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Actual evapotranspiration of abandoned grassland on a slope in the Western Italian Alps: Impact of shrub encroachment

Davide Gisolo[1], Ivan Bevilacqua[1], Justus van Ramshorst[2], Alexander Knohl[2,3], Lukas Siebicke[2], Alessio Gentile[1], Maurizio Previati[1], Davide Canone[1], and Stefano Ferraris[1]

[1]Interuniversity Dept. of Regional and Urban Studies and Planning (DIST), Polytechnic Univ. of Turin, Italy
[2]Bioclimatology, Faculty of Forest Sciences and Forest Ecology, University of Göttingen, Germany
[3]Centre of Biodiversity and Sustainable Land Use (CBL), University of Göttingen, Göttingen, Germany

Land cover changes affect the local hydrological cycle, including actual evapotranspiration (ETa). Encroachment by shrubs on abandoned grasslands is an increasing phenomenon in the Alps, a region already suffering climate change effects. In addition, shrub encroachment is thought to occur faster on steep slopes. Unfortunately, steep mountain slopes are rarely studied because of complex morphologies, despite a need for data to better understand these changing ecosystems.

Four growing seasons (two wet – 2014 and 2015 and two dry – 2016 and 2017) of eddy covariance, meteorological, hydrological, and soil data were collected at an abandoned grassland on a slope encroached by shrubs in the Italian Western Alps. The objectives were to: 1) study the ETa differences between two land cover types, grassland and shrubland, based on Hydrus 1D model simulations. 2) Compare the simulated ETa from the two land covers ($ETa_{Sim\ grass}$ and $ETa_{Sim\ shrub}$) with the observed eddy covariance-derived evapotranspiration (ETa_{Obs}).

The simulated ETa from shrubland showed a better agreement with the observed ETa (R^2=0.4 to 0.5, slope=0.8 to 1.3). The simulated ETa from shrubland ($ETa_{Sim\ shrub}$) was higher compared to the simulated ETa from grassland ($ETa_{Sim\ grass}$) with the observations (ETa_{Obs}) in between, confirming that ETa_{Obs} represents a mixture of shrubland and grassland contributions. The relative contribution was different for each year due to meteorological conditions. On average across all years, a 51:49% contribution from respectively grassland and shrubland resulted in a good approximation of ETa_{Obs}, in particular in 2015 and 2016 growing seasons, characterised by long dry spells. In those growing seasons, the differences between cumulative ETa from simulations and observations were below 10 mm. In the other two growing seasons, more frequent rainfalls and the absence of long dry spell caused cumulative ETa underestimation (-25 mm) in 2014 and overestimation (66 mm) in 2017. Differences between shrubland and grassland were enhanced during dry spells, leading to a cumulative $ETa_{Sim\ shrub}$ more than 100 mm higher than the cumulative $ETa_{Sim\ grass.}$ In the longest dry spells of the growing seasons, ETa_{Obs} was closer to $ETa_{Sim\ shrub}$, confirming the role of deeper roots of shrubs.
The results indicate that the shrub-covered area, expected to increase, plays already a key role in the local hydrological cycle, particularly with changes in water availability.