EFFECT OF DEM RESOLUTION ON SIMULATED HYDROLOGICAL CONNECTIVITY IN A MEDITERRANEAN AGRO-ECOSYSTEM WITH DIFFERENT CROPS

Manuel López-Vicente*, Sara Álvarez

Dept. of Soil and Water, Experimental Station of Aula Dei, EEAD-CSIC. Avda. Montañana 1005, 50059, Zaragoza, Spain. *E-mail: mvicente@eead.csic.es; mlopezvicente@gmail.com

4th MC meeting & WG meetings 21-23rd of September 2016, Prague, Czech Republic

STATE-OF-THE-ART

The raster 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 predictions of the distributed hydrological models.

Few studies have dealt with the effect of DEM resolution on simulated hydrological connectivity (***HC***): Cantreul et al. (2016) found in a cultivated catchment that ***HC*** increased for a given pixel when the pixel size decreases. They also identified well disconnected areas with the highest resolutions. However, on land surfaces with small-scale depressions the use of coarser DEMs tended to overestimate ***HC*** (Yang & Chu, 2013). → *There are contrary conclusions depending on the land characteristics.*

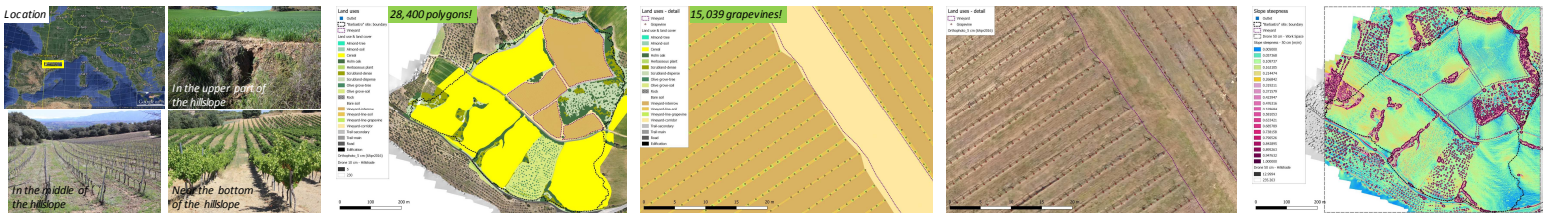
DEMs can be derived from several sources: using contour line maps (the most common source of data in the past), through remote sensing techniques (reflection radiometer and radar; spaceborne or airborne imagery), from Laser Imaging Detection And Ranging (LIDAR), by using photogrammetry restitution with specific software, and more recently with Structure-From-Motion (SFM). These DEMs have different precision, accuracy, range of spatial resolution, time and economic cost.

OBJECTIVE

We did not find any publication dealing with the **effect of DEM resolution on** the magnitude and spatial patterns of **simulated *HC* in woody crops** (vineyard, olive, etc.).

We seek to prove that connectivity thresholds and even the simulated functional ***HC***, related to different hydrological processes, depends on the DEM resolution.

MATERIALS AND METHODS



STUDY AREA

A Mediterranean agro-ecosystem, the Barbastro site (26.6 ha), in a hilly landscape (NE Spain): 4 vineyards (2 varieties), 5 cereal fields, 1 abandoned & 1 cultivated olive grove. Small and scatter forestry patches & 2 trails.

DEMs acquisition

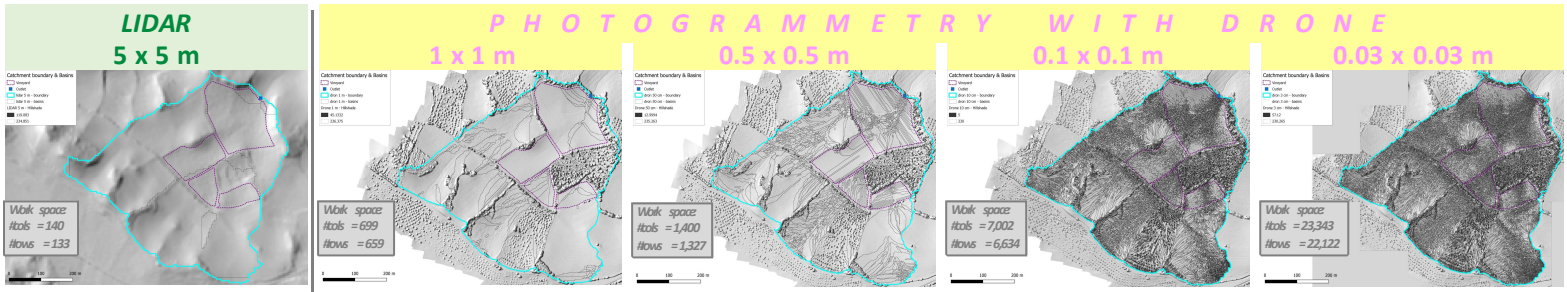
LIDAR-DEM: free downloaded from the Spanish *National Geographic Institute* (IGN). The 6 photogrammetry-derived DEMs: from 333 pictures taken with a digital camera by the company *3DSCANNER | Patrimonio e Industria*, and using a professional mapping drone (*eBee* by *senseFly Ltd.*).

HYDROLOGICAL CONNECTIVITY MODELLING

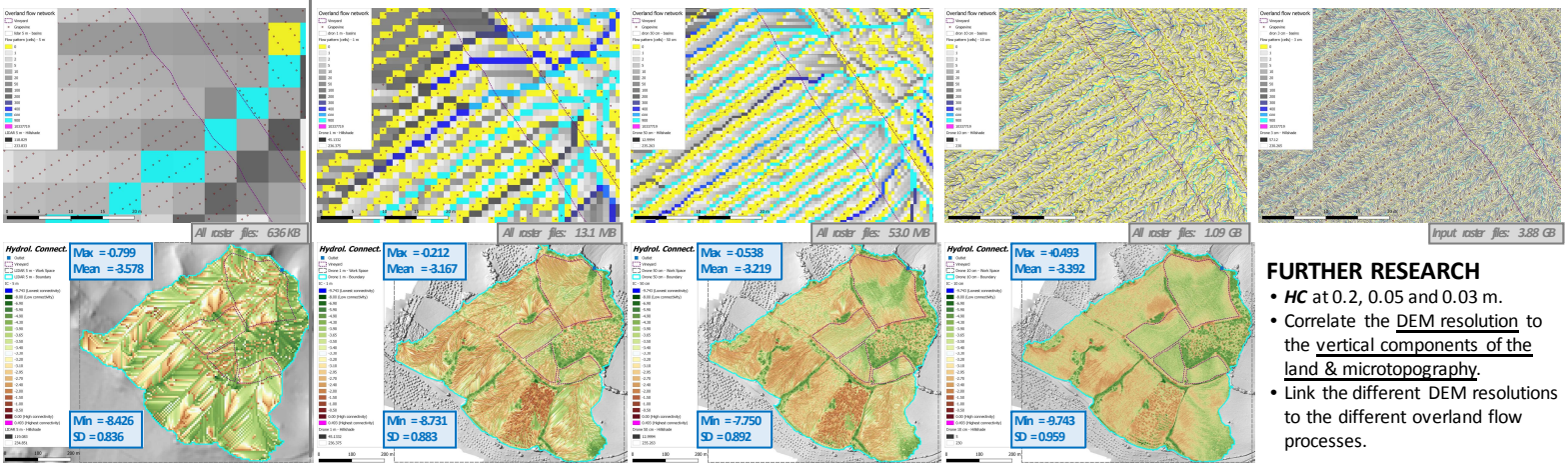
The Index of runoff and sediment Connectivity (IC; Borselli et al., 2008) is a proxy for hillslope–channel coupling and runoff and sediment delivery estimations. It uses GIS techniques (Cavalli et al., 2013) and accounts the effect of linear landscape elements (López-Vicente et al., 2016):

$$IC_K = \log_{10}\left(\frac{D_{up}}{D_{dn}}\right) = \log_{10}\left(\frac{\overline{W}\cdot\overline{S}\cdot\sqrt{\sum A}}{\sum \frac{d_i}{W_i\cdot S_i}}\right)$$

W-IC linked to C-RUSLE. Values from Gómez et al. (2003), López-Vicente et al. (2013), Martínez-Casasnovas et al. (2016), Miller et al. (2003), Novara et al. (2011) and Panagos et al. (2015).



RESULTS



FURTHER RESEARCH

- ***HC*** at 0.2, 0.05 and 0.03 m.
- Correlate the DEM resolution to the vertical components of the land & microtopography.
- Link the different DEM resolutions to the different overland flow processes.

CONCLUSIONS

- ***HC*** maps derived from high (0.1 to 1 m) spatial resolution DEMs provide more information about the overland flow processes and microtopography than the ***HC*** maps derived from coarser DEMs.
- Further research is needed for very high (0.05 & 0.03 m) spatial resolutions.

HC VALUES & SPATIAL PATTERNS

- ***HC*** increased with the photogrammetry-DEMs in comparison with the LIDAR-DEM. However, ***HC*** decreased and more extreme values appeared at higher resolutions within the set of photogrammetry-DEMs.
- Similar spatial patterns appeared at 5, 1 and 0.5 m, and microtopography started influencing the spatial pattern of the ***HC*** values at 0.1 m.
- The different DEM resolutions triggered different ***HC*** values in the main ephemeral gullies and in the depositional area at the bottom.

Resolution (m)	CHANGES: IC - mean value		IC - minimum value (Lowest connectivity)		IC - maximum value (Highest connectivity)	
	Against 5x5	Against Before	Against 5x5	Against Before	Against 5x5	Against Before
5						
1	11%	11%	-4%	-4%	73%	73%
0.5	10%	-2%	8%	11%	33%	-154%
0.1	5%	-5%	-16%	-26%	162%	192%

Acknowledgements

This research was funded by the project "Environmental and economic impact of soil loss (soil erosion footprint) in agro-ecosystems of the Ebro river basin: numerical modelling and scenario analysis (EroCostModel) (CGL2014-54877-JIN)" of the Spanish Ministry of Economy and Competitiveness. We especially thank Mr. Gonzalo Alcalde Fábregas (Fábregas Cellar, D.O. Somontano) for giving up the vineyards where part of this research has been done.

References

- Borselli, L., Cassi, P., Torri, D. 2008. *Catena* 75(3), 268-277.
- Cantreul, V., Cavalli, M., Degré, A. 2016. *Geophysical Research Abstracts* 18, EGU2016-2697-1.
- Cavalli, M., Trevisani, S., Comiti, F., Marchi, L. 2013. *Geomorphology* 188, 31-41.
- Gómez, J.A., Battany, M., Renschler, C.S., Fereres, E. 2003. *Soil Use and Management* 19, 127-134.
- López-Vicente, M., Navas, A., Gaspar, L., Machín, J. 2013. *Agric. Water Management* 125, 1-12.
- López-Vicente, M., Poesen, J., Navas, A., Gaspar, L. 2013. *Land Degrad. Dev.* 24, 472-484.
- Martínez-Casasnovas, J.A., Ramos, M.C., Poesen, J. 2016. *Land Degrad. Dev.* 27, 160-170.
- Miller, J.J., Yuan, Y., Curtis, T. 2003. *Int. J. of Wildland Fire* 12, 95-100.
- Novara, A., Gristina, L., Saladino, S.S., Santoro, A., Cerdà, A. 2011. *Soil & Tillage Research* 117, 140-147.
- Panagos, P., Borrelli, P., Meusburger, K., Alewell, C., Lugato, E., Montanarella, L. 2015. *Land Use Policy* 48, 38-50.
- Yang, J., Chu, X. 2013. *J. of Hydrologic Engineering* 18(8), 1157-1169.