Fine-scale mapping of High Nature Value farmlands: novel approaches to improve the management of rural biodiversity and ecosystem services

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Abstract

High Nature Value farmlands (HNVf) are defined as rural lands characterized by high levels of biodiversity and extensive farming practices. These farmlands are also known to provide important ecosystems services, such as food production, pollination, water purification and landscape recreation. Recently, this concept has been introduced in Rural Development Programmes related to biodiversity preservation in traditional agricultural landscapes. However, there are no specific rules concerning the practical use of the concept, particularly on the identification of potential HNVf areas at a local scale. However, this application becomes important for farmland biodiversity protection in the context of multi-scale agricultural development.
We present a novel approach for HNVf mapping, which provides an improved local discrimination of farmlands according to their contribution for the conservation of rural biodiversity and ecosystem services. Our approach is based on a multi-criteria valuation of habitat types based on the national land cover map and agrarian censuses. It is considered applicable in other EU countries since comparable datasets are usually available. This methodology is also expected to provide the backbone of a standard, cost-effective methodology for HNVf monitoring, with an emphasis on the impacts of land use change on species, habitats and landscape function.

Keywords: HNVf, rural biodiversity, ecosystems services, mapping, local scale

1. Introduction

Biodiversity is an important product of agriculture landscapes, but in many European farmlands species richness has been declined (Billeter, LiiRA et al. 2008). Furthermore, research and policy on biodiversity conservation and agriculture management have not progressed very well (Moonen and Bàrberi 2008). Since rural landscapes are dominant in most European countries

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and the European Union (EU) has established ambitious goals concerning the halting of biodiversity loss (Pereira and Cooper 2006; EEA 2006a; EEA 2006b; Fontaine 2007), it is imperative to establish sound frameworks to monitor agricultural impacts on biodiversity, selecting the best general indicators (EASAC 2005; EEA 2005; EEA 2006b; EEA 2007) and at the same time paying attention to the specificity of different agro-ecosystems. It is important to understand the relationships between landscape, biodiversity and land use to manage land and making plans for the future maintenance or enhancement of the current resources Jongman et al 2006).

More than 50% of Europe's most highly valued biotopes occur in low intensity farmland (Bignal and McCracken 1996). Over the last few decades biodiversity losses in farmlands were, in great extent, due to large scale rationalization and intensification of agricultural production and, on the other hand, many marginal and extensively farmed areas were either improved or abandoned, both resulting in reduced on habitats and species diversity (EEA 2004).

2. High Nature Value Farmland

Among the many initiatives to prevent biodiversity decline, the identification and mapping of High Nature Value Farmlands (HNVf, low-intensity traditional agricultural areas, such as the Montados in Portugal) is surely one of the most valuable (Andersen, Baldock et al. 2003; EEA 2004; Paracchini, Terres et al. 2006; Cooper, Arblaster et al. 2007; Poux and Ramain 2009). Besides gathering information about these areas, a major objective is to take conservation measures to protect hotspots of biodiversity (EEA 2004).

HNVf is a term applied on rural lands characterized by the existence of high levels of biodiversity, and by extensive farming practices (EEA 2004). Recently, this term, introduced for the first time by Baldock et al in 1993 (Baldock D, Beaufoy G. et al. 1993) as farming systems with low-inputs of chemicals and of management practices, was also adapted to the forests thematic in the framework of the Rural Development Plans (Beaufoy and Cooper 2008).

Europe is characterized by unique and variable rural landscapes, heritage of many centuries of cultural and natural history (EEA 2004). Many of them can be considered as HNVf. According to Andersen (Andersen, Baldock et al. 2003), there are three types of High Nature Value farmland:

Type 1: farmland with a high proportion of semi-natural vegetation;

Type 2: farmland with a mosaic of habitats and/or land uses;

Type 3: farmland supporting rare species or a high proportion of European or World populations.

In Europe (EU 15), about 15-25% of the utilized agricultural area (UAA) is considered as HNV farmland. The majority of this area is located in the Southern Europe, being that in Portugal the percentage of HNV farmland is about 37% of UAA (EEA 2004).

Another important term associated with HNVf is HNV farming, used in more recent documents (Beaufoy and Cooper 2008). It refers not only to the land use (farmland) but also associated to management practices on farming. In the context of the Rural Development Programs the HNV farming indicator is an obligation of the EU states in order to see if the rural programmes objectives are being achieved under the strategy of Pillar 2 from CAP (Beaufoy and Cooper 2008). These indicators were not only to describe and characterize where HNVf is located, the farmland systems and practices as well as species and habitats of conservation concern (baseline indicators), but also to survey HNVf, contributing to monitor agricultural impacts on biodiversity (result and impact indicators). Member States are committed to identify and maintain HNV farming, and it is important to all countries to identify these systems in order to implement the economic support measures for it (Beaufoy 2009). Ultimately, HNVf associated with high levels of biodiversity can also be related with the concept of ecosystem services, since in this traditional agricultural areas ecosystems provide a range of ecosystem services such as food, water purification, soil formation, recreation.

3. Mapping HNVf across Europe

3.1. Problems with existing methodologies

Ecological, historical and cultural differences in the values of landscapes among countries require region-specific rules to identify HNVf. This paper addresses this problematic and presets a new methodology to map HNVf at a local level, regarding the importance of this identification to the improvement of rural natural and economic environment.
The standard procedures for mapping HNVf in Europe include the use of land use data (CLC - Corine Land Cover), with classes based on Environmental Stratification (Metzger et al 2005). When available, the methodology also suggests the use of complementary information on farming practices, altitude and latitude, soil quality, climatic condition, steepness of slope at national level to improve the cartography (Paracchini, Terres et al. 2006). However, the final map cannot be used to draw conclusions on the presence of HNV farmland at the local level, but only at the regional level (Paracchini, Terres et al. 2006).
However, for identification at the local level the application of a downscaling exercise using a bigger scale land use map seemed to be a good option. At a local level we had available the COS (Portuguese land cover map – 1:25000) done by the IPVC/ESAPL with aerial pictures from 2005. The exercise done was to identify compatibility among land use classes of COS and CLC. However, there is no good relationship between the two classifications and the final result map showed more than the double extent of HNVf area than using the CLC dataset. So, differences in land use class notions at maps with different scales (table 1) showed incompatibility of CLC at the local scale and a better fit of COS to map HNVf at a local scale. Scale and the related legend are very important when trying to map HNVf, because different agro-ecological processes operate at different scales that must be taking in account. This also implies that the methodology of identification of HNVf should be renewed.

3.2. Local scale HNVf mapping – proposal of a new methodology

In order to best consider those areas that could be excluded when applying the CLC methodology, a new refined methodology has been decided upon to identify local HNVf. The local land cover dataset (COS2005) is the base of this methodology.
The first step was to define the "total farmland area", considering not only the pure agricultural and agro-forestry areas, but also forestry and semi-natural areas directly linked with farmland (until 5ha and 1 ha close to agricultural areas respectively). Herewith, we are placing the farmland not as fragments with restricted boundaries, but in its context as a continuous place where biodiversity circulates among habitats.
Taking in account the different levels of analysis, the patch and parish level, the HNVf level map should be presented at the lower detailed scale, the parish level, in order to not lose information in the transition among scales. The patch level map results from the use of only four indicators that are available at this level.
As a landscape concept, HNVf should not be mapped directly by the patch of COS, but using some HNV features, considering features different metrics and indicators of the landscape and farming environment (Figure 1). Landscape indicators: (1) landscape composition to extract information about the patch of COS; (2) landscape structure to measure the quality of the neighbourhood of each patch. Available data of (3) farming features was also added at the parish level, to identify the importance of primary sector of activity in each parish. Finally, (4) natural value was taken into account, using available data from the Baixo Tâmega report (FCUP 2009), because the value of biodiversity and ecosystems could be inferred by a serial stratification analyses.
For all indicators an average values were calculated for each parish, based on "total farmland area". To isolate any problem between variables a correlation analysis has been carried out. The farmland area appears not correlates significantly with the HNV indicators.

To select some indicators, a correlation analyses and a Spearman index was done. The method for mapping was the reclassification of the selected indicators in 5 classes using equal breaks method. The scale range varies from 1 (low nature value farmland) to 5 (high nature value farmland). The objective was not to cut areas but to make a scale range between them. The final maps result from the mean value among selected indicators.

3.3. Testing the new framework in Northern Portugal

The region chosen to carry out this exercise was Baixo Tâmega, North Portugal, a mosaic of different agrarian systems and landscapes that have been suffering abandonment in the last few decades. On the other hand, there are some areas with more specialized and intensive agricultural areas, mostly related to wine production. There are also non-cultivated areas, mostly in mountain areas, with semi-natural vegetation associated with extensive grazing. Due to the regular presence of semi-natural vegetation types, most of these farmlands are classifiable as HNVf areas (Andersen, Baldock et al. 2003).
Both final maps (figure 2) show good results for the identification of HNVf, so this methodology seems to be efficient to map HNVf at local scale. On the one hand, the "*Parish HNVf map*" supports more indicators than the "*Patch HNVf map*". Still, the "*Patch level map*" gave us a more accurate picture of HNVf extension. The choice will depend on the study objectives and data availability.
This methodology applied on our study area can be used either spatially, comparing the extent of potential HNVf areas among different regions, or temporally, comparing changes in extent of HNVf in one region at different times as a monitoring effort.

4. Discussion

The concept of HNVf, areas associated with low intensity farming, has become very important regarding agrobiodiversity protection under the Rural Development Programs. It is already developed in many European countries in different point of views, and begins to take more and more included in the political agricultural context. This could mean economic support to these areas, through European financial instruments.
Land Cover, farming characteristics and species data are the common approach to the identification of HNVf at European and national level. The availability and the quality of farming and species datasets is a recurrent problem. Two methodologies were tested to map HNVf in Baixo Tâmega region, using land cover datasets at different scales. However, the result maps showed different HNVf extents.
A new refined methodology based on land cover map landscape indicators, farming and natural/conservation data was designed to map HNVf at a local scale. The use of datasets on nature including information on the valuation of ecosystem services inferred from land-use dataset was an advantage used in this case study. In the literature HNVf is known to promote biodiversity in agroecosystems. We can suggest a novel approach that HNVf is associated to areas where ecosystem services are more valuable, for instance, systems of autochthonous hardwood close to agricultural areas have the highest value in the supporting services as soil formation or nutrient cycling.
This methodology appears as an important instrument in the identification of HNVf areas to support policy implementation in the framework of agrobiodiversity protection. Additionally, we expect with future research to check the possibility to adapt this methodology in other EU countries, since the exercise is based on local land cover datasets. If countries have similar local datasets, this methodology can be tested and applied.

Table 1 - Comparison between CLC and COS land use classes.

CLC – Lusitanian region	COS
Pastures Land principally occupied by agriculture Agro forestry areas Moors and heathlands	Annual crops associated with permanent crops (orchards, vineyards and olive groves) Orchards and orchards associated with olive groves, vineyards and annual crops Olive groves and olive groves associated with orchards, vineyards and annual crops Vineyard and vineyards associated with olive groves, orchards and annual crops. Agro forestry areas Complex and partial cultural systems Semi-natural areas

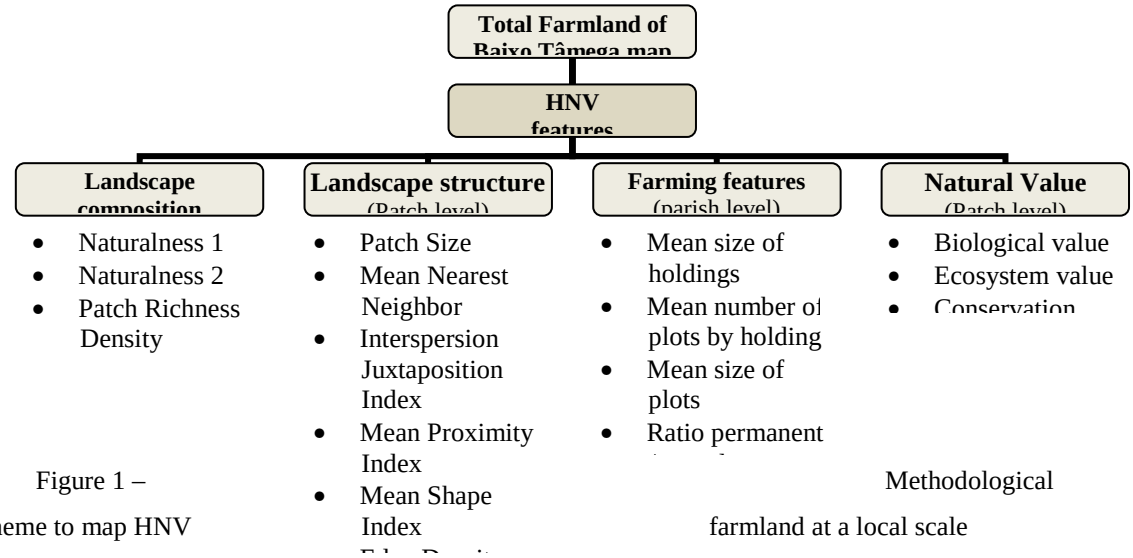

Figure 1 – Methodological scheme to map HNV farmland at a local scale

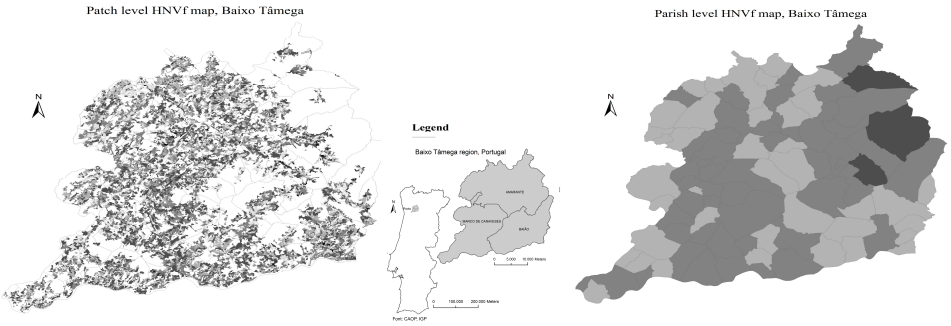

Figure 2 – Patch and Parish HNVf map using the new methodology

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