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The contribution of W-band radar monitoring for understanding of runoff and soil erosion response at field scale

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Vegetation cover has a great influence on hydrological response at field scale, and, consequently, on runoff and soil erosion processes. The maintenance of bare soil in vineyard inter-rows with tillage, as well as the tractor traffic, are known to expose the soil to compaction, reduction of soil water holding capacity and increase of runoff and erosion. The use of grass cover is one of the most common and effective practices in order to reduce such threats.

Rain-driven runoff (RO) and soil loss (SL) at sites with different cover have been investigated over last decades. It has been found that RO and SL often correlate with rain properties. This correlation, however, is highly variable among different sites and also for different time periods. In many studies rain is represented only by a few parameters such as e.g. maximum intensity and total precipitation. Size of rain drops is rarely analysed, although it is important for an accurate estimation of kinetic energy of rain. Polarimetric millimetre-wavelength radars are one of the instruments capable of drop size measurements. In contrast to in-situ rain sensors, such radars have much larger sampling area and can estimate range profiles of drop size distributions with high spatial and temporal resolution.

The objective of this work is to relate runoff and soil erosion to rain properties based on traditional monitoring techniques complemented by observations from a radar. With this aim, a site in the Alto Monferrato vine-growing area (Piedmont, NW Italy) was equipped with a 94-GHz radar in June 2023. The site has two vineyard-field-scale plots with inter-rows managed with conventional tillage (CT) and grass cover (GC), respectively. The radar is located about 100 m from the plots. The radar elevation was set to 30° so that the radar samples rain above the plots.

During the summer and autumn seasons of 2023, 26 rain and 13 runoff events were observed. The preliminary results of the conventional analysis show that in this period runoff is directly related to erosivity index (EI30) both in CT and GC plots, and, only in GC treatment to maximum rainfall intensity over 10 minutes and antecedent rainfall in previous 7 days. Maximum rainfall intensity over 30 and 60 minutes, on the contrary, has a negative direct proportion with runoff. Soil erosion for both treatments was also directly related also with maximum rainfall intensity over

10 minutes and antecedent rainfall in previous 7 days and, in addition has a negative proportion with rainfall energy. It should be noted the relevant role played by rainfall intensity over short time interval and the antecedent rainfall, resulting in increased soil moisture. Relationships are different from those obtained in the same site in a previous study, reflecting the peculiarity of summer 2023, characterized by few rainfall events occurred on very dry soil. Information obtained from W-Band radar monitoring allows to investigate relationships in a deeper way among rainfall characteristics and generation of runoff and soil erosion.