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How effective are soil and water conservation techniques in reducing annual plot runoff and soil loss? A pan-European and Mediterranean review and analysis.

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While a substantial number of experimental studies on the effectiveness of soil and water conservation techniques (SWCTs) in reducing annual runoff (R_a) and annual soil loss (SL_a) at plot scales in Europe and the Mediterranean exists, a comprehensive overview and analysis of plot R_a and SL_a data is lacking. Therefore, the objective of this study is to analyse the effectiveness of SWCT in reducing R_a and SL_a in Europe and the Mediterranean, as well as to explore the factors that determine SWCT effectiveness. In the framework of the FP6 project DESIRE (http://www.desire-project.eu), a comprehensive plot database was compiled based on an extensive literature review covering 101 reports and publications. The database contains R_a and SL_a data measured on runoff plots, where various SWCTs were tested in the Euro-Mediterranean region. The total database contains 353 plots, corresponding to 2 093 plot-years from 103 plot measuring stations throughout Europe and the Mediterranean. For 224 of these plots (corresponding to 1 567 plot-years), R_a and/or SL_a from a paired plot with the same dimensions, land use and measuring period, but without the application SWCT was available, allowing to assess the effectiveness of the applied SWCTs. Documented SWCTs include cover crops, mulching, grass buffer strips, strip cropping, exclosure, no-tillage, reduced tillage, contour tillage, deep tillage, drainage, soil amendment, terraces, contour bunds and geotextiles.

Analyses of the database shows that there are clear differences in effectiveness in reducing R_a and SL_a between different SWCTs. Techniques related to crop and vegetation management like mulching (median reduction of R_a to 32% and SL_a to 23% of the corresponding values measured on the plot without SWCT) and cover crops (36% for R_a and 14% for SL_a) are more effective than soil management techniques like no-tillage (85% for R_a and 57% for SL_a) or reduced tillage (90% for R_a and 68% for SL_a). While these techniques are commonly referred to as soil and water conservation techniques, these figures also show that they are less effective in reducing R_a than in reducing SL_a. Furthermore, analysis of time series of multiple consecutive years of R_a and/or SL_a measurements show that no-tillage and conservation tillage become less effective in reducing R_a over time, but no such effect is observed for annual SL_a.

This has important consequences for the use of these techniques in e.g. drought-prone areas where water conservation is a key issue and also needs to be considered in the assessment of the effects of SWCTs at larger scales. Furthermore, effectiveness of different SWCTs is found to be highly variable and requires further analysis of the factors controlling SWCT effectiveness. All SWCTs show a more consistent and effective reduction of both R_a and SL_a with increasing magnitude of R_a and SL_a, which is attributed to the reduced influence of measurement uncertainties with increasing R_a and SL_a. No general relations between SWCT effectiveness in reducing R_a and SL_a and plot slope length, slope gradient or annual precipitation were found.

Keywords: soil and water conservation techniques, runoff reduction, soil loss reduction, plot scale, Europe and the Mediterranean