Spatial variation of soil erosion classification at regional scale: the case study of Apulia Region

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Introduction

Soil erosion results in the loss of soil, nutrients, and organic carbon and therefore in a decrease of the productivity of soil and its ability to sustain life. The loss of soil nutrients and organic carbon is often particularly related to sheet erosion processes that preferentially transport the finest soil fraction containing most organic carbon and nutrients. (Franzluebbers, 2002; Martínez-Mena et al., 2002; Koiter et al., 2017). While this process affects soils globally, Mediterranean environments characterized by scarce and torrential precipitation, long drought periods, shallow soils, and scarce plant cover - are especially susceptible to soil erosion and to inappropriate soil management, leading to accelerated soil loss (Schwilch et al., 2012; Durán Zuazo et al., 2014). In 2006, the European Commission had classified soil erosion as the first of the eight major threats to soil (Montanarella, 2013). The European Common Agricultural Policies (CAP) strengthens the importance of fighting against erosion and enhancing overall soil health. Thus, at national and regional level, it is necessary to put into place measures that allow effective intervention, measurement and monitoring in these terms. In this study a scalable GIS framework has been created that allows to estimate the soil erosion status, using open datasets. In addition to quantitative information (tons of soil loss per hectare), it can also provide decision makers with qualitative information. In fact, the establishment of erosion classes, done following the classification already existent in the literature, will allow to establish which areas have high, medium, or low level of erosion.

Materials and Methods

One of the biggest threats to soil in EU is the Erosion by water. It has negative impact on all the environment, causing problems in many sectors. For this reason, a new database that reports detailed assessment of soil erosion by water for the EU, was released the 1/9/2015 (Panagos et al. 2015) with the name of RUSLE2015. This database is made basing on the Revised Universal Soil Loss Equation (RUSLE) to estimate soil loss in Europe, with the resolution of 100m. This database, freely downloadable (https://esdac.jrc.ec.europa.eu/content/soil-erosion-water-rusle2015), was clipped for the Apulia region, and categorized using 3 classifications based on 3 different soil erosion rate (t ha^{-1} yr^{-1}). The first classification is based on the Global Soil Erosion Modelling (GloSEM, https://esdac.jrc.ec.europa.eu/content/global-soil-erosion), which has a resolution of 25 km. The second is based on Borrelli et al. 2017 classification, which has a resolution of 250m, while the third one is based on Panagos et al. 2015, 100m resolution. These classifications have the same intensity of the risk (high, moderate, low) but are referred to different rate of t ha^{-1} yr^{-1} (Table1).

Table 1

Soil Erosion Rate	GloSEM 2019 (t ha^{-1} yr^{-1}) 25km	Borrelli 2017 (tha^{-1} yr^{-1}) 250m	Panagos 2015 (t ha^{-1} yr^{-1}) 100m
High	>10	>5	>10
Moderate	5 - 10	3 - 5	2 – 10
Low	<5	0 - 3	0 - 2

Using these classifications is possible to apply the three classes to the RUSLE2015, using Qgis, obtaining three different maps referred to each classification.

Results

In this study we compared the results from the open databases: by GloSEM (2019) in Fig.1, Borrelli et al. (2017) in Fig.2 and Panagos et al. (2015) in Fig.3. In all three classifications the areas featuring high risk of soil erosion are in the Tavoliere and in the Daunian Sub-Apennine, in the north-west, as well as in the Murgia plateau in the center of the Apulia.

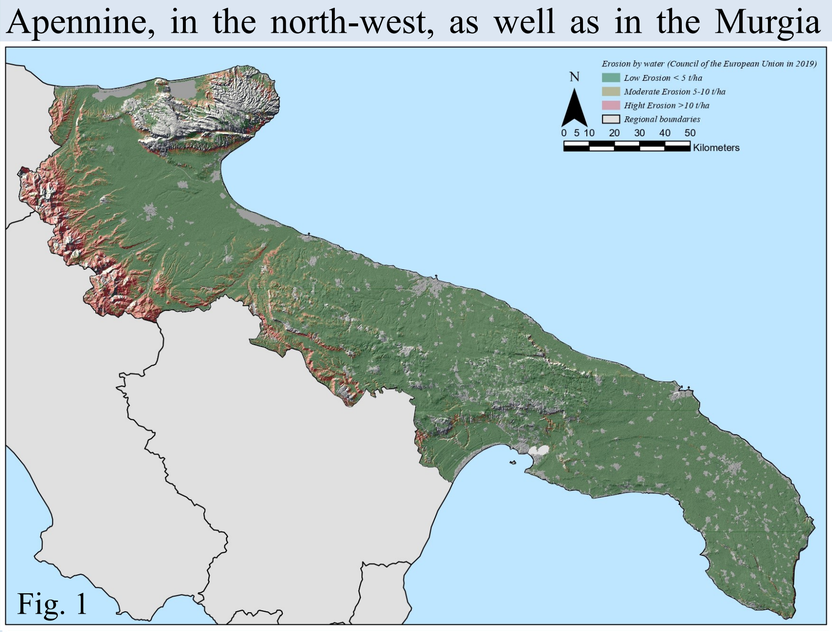

Fig. 1

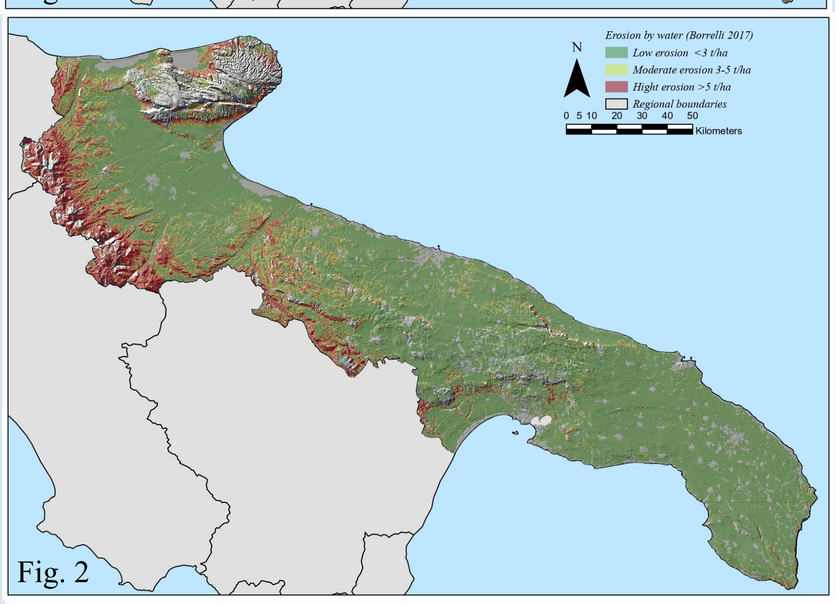

Fig. 2

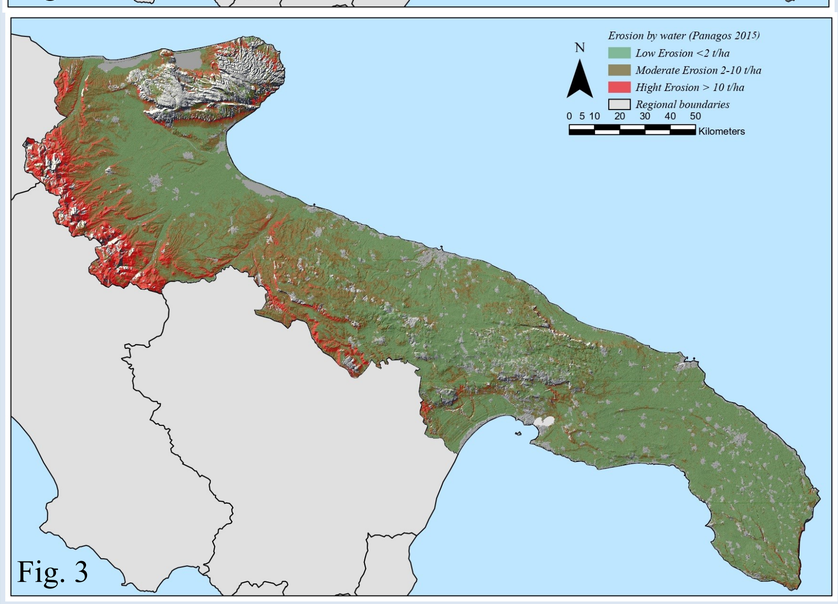

Fig. 3

The classifications showed in the figures, highlight the spatial variability of the erosion by water gradient in relation to the altitude and the slopes. It is possible to observe how factors, such as altitude and slope, affect erosion and therefore areas with low erosion levels (green), areas with moderate erosion level (yellow) and finally with high level (red), but with different soil loss rates.

The analysis shows that using the classification proposed by GloSEM (2019), only 14% of Apulian crop land is classified with severe (7%) or moderate (7%) erosion problems, while the other two classifications show a much more serious and worrying situation. In fact, the classifications proposed by Panagos et al. (2015) and Borrelli et al. (2017) show 28% and 9% respectively for the moderate erosion risk, while 7% and 14% respectively for high erosion risk. The main difference between the three classifications is in the resolution of the datasets used, the best resolution in our elaboration is the one proposed by Panagos et al. (2015) with a resolution of 100m (Table 2).

Table 2

Soil Loss Rate	GloSEM 2019	%	Borrelli 2017	%	Panagos 2015	%
High	112933 ha	7%	224088 ha	14%	112933 ha	7%
Moderate	111155 ha	7%	149626 ha	9%	442405 ha	28%
Low	1382941 ha	86%	1233315 ha	77%	1051691 ha	65%
Total	1607029 ha	100%	1607029 ha	100%	1607029 ha	100%

Conclusion: The study revealed that majority of extremely vulnerable soil erosion areas in Panagos et al. (2015) classification (>10 t ha^{-1} yr^{-1}) belongs to Daunian Sub-Apennine and Murgia plateau area. The model can be used to predict the effect of a range of policy scenarios. It is also replicable, comparable and can be extended to model other regions.

Reference: Borrelli, P., Robinson, D. A., Fleischer, L. R., Lugato, E., Ballabio, C., Alewell, C., & Panagos, P. (2017). An assessment of the global impact of 21st century land use change on soil erosion. Nature communications, 8(1), 1-13. Franzluebbers, A. J. (2002). Water infiltration and soil structure related to organic matter and its stratification with depth. Soil and Tillage research, 66(2), 197-205. Martinez-Mena, M., Castillo, V., & Albaladejo, J. (2002). Relations between interrill erosion processes and sediment particle size distribution in a semiarid Mediterranean area of SE of Spain. Geomorphology, 45(3), 261-275. Panagos, P., Borrelli, P., Poesen, J., Ballabio, C., Lugato, E., Meusburger, K., & Alewell, C. (2015). The new assessment of soil loss by water erosion in Europe. Environmental science & policy, 54, 438-447. Schwilch, G., Laouina, A., Chaker, M., Machouri, N., Sfa, M., & Stroosnijder, L. (2015). Challenging conservation agriculture on marginal slopes in Sehoul, Morocco. Renewable agriculture and food systems, 30(3), 233-251. Zuazo, V. H. D., Pleguezuelo, C. R. R., Tavira, S. C., & Martínez, J. R. F. (2014). Impacto de la erosión y escorrentía en laderas de agroecosistemas de montaña mediterránea. Ecosistemas, 23(1), 66-72.