



## The effects of fuel reduction treatments on runoff, infiltration and erosion in two shrubland areas in the north of Spain

Cristina Fernández\*, José A. Vega, Teresa Fonturbel

Centro de Investigación Forestal-Lourizán, Xunta de Galicia, Carretera Marín km 4, P.O. Box 127, 36080 Pontevedra, Spain

### ARTICLE INFO

#### Article history:

Received 27 May 2011  
Received in revised form  
7 February 2012  
Accepted 26 March 2012  
Available online

#### Keywords:

Prescribed burning  
Mastication  
Clearing  
Hydrological parameters  
Sediment yields

### ABSTRACT

The immediate effects of prescribed burning, shrub clearing and shrub mastication on runoff, infiltration and erosion were evaluated in two contrasting shrubland areas in northern Spain. Rainfall simulations ( $67 \text{ mm h}^{-1}$  for 30 min) were conducted immediately after fuel reduction treatments in each runoff plot. Compared to shrub mastication and shrub clearing, prescribed burning generated the lowest infiltration rate and highest runoff and erosion rates at both study sites. However, sediment yields measured immediately after treatments were low in all cases, from  $0.31$  to  $2.22 \text{ g m}^{-2}$  after shrub clearing,  $0.40$ – $1.63 \text{ g m}^{-2}$  after shrub mastication and  $2.30$ – $8.11 \text{ g m}^{-2}$  after prescribed burning. Slope, type of fuel reduction treatment and the depth and cover of the soil organic layer remaining after treatment were the most important variables determining runoff and erosion during the first rainfall event following treatment. In the rainfall simulation plots subjected to prescribed burning, the maximum temperatures reached at the organic layer/mineral soil interface during burning also had a significant effect on soil loss. The findings show that good fuel management prescriptions make fire hazard reduction and soil conservation compatible in cases where the remaining soil cover is about 70%.

© 2012 Elsevier Ltd. All rights reserved.

### 1. Introduction

In the past decade, shrubland areas burned by wildfires accounted for greater than 35% of all burned areas in Spain (Ministerio Medio Ambiente, 2006). Shrubland areas are increasing as a result of the high levels of land abandonment in many rural areas in Spain, with a subsequent increase in fire risk (Vélez, 2009). In addition, disposal of agricultural residues through burning practices along with similar activities associated with hunting and grazing account for more than 25% of wildfire ignitions in shrubland areas (Chas and Touza, 2009). Fuel reduction treatments are commonly used to reduce the risk of severe wildfire (Covington et al., 1997; Vega et al., 2000), and fuel management has become a priority at the wildland–urban interface. The Spanish Environmental Ministry (Ministerio de Agricultura, Alimentación y Medio Ambiente) is currently developing a Forest Fire Prevention Programme to address these problems and in some cases is implementing fuel reduction treatments in shrubland areas in order to reduce the fire risk.

Mechanical methods (clearing or mastication) are alternative fuel reduction techniques that are increasing in popularity, but very

little is known about the environmental effects associated with their use and also the replicated experiments comparing prescribed burning, mastication and clearing are scarce (Fernández et al., 2008; Potts et al., 2010). The effects of prescribed burning on soil hydrological parameters, erosion or water quality have been investigated in different environments around the world (e.g. Robichaud, 2000; Coelho et al., 2004; Hubbert et al., 2006; Moffet et al., 2007; Pierson et al., 2009; Smith et al., 2010) and also in Spain (e.g. Soto and Díaz-Fierros, 1998; Gimeno et al., 2000; Marcos et al., 2000; De Luis et al., 2003; Vadilonga et al., 2008). However, there is almost no quantitative data on the effects of shrub mastication or shrub clearing (Fernández et al., 2008). Moreover, some information on the relationships between the thermal regime, hydrological parameters and soil erosion has been reported for prescribed fires (Vega et al., 2005; Fernández et al., 2008), but further details about thermal regimes and other fire behaviour characteristics are still required for developing burn prescriptions.

Rainfall simulation experiments have been widely used to study the effects of prescribed burning on hydrological characteristics in shrubland and forest areas (e.g. Marcos et al., 2000; Robichaud, 2000; De Luis et al., 2003; Fernández et al., 2008) because they enable comparison of the same rainfall characteristics in different treatments and replicates, despite the fact that natural rainfall characteristics and spatial scales may not always be reproduced (Rickson, 2001). Although increased erosion after fire can last anywhere

\* Corresponding author. Tel.: +34 986 805013; fax: +34 986 856420.  
E-mail address: [cfilgueira@gmail.com](mailto:cfilgueira@gmail.com) (C. Fernández).