



# A territorial approach to assess the transition to trellis vineyards in special protection areas for steppe birds in Spain



F. Montero García<sup>a,\*</sup>, A. Brasa Ramos<sup>a</sup>, F. Montero Riquelme<sup>a</sup>, G.J. Carsjens<sup>b</sup>

<sup>a</sup> Escuela Técnica Superior de Ingenieros Agrónomos y de Montes, Universidad de Castilla-La Mancha, Campus Universitario, 02006 Albacete, Spain

<sup>b</sup> Land Use Planning Group, Wageningen University, P.O. Box 47, 6700 AA Wageningen, The Netherlands

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## ABSTRACT

Traditional vineyards in Spain are being upgraded to trellis vineyards. A key question is to what extent the transition to trellis vineyards is compatible with the environmental preservation goals in Special Protection Areas. This paper presents a GIS-based model to assess the suitability of Special Protection Areas for the development of trellis systems. The model was applied in a Special Protection Area for steppe birds in Castilla-La Mancha, Spain, a region with the largest concentration of vineyards in the world. The model includes three components: (1) a vineyard structure analysis, (2) an analysis of habitat fragmentation, and (3) a suitability analysis. The results showed that 50.9% of the study area, including 82.1% of the existing vineyards, was classified as suitable for transition to trellis systems. In the remaining unsuitable areas an increase in trellis systems should be avoided. The model is a stepping stone for improving the sustainable land use development of Mediterranean agricultural landscapes. Further research is needed to include wider socio-economic and environmental consequences of modernizing viticulture practices.

## 1. Introduction

Grapevine is one of the traditional rain-fed crops that shaped the agricultural landscapes in the Mediterranean Basin (Montero Riquelme and Brasa Ramos, 2005). Spain is the second-largest producer of grapes for wine in the European Union, comprising 29.6% of the yearly production in the EU (Eurostat, 2016). Grapevine is an important crop from socio-economic point of view, but also environmentally as a permanent plant cover, for managing land and water resources in a sustainable way, and preventing erosion and desertification (Martín de Santa Olalla, 1994). In general, the Mediterranean agricultural landscapes perform a multifunctional role that exceed the production of commodities and food, by providing many other services that benefit society, such as protection of biodiversity, socio-economic viability of rural areas and food security (Egea and Pérez y Pérez, 2016; Biasi and Brunori, 2015; Lovell et al., 2010; Kallas et al., 2007; Tió and Atance, 2001).

Mediterranean agricultural landscapes are subject to modernization of production processes, such as the application of new crop production techniques (Pérez-Hugalde et al., 2011; Pain and Pienkowski, 1997; Tucker et al., 1994). In grapevine production, traditional vineyards are being upgraded to trellis vineyards (see Fig. 1), in which the traditional

bush-vine system is replaced by a row-based system supported by wires and poles (also known as *espalier*, *espaldera* or *spalliera*) (Assandri et al., 2017). A trellis system requires a higher plant density, compared to the traditional bush-vine system, and a larger distance from the fruiting zone to the ground. Trellis systems ease the work of farming activities, such as leaf removal, shoot removal and cluster thinning (Bem et al., 2015) and allow a higher degree of mechanization of production and harvesting techniques (Torquati et al., 2015). These techniques enable a more precise application of fertilizers, pesticides and irrigation water, resulting in higher yields (García García et al., 2012) and wine quality improvement (Ewert et al., 2015).

Although trellis systems provide the farmers with a more competitive position in the grapevine market, conservationists argue about the impact on the Mediterranean landscape and biodiversity. Upgrading and modernization of agricultural practices in general have shown to be harmful to biodiversity (Alonso et al., 2003; Gabriel et al., 2010; Jeliakov et al., 2016). Concerns of conservationists in the Iberian Peninsula especially involve the decrease of steppe bird populations (Cardador et al., 2015). Endangered steppe bird species are, for example, the little bustard, *Tetrax tetrax*, and the stone curlew, *Burhinus oedicnemus* (Pinto et al., 2005). However, the Great Bustard *Otis tarda* (see Fig. 2) is the most affected by agricultural development, as it is

\* Corresponding author.

E-mail addresses: [franciscoj.montero@uclm.es](mailto:franciscoj.montero@uclm.es) (F. Montero García), [antonio.brasa@uclm.es](mailto:antonio.brasa@uclm.es) (A. Brasa Ramos), [francisco.montero@uclm.es](mailto:francisco.montero@uclm.es) (F. Montero Riquelme), [gerrit-jan.carsjens@wur.nl](mailto:gerrit-jan.carsjens@wur.nl) (G.J. Carsjens).

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Fig. 1. Traditional bush-vine system (left) and row-based trellis system (right).



Fig. 2. Great Bustard (*Otis tarda*).

very sensitive to habitat changes. The Great Bustard is one of the most emblematic European wild bird species, and among the biggest and heaviest flying birds: large males weigh more than 20 kg with a total wingspan of 150 cm. It is worldwide endangered and qualified as “threatened-vulnerable” by the International Union for Conservation of Nature (Stattersfield et al., 2000). The Iberian Peninsula is home to 50% of the population of Great Bustards in Europe (Pinto et al., 2005). The ideal habitat for the Great Bustard is a landscape mosaic consisting of extensive rain-fed cereals and legumes, natural meadows and fallow plots (Madroño, 2004). Although the traditional bush vineyards are not ideal habitat, they provide a refuge and a food source (Madroño, 2004). In contrast, trellis vineyards are considered unsuitable habitat, because the vegetation walls with posts and wires create unsafe areas for the birds, by limiting the visibility and posing a risk of collision (Pinto et al., 2005).

The European Union seeks to conserve wild birds, such as steppe birds, by issuing rules for their protection, management and control. The Birds and the Habitats Directives are the main legislative instruments for ensuring conservation and the sustainable use of nature in the EU, in particular through the Natura 2000 network of areas with high biodiversity. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species, such as steppe birds. The network stretches over 18% of the EU land surface and is the largest coordinated network of protected areas in the world (European Commission, 2014). Special protection areas (SPAs) are an important component of the Natura 2000 Network (Council Directive 92/43/EEC). The Natura 2000 Network in Spain includes 644 SPAs, stretching 137,000 km<sup>2</sup> or 27% of the total land surface. Environmental authorities in these SPAs have to draw up management plans and implement conservation measures to prevent damaging activities, plans and projects that can significantly disturb species and habitats. The Birds Directive (Art. 4) states that conservation measures must be supported by scientific criteria, but the directive also allows the authorities to adapt to local circumstances.

In steppe land SPAs the authorities are confronted with applications of farmers for licenses for new trellis vineyards. A key question the authorities need to answer is to what extent the transition to trellis vineyards, as a major economic activity, is compatible with the environmental preservation goals in the SPAs. Preservation-development conflicts have been widely discussed in scientific literature, as well as the need to develop approaches and supporting tools for land-use planning and environmental management (de la Rosa et al., 2004; Espejel et al., 1999; Lamelas et al., 2009; Martín-López et al., 2011; Pino et al., 2000; Xu et al., 2006; Tassinari et al., 2013; Vonk and Geertman, 2008). However, an approach that allows to assess the options for trellis vineyards in SPAs is currently lacking.

This paper presents an approach and GIS-based model that allow to identify the suitability of areas in SPAs for the development of trellis systems, without compromising the conservation goals for steppe birds. A case study was done for a SPA dedicated to the protection of steppe birds in Castilla-La Mancha, Spain.

## 2. Methodology

The approach and GIS-based model consists of three main components, a Vineyard Structure Analysis, an Analysis of Habitat Fragmentation and a Suitability Analysis (Fig. 3). The main input of the model consists of geospatial data about land use and infrastructure. The Vineyard Structure Analysis aims at identifying the spatial distribution of grapevine production areas. The Analysis of Habitat Fragmentation aims at identifying the fragmentation of habitat areas of the Great Bustard. The results of both analyses are combined in the Suitability Analysis, which aims to classify areas in different categories of suitability for establishing trellis vineyards. The next sub-sections introduce the case study area, the land use data that were used as input

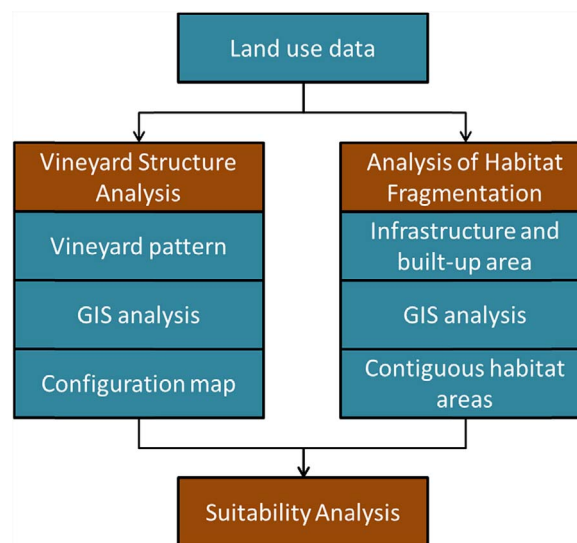


Fig. 3. Scheme of main components of the model.

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