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Erosion-vegetation dynamics in the Lucciolabella biancane badland cultural landscape (Southern Tuscany, Italy)

Simona Maccherini (1), Francesca Vergari (2), Elisa Santi (3), Michela Marignani (4), Marta Della Seta (2), Mauro Rossi (3), Dino Torri (3), and Maurizio Del Monte (2)

(1) BIOCONNET, Biodiversity and Conservation Network, Department of Environmental Sciences "G. Sarfatti", University of Siena, Via P.A. Mattioli 4, 53100 Siena, Italy, (2) Earth Sciences Department, Sapienza University of Rome, P.le Aldo Moro 5, 00185 Roma, Italy, (3) CNR-IRPI, Via Madonna Alta, 06123 Perugia, Italy, (4) Department of Life and Environmental Sciences, University of Cagliari, Viale S. Ignazio 13, 09123 Cagliari, Italy

In this work we present the results of multidisciplinary and long-lasting investigations on the complex cause-effect relationship among water erosion processes and vegetation cover on the Lucciolabella Natural Reserve, located in Upper Orcia Valley (Southern Tuscany). The area is a Site of Community Importance, where the cultural landscape of biancane badlands – water erosion landforms generated on Plio-Pleistocene marine clay outcrops – is preserved. We explored the direction and rate of change in land use and natural habitats of the biancana badland landscapes over the last 50 years, evaluating the erosion–vegetation dynamics and examining the processes involved in the biancana badland area.

Historical information, such as early cadastral documents and diachronically analyzed aerial photographs, has been used to construct a database of the natural trends of modifications relative to habitat and plant species distribution, with the analysis of the consequent variations on the frequency of instability events. Old and recent land use maps were compared by using the TWINSPAN classification. Soil erodibility evaluation on the eroded biancana surfaces, regosols and well-developed vertisols, was carried out together with a decadal erosion monitoring program and the investigation of the physico-chemical properties of parent material. We also considered the effects of a few roots on saturated soil shear strength to introduce direct links between plants and soil processes. Moreover we run the LANDPLANER model in order to deepen the effect of the fragmentation of the vegetation cover on water erosion processes affecting biancana badlands.

Long-lasting geomorphological survey and field erosion monitoring highlighted that biancana stations experience a very strong surface lowering rate due to water erosion, attaining an average rate of 2.4 – 2.6 cm/a. Moreover, biancanas in a more juvenile development phase, such as the ones of Lucciolabella Natural Reserve, show the maximum erosion rate, which reach more than 4 cm/a, and the most relevant dispersive clay fraction. The surface proneness to water erosion is enhanced by the wide presence of piping in the area. We showed that rills and subsurface micropipes are characterized by analogous erosion processes, meaning that they can be contrasted and eventually halted through a common mitigation strategy, and we observed a clear positive trend that will substantially suppress rilling at very low plant cover (no more than 20%).

The analysis of the landscape changes showed a decrease in bare or scarcely vegetated spots of 0.9 ha/a during the last decades. Even if vegetation cover seems to stabilize upper layers of soil profile, rural abandonment and the lack of appropriate management practices have contributed to vegetation encroaching on biancana badland slopes mainly ascribed to generalist ruderal species, causing a loss of elements of high ecological and cultural values. If the encroachment continues to progress at this rate, in 35–40 years from now all the biancana domes will be completely re-vegetated.

Badlands were previously kept alive by limited but nonetheless devastating grazing activities. If this picture is correct, then mimicking traditional badland grazing practices seems to be a necessary step towards saving the landscape and biodiversity that the protected areas were established to preserve.