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The effect of chestnut coppice forests abandon on slope stability: a case study

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Sweet chestnut has been fundamental for Italian mountainous economies for many centuries. This kind of forest was traditionally managed by coppicing in shortly rotation (15-20 years) to rapidly produce wood biomass until half of XX century. In the last decades these forests were in large part abandoned due to change in economy which made coppiced forest management unprofitable, especially in steeper slopes and where forest viability is scarce. As a consequence most of them are over aged and very dense, leading to an observed increasing in localized slope instability, primary because of the uprooting of stools (Vogt et al., 2006).
In this work the effect of the abandon of chestnut coppice on slope stability was analyzed, focusing on shallow landslides triggering. The mechanical contribution to soil shear strength of differently managed chestnut stand was estimated and compared in terms of additional root cohesion.
The study area is located in the Valcuvia Valley (Lombardy Prealps - Northern Italy) at an elevation about 600 m a.s.l., where two different stands, one managed and the other abandoned (over 40 year aged), were chosen. The two sampling stands are on cohesionless slopes (quaternary moraine deposits) and are homogeneous with regard to the substrate, exposure and elevation. Slope steepness influences heavily forestry practices and steeper stands are more frequently abandoned than stands on gentler terrain: in fact in the abandoned coppice the slope was higher (35 degrees against 13 in the managed stand) and no stands completely homogeneous can be found.
In each site the main characteristics of the stand were surveyed and a trench in each stand was excavated to analyze root diameter and number distribution with depth; root specimens were also collected for the tensile force determination through laboratory tensile tests. Root distribution and force were then used to estimate root cohesion values through a Fiber Boundle Model (Pollen and Simon, 2005).
Results, as expected, show that management didn't affect root mechanical properties, whereas root distribution within the soil profile did. In terms of additional root cohesion, values are higher in the managed stand, and lower in the abandoned one, at least in the first 50 cm of soil. In the abandoned stand, in fact, roots reach deeper layers of soil (100 cm) than the managed one (50 cm), mainly because of an unexpected greater soil depth.
To assess the implication of such results in terms of slope stability, a simple infinite slope model was applied to the two conditions. The results showed that the abandoned stand is prone to instability also with a low level of saturation. On the contrary, by applying the additional root cohesion profile obtained in the managed stand to the steeper slopes, stability should be guaranteed, except in the case of total saturation.
In conclusion, although more investigations are required especially to extend the number of stands, coppicing practice seem to be fundamental to prevent shallow landsliding in sweet chestnut forests over cohesionless slopes.