I.S.B.N.: 2-85352-399-3. Pp: 273-277.

SOIL INVESTIGATION USING A PARTICIPATIVE APPROACH FOR AGRI-ENVIRONMENTAL IMPROVEMENT IN MONEGROS, SPAIN

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Summary

The saline wetlands of the Monegros Desert, in the center of the Ebro Basin (NE Spain), host valuable biodiversity and pedodiversity. A part of this area has been proposed for inclusion in the Natura 2000 E.U. Network. However, agricultural intensification is changing the area as more land is consolidated for new irrigation or is plowed to obtain CAP (Common Agricultural Policy) subsides. Soil mapping is needed to assist in the delimitation of natural habitats and make conservation compatible with agriculture. The methodology presented here to characterize agri-environmental areas takes into account current agricultural and environmental practices. The approach was participative, asking the opinion of farmers and agricultural and environmental officers about a new agri-environmental measure which could be proposed to the Rural Development section of the CAP. The measure would economize agriculture inputs in unproductive areas and also meet nature conservation purposes. A GIS data base was built for selecting the farming plots suitable for new agricultural practices favoring biodiversity and pedodiversity. At the local scale, we used remote sensing and pedodiversity criteria for selecting low productive areas to be prospected. The opinion poll resulted in a positive response, with a 67% of the managed surface favoring a new CAP measure compatible with nature conservation. The poll confirmed the interest of the farmers in having detailed maps of the soil features that limit crop production.

Introduction

The Monegros saline wetlands are isolated endorheic environments occupying gentle depressions surrounded by irrigated or dry-farmed areas. The determining factors in their genesis and evolution have been the arid climate and the gypsiferous and calcareous rocks. More than a hundred depressions containing ephemeral brines and halophylous vegetation have been inventoried. These wetlands have scientific and environmental value as natural habitats for endemic microbes *(Casamayor et al., 2005)*, plants *(Domínguez et al., 2006)* and animals (Melic and Blasco, *1999)*. Half of the agricultural area has been proposed for inclusion in the Natura 2000 E.U. Network. The other half will be irrigated for cultivation.

The soils are shallow, calcareous or gypseous, with low organic matter contents. The soils are deeper and saline in the wetlands, with salinity largely exceeding thresholds for crop production. Despite the low returns imposed by natural limits, dry farming often is practiced in areas of shallow soils with low water holding capacity, in spite that evapotranspiration much greater than precipitation results in no yield. Due to very irregular precipitation from a year to year the only feasible crops are winter cereals, which remain unprofitable in dry years. Farmers are compelled to enlarge the plowed surface to earn subsidies from CAP, and even plow saline sites like the saline depressions with remarkable environmental value. Moreover, the works associated with the new irrigated areas, i.e. land consolidation, pipelines, and roads, have increased the degradation or disappearance of habitats (Castañeda and Herrero, 2008) and have led to soil loss and a decrease in natural vegetation.

Due to the lack of soil maps, little knowledge exists on the location of either low productive areas related to poor soils or soils with high value in terms of diversity. Maps are needed to identify soil features that limit agricultural production and to pinpoint pedodiversity. The agri-environmental rules can be adapted to better allocate subsidies, without increasing the CAP budget, and encourage farmers to manage their land in a way that saves on labor and farm inputs, as well as address nature conservation issues related with biodiversity (van der Horst, 2007) and pedodiversity.

This work presents an integrated methodology aimed at identifying low productive areas where plow-exemption rules should be implemented as a means of promoting habitat protection at the local scale. The methodology takes into account rural practices and seeks the agreement of local farmers. For this purpose we established a set of feasible procedures and criteria that can be easily applied by local officers responsible for agriculture and environment. Our objective was to suggest new non-plowing practices that allow the regeneration of halophylous protected vegetation and the conservation of soils.

Material and Methods

As a starting point, information was available from environmental and agricultural GIS sources. The environmental data were the wetland inventory (Castañeda and Herrero, 2008), the maps of halophilous vegetation at 1:5000 scale (Domínguez et al., 2006), and the SPA for birds (European Union, 1979). The agricultural data were the Spanish Farming Land Geographic Information System (SIGPAC), and the 2005-2006 alphanumerical data from the GIS of Herbaceous Crops of the Spanish Ministry of Agriculture, Fisheries and Food.

In order to select the agri-environmental areas for soil prospecting, a new GIS database was created using the highest detail level delimitations of SIGPAC as the basic geographic unit, i. e. the plots declared by farmers for CAP subsidies. The environmental and agricultural data mentioned above were superimposed onto the farming plots' GIS coverage, together with an image of the Quickbird satellite acquired on July 11, 2007.

Using GIS we first selected areas with soil-related low crop production, often due to salinity near wetlands (Figure 1). For this purpose we drew a buffer line 200 m from the border of the wetlands, and some additional plots showing outstanding white unproductive patches were also prospected. All the farming plots totally or partially included in that area were extracted from the database furnished by the Government of Aragon. A poll was carried out on a representative sample of farmers in order to learn their opinions and concerns about a new agricultural measure to be applied in low productive areas under the Natura 2000 conservation policy. The local officers in charge of environment and agriculture were also interviewed.

Four representative wetlands (Agustín, Gramenosa, Guallar and Salineta) were selected based on their accessibility and their location in relation with dryfarmed, irrigated, and Natura 2000 areas. Then, a visual analysis of the Quickbird image was employed to delimit the sites of interest (related to low production) within the surrounding farming plots, and other supplementary test plots located between 200 to 1000 m from the wetlands. A subsequent field survey was carried out to refine the sites location using local geomorphologic criteria. The soil prospection of the selected sites was based on pits, auger holes, and surface descriptions, including crop monitoring. Soil samples were taken for laboratory analysis. Only the prospecting of white patches is shown in this article. Saline areas prospecting, currently ongoing, will be the subject of a forthcoming work.

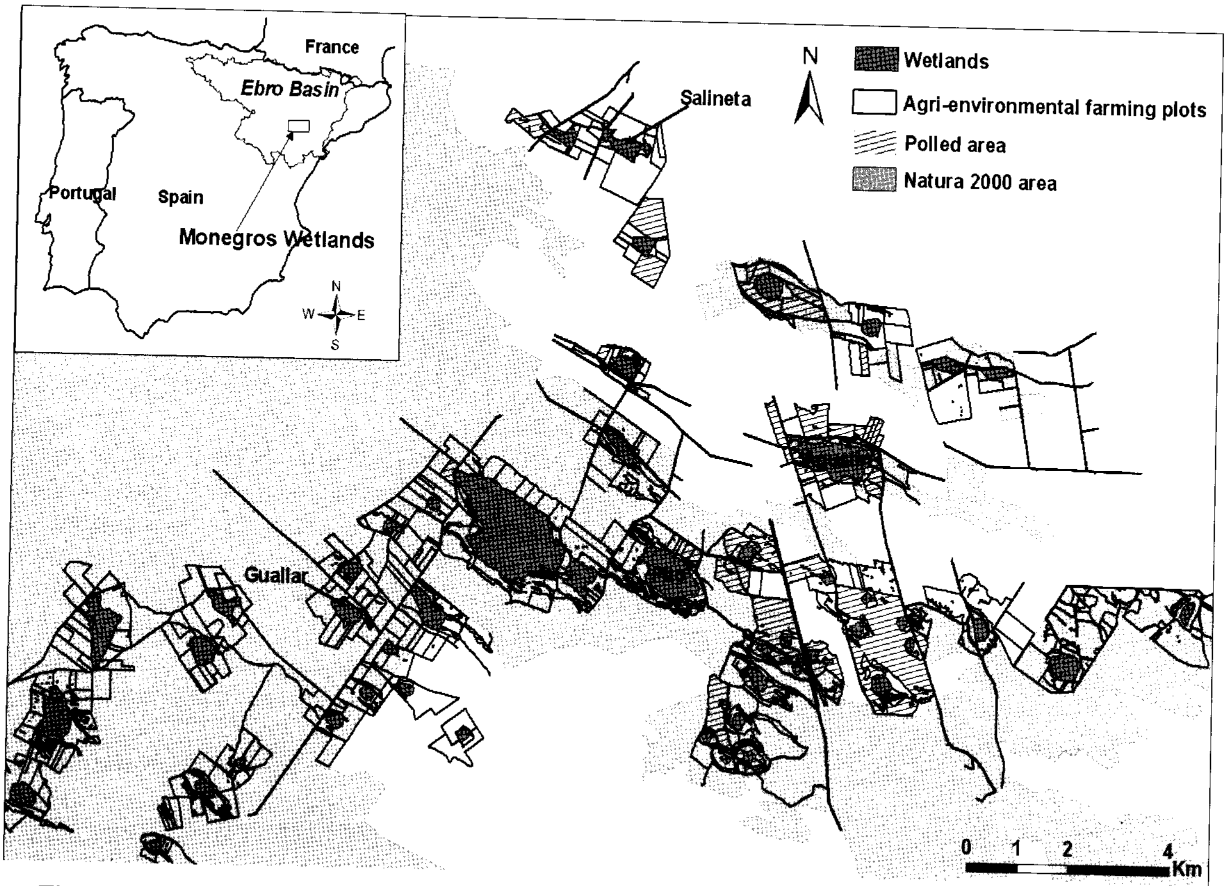

Figure 1. Location of the study area and the selected farming plots. Most of the area not included in Natura 2000 is, or will be, equipped for irrigation with Pyrenean water

Results and Discussions

The farming plots database contained 1264 plots located in the wetlands' surroundings, with a total surface extent of 5747 ha, five times more than the wetland surface extent. When the farming plots were included only partially in the 200 m-limit, the entire plot was computed up to a maximum distance of 500 m from the wetland border (Figure 2). The studied area was considered of agri-environmental interest, with 81% cataloged as SPA for birds, and the rest included in the near future irrigation. The poll was carried out over 8% farming plots, representing 16% of the agri-environmental area extent. The size distribution of the polled plots was similar to that of the plots of the entire studied area, confirming their representativeness. Most of the polled farmers acted as land managers for the subsidy recipients.

The opinions gathered from the land managers were classified in terms of the amount of land they were responsible for. The subsidy recipients were cultivators only in a 50% of the polled area. Three people managed around 80% of the polled area, a sign of the disappearance of small farms. Hence, the decisions made by a few farmers will impact large areas. From a total of 27 agriculture /environment ideas discussed in the personal interviews, we concluded that 37% of the polled area agreed with the new plowing exemption measure, 30% agreed strictly in exchange for a legal economic compensation, and 16% were suspicious about future changes of the CAP. Environment officers would prefer a measure adapted to the existing agri-environmental program, and agricultural officers were uncertain about the technical and economical feasibility of its application, although they approved of new agri-environmental measures, especially non-plowing. The poll confirmed the interest of the farmers in detailed maps of the soil features that limit the crop production. Farmers agreed with the conservation of the natural habitats and were involved during the soil and crop surveys.

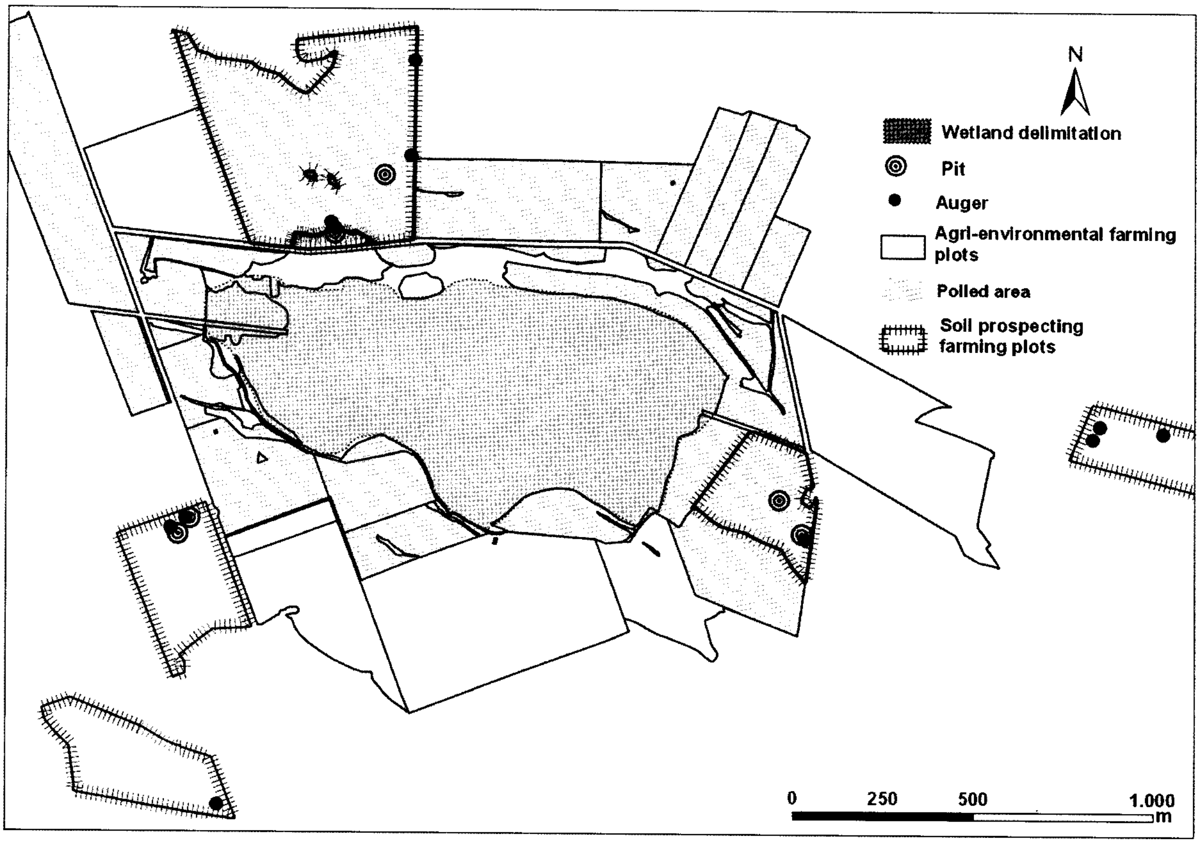

Figure 2. Detail of Agustín site showing the farming plots selected for the poll and the soil prospecting points for white patches' soil characterization.

On the whole, the Southern Monegros area appears to be flat, but the field survey pointed out a relationship between low production areas and the local topography. The farming plots were frequently located on gentle slopes at the margins of the depressions, mostly occupied by wetlands, halophytes, and soils with a dark surface horizon. In general, the whitish areas occur in relatively higher topographic positions, and their soil was gypseous with electrical conductivity in the 1:5 extract (EC1:5) ranging from 0.2 dSm^{-1} to 5.2 dSm^{-1}. The visual interpretation of the satellite Quickbird image acquired simultaneous to the field survey, allowed us to delineate these white patches within the plots. The white patches represented 4% of the farming plots area. Supplemental field inspections helped in the detection of sites where the crops showed poor growth and where halophilous vegetation eventually appeared. These areas were selected for drills and pit openings. Dark, white, and intermediate colored areas were prospected, and their profiles studied and sampled.

The sampling depth ranged from 30 cm to 150 cm (Table 1) with the shallow holes more frequent in the white patches. EC1:5 of 75% of soil samples was > 2.5 dSm^{-1}. Provided that gypsum is ubiquitous in the landscape, EC $\leq$ 2.25 dSm^{-1} cannot automatically be deemed saline. The lithic or paralithic contacts at shallow depths, and the occurrence of gypseous horizons near the surface were responsible for water stress, the main limitation for the life in Monegros. These soil features plus the salinity at different soil depths, frequent in depressed sites, were considered the blueprint for easy criteria to identify low crop production areas.

Table 1. Summary of the soil prospecting sites, and sampling techniques used.

Wetland	Soil prospecting	Depth (cm)		Data obtained
		Min	Max	
Agustín	6 pits, 19 soil samples	80	150	Pedon description
	6 auger holes, 17 soil samples	30	110	Electrical conductivity in 1:5 and 1:10 extracts; gypsum and calcium carbonate contents
Salineta	5 auger holes, 16 soil samples	50	125	
Pito	5 auger holes, 14 soil samples	50	100	
Guallar	13 auger holes, 50 soil samples	60	125	

Conclusions

A great amount of information from different database sources was processed by means of GIS tools, which enabled the recognition of farming plots with agri-environmental interest and the selection of the farmers for the opinion poll. The criteria of low productivity extracted from the analyses of satellite images and from the field survey (presented here in a test area) are complementary. We consider it worthwhile to extend these criteria to the remaining farming plots. The GIS database created and the consultative approach will be advantageous to the systematic selection of plots for agri-environmental purposes. As in other saline wetlands in Spain (Gallocanta and Chiprana), this measure to implement agricultural practices mandated under CAP rules will combat the degradation of biodiversity and soils.

Acknowledgements

MEC and FEDER funded this work within the Project AGL2006-01283.

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