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Changes in landscape fire-hazard during the second half of the 20th century: Agriculture abandonment and the changing role of driving factors

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ABSTRACT

Past the middle of the 20th century, forest fires started to increase markedly in the Mediterranean countries of southern Europe. Hazardous land-use and land-cover (LULC) changes are considered major drivers of increased fire-hazard and fire risk. However, the contribution of various LULC changes to increased fire-hazard, as well as the role of environmental or socioeconomic factors in driving them, including its changing role over time, are poorly known. Understanding how changes in socio-economics in interaction with other factors modify landscape fire-hazard and risk is a major priority in fire-prone areas. Here we determined changes in fire-hazard through time, focusing on the contribution of agriculture abandonment to it, and on the changing role of its driving factors, in a large (56,000 km^2) rural area in West-Central Spain. The study period covers from 1950s to 2000. LULC maps at different time steps (1950s, 1978, 1986 and 2000) were available, as well as environmental and socioeconomic information at various scales. We analyzed trends in LULC change, focusing on those altering fire-hazard, and used general linear models (GLM) with generalized linear mixed models (GLMM) to account for the effects of variables at different spatial scales in determining changes leading to shifts in fire-hazard. We found that the proportion of hazardous LULC types increased twofold (26–42%) from 1950s to 2000. Until 1986, agriculture abandonment was the dominant LULC change leading to increased fire-hazard. Post-1986, LULC changes were mainly driven by deforestation due to fires and densification caused by natural vegetation dynamics. Models showed that the first abandoned lands were driven by local environmental and socioeconomic constraints (small farms, in distant locations, in municipalities with low population), whereas later abandonments were driven by non-local ones (large farms, in more productive soils, closer to towns, populations with high unemployment, and higher employment in the services sector). Throughout the entire period, high proportion of wildland vegetation, low mechanization level, and large number of land-holders older than 55 years favored abandonment. This implies that as the population ages, larger, more accessible and productive areas are abandoned, fire-hazard will increase closer to human settlements, increasing the wild-land urban interface and fire risk.

1. Introduction

Fire activity has increased markedly during the second half of the last century in many parts of the world (FAO 2001; Bowman et al., 2009). Fires are mainly driven by climate, fuels, availability of ignitions and, in some countries, firefighting capacity. While changes in climate (Westerling et al., 2006; Koutsias et al., 2012) and urban encroachment (Syphard et al., 2007, 2012; Lampin-Maillet et al., 2011) have been proposed as major drivers of change in fire regime in some areas, changes in fuels and landscape-level fire-hazard might have also played a dominant role (Fernandez-Ales et al., 1992; Lepart and Debussche, 1992; Moreira et al., 2001; Kalabokidis et al., 2007; Carmel et al., 2009). In the case of Mediterranean countries of southern Europe, fires started to increase during the early 1970's, but not so much in Northern Africa, indicating that socioeconomic factors were a major driver of change. More so, trends in fire activity in various countries was decoupled from changes in climate (San-Miguel-Ayanz et al., 2012), which further supports that socioeconomic changes, including changes in fuels and landscapes

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(Moreno et al., 1998; Rego, 1992), and also firefighting capacity in recent times (Brotons et al., 2013), were behind it, although additional effects of changes in climate cannot be excluded (Koutsias et al., 2013; Bedia et al., 2014). Recent studies indicate that trends in fire activity in some of the southern European countries have discontinuities that suggest a role for various factors, including land-use and land-cover (LULC) changes (Moreno et al., 2014).

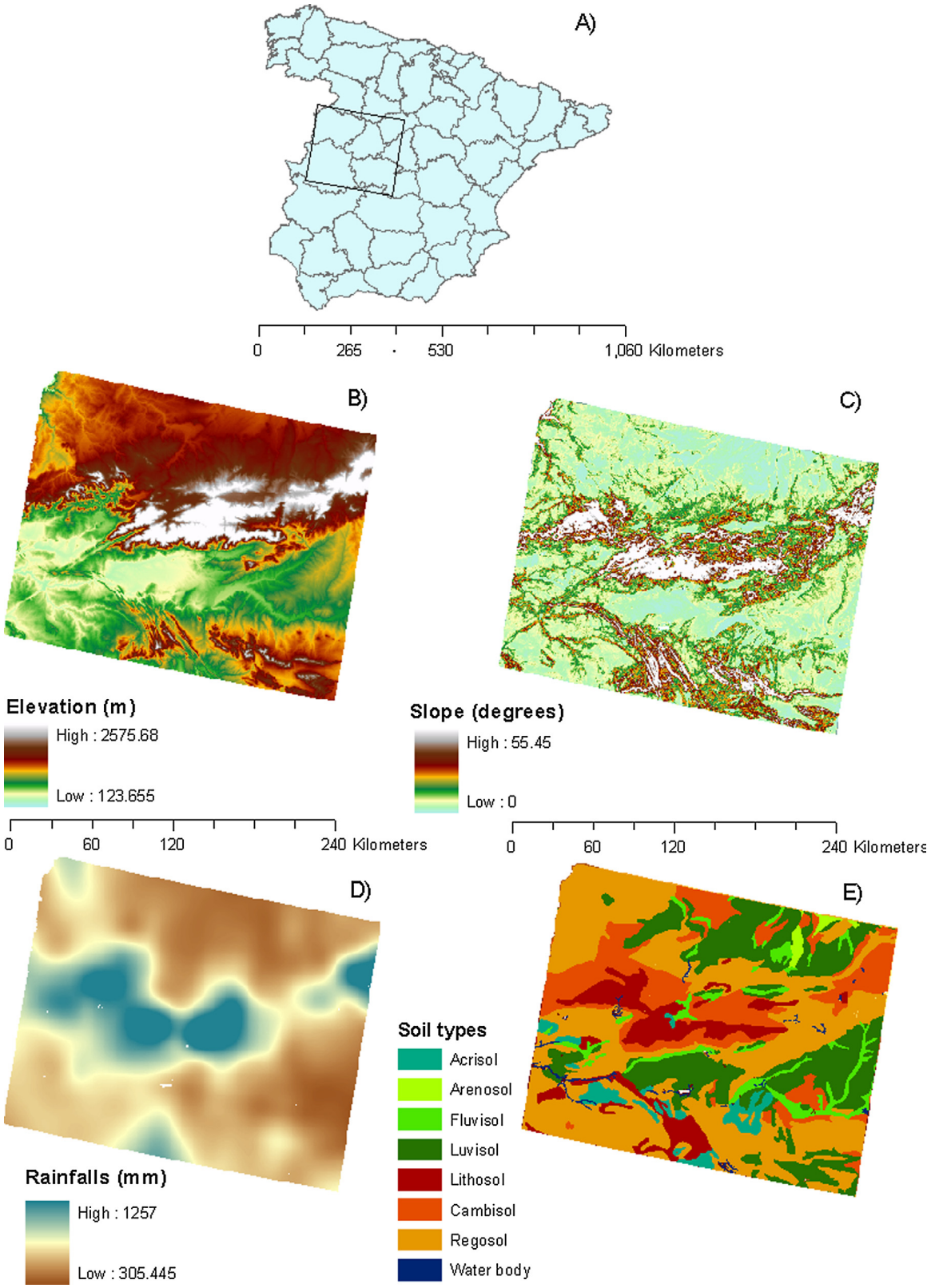

Fig. 1. Location of the study area in West-Central Spain (A). Map of elevation in meters (B), map of slopes in degrees (C), map of mean annual rainfalls in mm (D) and map of soil types (E).