Effect of DEM resolution on simulated hydrological connectivity in a Mediterranean agro-ecosystem with different crops

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It is known that the raster digital elevation model (DEM) resolution has influence on simulating hydrological features such as stream characterization, watershed delineation, flow accumulation threshold values and network morphology. The accuracy and resolution of the input DEM have serious implications on the values of the hydrologically spatial indices derived from the DEM and used in the distributed hydraulic and hydrological models. However, very few studies have dealt with the effect of DEM resolution on simulated hydrological connectivity. Recently, Cantreul et al. (2016) found in a cultivated catchment in Belgium that connectivity increased for a given pixel when the pixel size decreases. They also described a lower impact of connections in the watershed, such as grass strips, at lower pixel sizes and well disconnected areas were identified with the highest DEM’s resolution. However, on land surfaces with numerous small-scale depressions the use of DEMs with a coarser resolution tended to overestimate hydrologic connectivity and simplified hydrographs (Yang and Chu, 2013). Hence, there are varied and even contrary conclusions depending on the topographic characteristics. We did not find any publication dealing with the effect of the DEM resolution on the magnitude and spatial patterns of simulated hydrological connectivity either in woody crops (vineyards, almond, olive, orange, coffee, tea and other fruit groves) or in forest areas and rangelands. DEMs can be derived from several sources, such as using topographic contour maps, that was the most commonly used source of data in the past, through remote sensing techniques (spaceborne or airborne imagery), from the Light Detection And Ranging (LiDAR) technology, and more recently by using the photogrammetry-based computer technique. These DEMs are characterized by different precision, accuracy, range of spatial resolution, time and economic cost. In this study, we seek to prove that connectivity thresholds and even the simulated functional connectivity, related to different hydrological processes, depends on the DEM resolution. Therefore, we ran the runoff and sediment connectivity index (IC) of Borselli et al. (2008) at five spatial resolutions (0.03, 0.1, 0.5, 1 and 5 m of width cell) by using LiDAR- and photogrammetry-derived DEMs. The model was run in a complex Mediterranean agro-ecosystem (42°02′ 00″ N, 0°04′12″ E), the Barbastro site (26.6 ha), located in NE Spain, in a hilly landscape. Land is mainly devoted to agriculture, including four vineyards, five cereal fields, one abandoned and one cultivated olive grove. Small and scatter forestry patches appear throughout the hillslope, and two unpaved trails modify the original overland flow pathways. The vineyards belong to the Fábregas Cellar (Certificate of Origin, D.O., Somontano). Finally, we proposed the most adequate DEM resolution to simulate the different hydrological connectivity processes at field and small sub-catchment scales.