed the characterization of the subsurface as well as the change in degree of moisture in different seasons.

A multi-attribute analysis, including coherence, energy and amplitude of the signals was applied to the dataset at considered time scales to highlight the discontinuities of the subsurface in terms of structures and water content. Additionally, a Hilbert transform analysis provided an extra layer to achieve the study objectives.

The present study demonstrates that time-lapse GPR surveys together with in situ data offer a

practical and nondestructive way of understanding complex subsurface flow processes across the landscape that lead to hillslope-stream connectivity in the field. This study is an initial step to understand the cerrado environment that is a unit of essential landscape at the watershed scale.

Keywords: Attribute analysis; non-invasive; Hilbert transportation; time-domain reflectometry