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Shrublands and Soil Erosion. An State-of-the-Art

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Arid and semiarid regions occupy two-fifth of the continents (Reynolds et al., 2007). These regions are characterized by dry climatic conditions, recurrent droughts and a scant rainfall pattern with a marked seasonality and a high inter-annual variability which makes water to be a scant resource and vegetation to follow a high variability spatial distribution pattern (Breshears et al., 1998; Cecchi et al., 2006; Dunkerley, 2008). These conditions make these areas more sensitive to climate change (Rowell, 2005) and to land use change as a consequence of land abandonment (Poyatos et al., 2003; Delgado et al., 2010; García-Ruiz, 2010), increasing the risk of desertification (Puigdefábregas and Mendizabal, 1998; Geeson et al., 2002), in such a way that 65-70% of arid and semiarid areas are vulnerable to this degradation process (UNEP, 1991). Soil Erosion and Land Degradation are closely related to the changes in the vegetation cover (Zhao et al., 2013). Although other factors such as rainfall intensity or slope (Ziadat and Taimeh, 2013) the plant cover is the main factor that controls the soil erosion, controlling the infiltration and runoff generation (Cerdà, 1998a; Kargar Chigani et al., 2012; Haregeweyn, 2013).
Soil erosion show non-sustainable rates under these regions, such as under Mediterranean conditions (Cerdà et al., 2010) and on agriculture land (Cerdà et al; 2007; 2009) due to climatic conditions, to parent material and to the roughed terrain (Romero Díaz et al., 2010). The traditional impact of grazing, of extremely intense fires, of ploughing and the widespread use of herbicides on agriculture, the increase of the road and railway embankments and the agricultural land abandonment cause vegetation removal. Canopy cover partitions rainfall reducing the amount of water reaching the soil and the kinetic energy of rainfall drops, protecting the soil against the impact of rainfall drops. Vegetation distribution controls the exposure of soils to rainfall drops affecting soil erosion (Cerdà, 1997a; Cammeraat et al., 2010; Kakembo et al., 2012). The lost of vegetation can trigger Desertification (Izzo et al., 2013) because soil erosion is highly dependent on the effective rainfall striking soil particles (Cerdà and Lasanta, 2005; Haile and Fetene; 2012; Miao et al., 2012, Prokop and Poręba, 2012).
Shrubs are the most characteristic vegetation type in semiarid and arid ecosystems all over the world (Tomaselli, 1981; Kummerrow, 1989), typical of intermediate stages of most vegetation succession series, being the first in terms of dominant vegetation coverage, occupying 24% of drylands, followed by crop vegetation with 20% (Reynolds et al., 2007). Moreover, shrub vegetation covers the soil permanently, being able to adapt to very unfavourable conditions like droughts, frosts, non-fertile soils,... improving the soil quality due to their capacity to activate organic matter cycles supplying greater amounts of litter (Alegre et al., 2004). Shrubs have complex root systems, inducing changes in soil properties and increasing soil macroporosity (indirect effects) that increase infiltration reducing runoff and the soil loss (Garcia-Estringana et al., 2010). Shrubs improve the infiltration capacity of soils (Cerdà, 1997), even in the most difficult conditions (Marques et al., 2005), the water retention capacity (Ruiz Sinoga et al., 2010) and the runoff and sediment redistribution.
Shrub vegetation has been seen as a key vegetation cover in semiarid lands to control the soil and water losses (Francis and Thornes, 1990; Barea et al., 1996; Romero Díaz, 2003; Cerdà and Doerr, 2007). But the majority of revegetation programmes in arid and semiarid regions still ignores the great potential of this type of vegetation. Romero Díaz et al. (2010) indicated that 99% of revegetation programmes carried out by public authorities in Spain used fast growing tree vegetation (Pinus sp. and Eucalyptus sp.) that grow faster in non-fertile soils resisting to isolation. But the introduction of these species is conducted using aggressive techniques like terracing, changing topography and making more vulnerable terrain to soil loss, with erosion rates one or two order of magnitude greater than other shrublands naturally recovered (Romero Díaz et al., 2010). In relation to tree vegetation shrubs cover the soil faster, being very efficient in reducing runoff and soil erosion (Kummerow, 1989; Haase et al., 2000), not being necessary aggressive techniques for revegetation operations. The land use is the key factor that

determines the soil loss and the vegetation recovery which can contribute to reduce the soil and water losses. Land abandonment use to trigger an increase in soil erosion, but the vegetation recovery reduces the impact of the abandonment. The natural vegetation recovery is the most effective way to regenerate degraded soils although under arid and semiarid climatic conditions this process is delayed due to the water stress and soil degradation and revegetation programmes are carried out. A firm commitment for shrub vegetation is necessary for improving soil recovery in semiarid and arid lands.

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References
Alegre, J., Alonso-Blázquez, N., de Andrés, F., Tenorio, J.L., Ayerbe, L. 2004. Revegetation and reclamation of soils using wild leguminous shrubs in cold semiarid Mediterranean conditions: Litterfall and carbon and nitrogen returns under two aridity regimes. Plant and Soil 263, 203-112.
Barea, J.M., Requena, N., Jimenez, I. 1996. A revegetation strategy based on the management of arbuscular mycorrhizae, Rhizobium and rhizobacteria for the reclamation of desertified Mediterranean shrubland ecosystems. In: Mycorrhization of Forest Plants under Arid and Semi-arid Conditions and Desertification Control in the Mediterranean, CIHEAM-IAMZ, Zaragoza, pp. 75–86.
Breshears, D.D., Nyhan, J.W., Heil, C.E., Wilcox, B.P. 1998. Effects of woody plants on microclimate in a semiarid woodland: Soil temperature and evaporation in canopy and intercanopy patches. International Journal of Plant Sciences 159, 1010-1017.
Cammeraat, E.L.H., Cerdà, A., Imeson, A.C. 2010. Ecohydrological adaptation of soils following land abandonment in a semi-arid environment. Ecohydrology 3, 421-430.
Cecchi, G.A., Kröpfl, A.I., Villasuso, N.M., Distel, R.A. 2006. Stemflow and soil water redistribution in intact and disturbed plants of Larrea divaricata in southern Argentina. Arid Land Research and Management 20, 209–217.
Cerdà, A. 1997. The effect of patchy distribution of Stipa tenacissima L. on runoff and erosion. Journal of Arid Environments 36, 37-51.
Cerdà, A. 1998. Relationship between climate and soil hydrological and erosional characteristics along climatic gradients in Mediterranean limestone areas. Geomorphology, 25, 123-134.
Cerdà, A., Imeson, A.C., Poesen, J., 2007. Soil Water Erosion in Rural Areas. Catena special issue 71, 191- 252.
Cerdà, A., Flanagan, D.C., le Bissonnais, Y., Boardman, J., 2009. Soil Erosion and Agriculture. Soil and Tillage Research 106, 107-108.
Cerdà, A., Hooke, J., Romero-Diaz, A., Montanarella, L., Lavee, H., 2010. Soil erosion on Mediterranean type-ecosystems. Land Degradation and Development 21, 71-74.
Cerdà, A., Doerr, S.H. 2007. Soil wettability, runoff and erodibility of major dry-Mediterranean land use types on calcareous soils. Hydrological Processes, 21, 2325-2336. doi: 10.1016/j.catena.2008.03.010.
Cerdà, A., Lasanta, A. 2005. Long-term erosional responses after fire in the Central Spanish Pyrenees: 1. Water and sediment yield. Catena, 60, 59-80.
Delgado J, Llorens P, Nord G, Calder IR, Gallart F. 2010. Modelling the hydrological response of a Mediterranean medium-sized headwater basin subject to land cover change: the Cardener River basin (NE Spain). Journal of Hydrology 383: 125–134. DOI: 10.1016/j.jhydrol.2009.07.024
Dunkerley, D. 2008. Intra-storm evaporation as a component of canopy interception loss in dryland shrubs: observations from Fowlers Gap, Australia. Hydrological Processes 22, 1985-1995.
Francis, C., Thornes, J.B. 1990. Matorral: Erosion and reclamation. En: Albaladejo, J., Stocking,, M.A., Díaz, E. (Eds.), Degradación y regeneración del suelo en condiciones ambientales mediterráneas. Consejo Superior de Investigaciones Científicas, Murcia, pp. 87-116.
Garcia-Estringana, P., Alonso-Blázquez, N., Marques, M.J., Bienes, R., Alegre, J. 2010. Direct and indirect effects of Mediterranean vegetation on runoff and soil loss. European Journal of Soil Science 61, 174-185.
García-Ruiz, J.M. 2010. The effects of land uses on soil erosion in Spain: a review. Catena 81, 1-11.
Geeson, N., Brandt, C.J., Thornes, J.B. 2002. Mediterranean desertification: a mosaic of processes and responses. John Wiley & Sons, LTD, 433 pp.
Haase, P., Pugnaire, F.I., Clark, S.C., Incoll, L.D. 2000. Photosynthetic rate and canopy development in the drought-deciduous shrub Anthyllis cytisoides L. Journal of Arid Environments 46, 79–91.
Haile, G.W., Fetene, M. 2012. Assessment of soil erosion hazard in Kilie catchment, East Shoa, Ethiopia. Land Degradation and Development 23, 293-306.
Haregeweyn, N., Poesen, J., Verstraeten, G., Govers, G., de Vente, J., Nyssen, J., Deckers, J., and Moeyersons, J. 2013. Assessing the performance of a spatially distributed soil erosion and sediment delivery model (WATEM/

SEDEM in Northern Ethiopia. Land Degradation & Development, 24: 188- 204. DOI 10.1002/ldr.1121
Izzo, M., Araujo, N., Aucelli, P. P. C., Maratea, A., and Sánchez, A. 2013. Land sensitivity to Desertification in the Dominican Republic: an adaptation of the ESA methodology. Land Degradation & Development, 24: 486-498. DOI 10.1002/ldr.2241
Kakembo, V., Ndlela, S., and Cammeraat, E. 2012. Trends in vegetation patchiness loss and implications for landscape function: the case of Pteronia incana invasion in the Eastern Cape Province, South Africa. Land Degradation & Development, 23: 548- 556. DOI 10.1002/ldr.2175
Kargar Chigani, H., Khajeddin, S. J. and Karimzadeh, H. R. 2012. Soil relationships of three arid land plant species and their use in rehabilitating degraded sites. Land Degradation & Development, 23: 92- 101. DOI 10.1002/ldr.1057
Kummerrow, J. 1989. Structural aspects of shrubs in Mediterranean type plant communities. In: Bellot, J. (Ed.), Jornadas Sobre las Bases Ecológicas para la Gestión de Ecosistemas Terrestres. Options Méditerranéens. Série Séminaires. CIHEAM IAMZ, Zaragoza, Vol. 3, pp. 5–11.
Marques, M.J., Jiménez, L., Pérez-Rodríguez, R., García-Ormaechea, S., Bienes, R. 2005. Reducing water erosion in a gypsic soil by combined use of organic amendment and shrub revegetation. Land Degradation and Development 16, 339-350.
Miao, C. Y., Yang, L., Chen, X. H., Gao, Y. 2012. The vegetation cover dynamics (1982–2006) in different erosion regions of the Yellow River Basin, China. Land Degradation & Development, 23: 62- 71. DOI 10.1002/ldr.1050
Poyatos R, Llorens P, Piñol J, Rubio C. 2008. Response of Scots pine (Pinus sylvestris L.) and pubescent oak (Quercus pubescens Willd.) to soil and atmospheric water deficits under Mediterranean mountain climate. Annals of Forest Science 65: 306/301–306/313. DOI: 10.1051/forest:2008003
Prokop, P., Poręba, G. J. 2012. Soil erosion associated with an upland farming system under population pressure in Northeast India. Land Degradation & Development, 23: 310- 321. DOI 10.1002/ldr.2147
Puigdefábregas, J., Mendizábal, T. 1998. Perspectives on desertification: western Mediterranean. Journal of Arid Environments 39, 209-224.
Reynolds, J.F., Maestre, F.T., Kemp, P.R., Stafford-Smith, D.M., Lambin, E. 2007. Natural and human dimensions of land degradation in drylands: causes and consequences. In: Canadell, J.G., Pataki, D.E., Pitelka. L.F. (Eds.) Terrestrial Ecosystems in a Changing World, Global Change – The IGBP Series, pp. 247-259.
Romero Díaz, A. 2003 Influencia de la litología en las consecuencias del abandono de tierras de cultivo en medio Mediterráneos semiáridos. Papeles de Geografía 38, 151-165.
Romero Díaz, A., Belmonte Serrato, F., Ruiz-Sinoga, J.D. 2010. The geomorphic impact of afforestations on soil erosion in Southeast Spain. Land Degradation and Development 21, 188-195.Rowell, 2005
Ruiz Sinoga, J.D., Romero Díaz, A., Ferre Bueno, E., Martínez Murillo, J.F. 2010. The role of soil surface conditions in regulating runoff and erosion processes on a metamorphic hillslope (Southern Spain). Soil surface conditions, runoff and erosion in Southern Spain. Catena 80, 131-139.
Tomaselli, R. 1981. Main physiognomic types and geographic distribution of shrub systems related to Mediterranean climates. In: di Castri, F., Goodall, D.W., Specht, R. (Eds.), Ecosystems of the world: Mediterranean-type shrublands. Elsevier, Amsterdam, Netherlands, pp. 95–106.
UNEP. 1991. Status of Desertification and Implementation of the United Nations Plan of Action to Combat Desertification. United Nations Environment Programme (UNEP). Nairobi.
Zhao, G., Mu, X., Wen, Z., Wang, F., and Gao, P. 2013. Soil erosion, conservation, and Eco-environment changes in the Loess Plateau of China. Land Degradation & Development, 24: 499- 510. DOI 10.1002/ldr.2246
Ziadat, F. M., and Taimeh, A. Y. 2013. Effect of rainfall intensity, slope and land use and antecedent soil moisture on soil erosion in an arid environment. Land Degradation & Development, 24: 582- 590. DOI 10.1002/ldr.2239