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Quality assessment of open access Digital Terrain Models to estimate topographic attributes relevant to soil vertic properties prediction. A case study of Entre Rios province (Argentina)

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Digital terrain models (DTM) allow deriving topographic attributes that help predict soil properties within a landscape. A variety of DTMs, digital elevation models (DEMs), and digital surface models (DSM) derived from Earth Observation (EO) data are freely accessible via Internet for download and use: MERIT-DEM, SRTM v3 (SRTM Plus), GDEM v3 (ASTGTM), AW3D30 v3, Copernicus GLO-30, NASADEM HGT v1, SRTMGL1 up-sampled (ASF DAAC) and MDE-Ar v2. However, information on their accuracy to represent terrain surfaces (particularly topographic attributes) can vary according to regions and geographies, which can impact soil cartography accuracy at sub-regional and catchment levels. This research evaluates the accuracy of the models mentioned above for estimating topographic attributes relevant to the cartography of soil vertic properties in the northern part of the Entre Ríos province, Argentina. To this end, east-west and north-south transects were used to collect 126 evenly distributed ground control points. The root mean squared error (RMSE) and symmetric mean absolute percentage error (sMAPE) served as the basis for comparing the performance of the terrain models. The sMAPE provides a percentage (or relative) error, facilitating a comparison of the accuracy with which each elevation value is predicted (in addition to the average error expressed by the RMSE value).

The results show that out of the 8 models compared, the Copernicus GLO-30 offers the highest accuracy (RMSE=1.36; sMAPE=1.5%) for representing terrain surface features in the province of Entre Rios, whereas the highest RMSE (7.79) and sMAPE (11.2%) corresponded to the ASTGTM v3. The paper describes a simplified approach for extracting a digital terrain model (DTM) from the digital elevation information provided in the Copernicus GLO-30. Grid-spline interpolation and multilevel b-spline interpolation (from SAGA open GIS software) were applied to remove natural and built features. The output DTM was used to calculate plan and profile curvature index, multi-

scale topographic position index (TPI), multiresolution index of valley bottom flatness (MrVBF), terrain ruggedness index (TRI), and topographic wetness index (TWI) that are important in modelling relationships between geomorphology, vertic soils, and surface hydrology in landscapes characterized by catenary sequences of Mollisols-Alfisols-Vertisols. A higher TRI was associated to increased local relief heterogeneity. Higher values of the MrVBF relate to broad flat valley bottoms and more extensive alluvial zones often confined between the slightly rolling and undulating plains, and peneplain landscapes. Lastly, the TWI was used to map potential areas for surface water accumulation that field verifications showed as corresponding with the location of vertic soils.

Integrating DTM-derived topographic attributes with other ancillary data enabled mapping the spatial distribution of soil vertic properties over the study area and associating their occurrence to specific landscape zones (ie. close to drainage networks). The approach and findings are relevant for showing where and how the landscapes of the Entre Rios province are affected by a combined impact of human activities (intensive agriculture) and a hydrographic network that boosts the processes of soil erosion and contaminant transport.