Geoderma 145 (2008) 252–258

Contents lists available at ScienceDirect

Geoderma

journal homepage: www.elsevier.com/locate/geoderma

Sieving crusts and macrofaunal activity control soil water repellency in semiarid environments: Evidences from SE Spain

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ARTICLE INFO

Article history:
Received 5 February 2007
Received in revised form 24 January 2008
Accepted 31 March 2008
Available online 23 May 2008

Keywords:
Runoff hydrograph
Organic matter
Rabbit latrines
Mica schist soil

ABSTRACT

Quick overland flow peaks observed in runoff hydrographs from rainfall experiments carried out on mica schist soils in Rambla Honda (SE Spain) suggest development of soil water repellency (SWR). In order to spatially characterize its occurrence and severity and the factors controlling it, potential water repellency was measured in 120 soil samples using the WDPT test at laboratory conditions. Actual water repellency measurements were additionally performed at field conditions in order to increase our knowledge about the occurrence of this phenomenon. Samples were taken in bare soils (n = 23), beneath plant clumps of *Retama sphaerocarpa* (n = 23) and *Anthyllis cytisoides* (n = 10) and from soils affected by rabbit latrines (n = 9). Soil organic matter was also determined in 47 selected samples with a broad range of potential water repellency values. Results indicate that occurrence of SWR in Rambla Honda (potential water repellency values) varies in the three soil dimensions, areal and depth. The areal variation is due to the patchy pattern of organic matter and the variation with depth of the washed-in layer of sieving crusts developed in colluvial and alluvial soils after abandonment by agriculture. These layers act as physical barriers that restrict or impede the translocation of hydrophobic compounds to deeper layers. Such three-dimensional heterogeneity stresses the importance of the sampling scheme used for adequate SWR assessment. The severity of water repellency is generally reduced in this area because of the relatively scarce organic matter content and its spatial variability. A weak exponential relationship was found between the severity of potential water repellency and total organic carbon (r^2 = 0.38; p-value < 0.01). Extreme values of actual and potential water repellency were found in rabbit latrines, stressing the importance of macrofauna in its development. Water repellency has an important impact on the local hydrology controlling runoff–runon between vegetated and bare patches, and possibly flash flooding during heavy rains in early autumn or after long dry periods. Review of a series of runoff hydrographs from previous rainfall simulations has distinguished four types of runoff patterns based on the occurrence of SWR.

1. Introduction

Soil water repellency (SWR) is much more widespread than formerly thought, and there is a considerable body of published research (see reviews by DeBano, 2000; Doerr et al., 2000; Dekker et al., 2005). The main hydrological impact of water repellency is a reduction in soil infiltration capacity promoting overland flow (Doerr et al., 2000, 2003) and increasing risk of erosion (Shakesby et al., 2000). In semiarid climate conditions, these water repellency-associated impacts have been demonstrated and quantified by rainfall simulation (Burch et al., 1989; Imeson et al., 1992; Nicolau et al., 1996; Cerdà et al., 1998; Coelho et al., 2005; Moral García et al., 2005). In spite such evidence, few studies have evaluated factors controlling the spatial distribution of this soil property.

According to Doerr et al. (2000), water repellency can be promoted by biotic (vegetation, soil fungi and micro-organisms, and soil organic matter and humus) and non-biotic factors (soil temperature, fire and soil texture). Although there are few data available about macrofauna activity in this respect, it could be another factor promoting this phenomenon, especially in semiarid areas (Cammeraat et al., 2002). As soil moisture content is also an important factor explaining water repellency, it would be expected to be higher in aridic or dry soils than in humid soils (Doerr and Thomas, 2000; Doerr et al., 2000). Jaramillo et al. (2000) tested this hypothesis and concluded that climate influences water repellency only through the production of organic matter. In drylands where the production of organic matter is small, soil water repellency is generally discontinuous, patchy and lower than soils developed in humid climates. However, the correlation between soil water repellency and organic matter content is not clear. While some studies have shown a positive correlation (Harper et al.,

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doi:10.1016/j.geoderma.2008.03.019