Agrology in olive grove soils in the P.D.O. Baena (Spain)

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Abstract

Nowadays it is possible to observe that many zones present great imbalances in the use of soils with respect to the potential possibilities. These imbalances are very important because they produce a decrease of the crop production and a degradation of soil properties that lead to great environmental problems.

In this project, a methodology of work based on the Geographic Information System (GIS) has been developed for the study of the problems these situations are generating. The development of this GIS methodology has generated a useful tool for the evaluation of the present soil use to get its optimal productive capacity. Then, and with the data collected in this evaluation, it is possible to develop a planning and exploitation model that formulates the way to adapt the current agrarian use with their potential productive capacity.
Keywords: GIS, thematic cartography, territory planning

1 Introduction

The application of GIS technologies in the agriculture has supposed a revolution in this field because they allow to optimize the production from the knowledge of the physical, chemical and biological characteristics the soil presents. This fact helps to prevent the degradation of the environment caused by inadequate growing techniques. Therefore, the knowledge of certain factors like kind of soil, current use, slope,… and their combination allow to evaluate the agrarian possibilities of a certain area, showing imbalances when they exist.

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The aim of this project is to develop a territorial analysis to obtaining a planning and exploitation model of the different resources to formulate the more suitable system of growing.

The practical application of this methodology has been carried out in the Protected Designation of Origin (P.D.O.) Baena. This area extends for 84.983 hectares distributed in 6 municipalities located in the province of Córdoba, (Spain). The main cultivation of this area is the olive grove which gives a quality olive oil very recognized. Therefore, the constitution of the P.D.O. Baena has allowed the knowledge of its oil in national and international markets.

2 Methodology

The methodology developed in this study has five consecutive phases.

1. Compilation of information. For this study, the information has been mainly focused in the physical and agrarian characteristics of the studied area.

- Uses Map: Province of Córdoba to scale 1:50.000 based in the topographical of the MTA at 1:10.000. Dirección de la Producción Agraria of the Consejería de Agricultura y Pesca of the J.A. (Version 2000).

- Agrarian Classes Classification of the Province of Córdoba. Dirección de la Producción Agraria of the Consejería de Agricultura y Pesca of the J.A. (1999).

- Digital Terrain Model (DTM) of the Consejería de Medio Ambiente of the J.A.

2. Obtaining of the superficial distribution of different variables from the initial information.

- Distribution of the different uses from the Uses Map.

- Distribution of the Agrarian Classes from the Agrarian Classes Classification.

- Distribution of the slopes and altitudes obtained from the DTM.

3. Crossing of the different information coverings to obtain the interrelation among the studied variables.

4. Obtaining of the different imbalances grades starting from the study of the crossings carried out previously.

5. Indication of possible correctives measures that would diminish current imbalances.

3 Analysis of the cartographic synthesis

3.1 Olive grove distribution

The project has been centered in the study of the olive grove, because this is the main production of the area with almost 66% of the total studied surface. The rest of the territory has been grouped together in an only class that collect all the agrarian, forest and unproductive uses in the studied area (Figure 1).

Table 1: Olive grove distribution in P.D.O Baena.

Surface (ha)	Baena	Castro del Río	Doña Mencía	Luque	Nueva Carteya	Zuheros	Total	% Total
Total olive grove	23.853	14.380	1.050	9.141	6.546	865	55.836	100
% olive grove/ total olive grove	42,72	25,75	1,88	16,37	11,73	1,55	--	100
Total surface	36.246	21.990	1.518	14.081	6.917	4.228	84.984	100
% olive grove / total surface	65,80	65,39	69,17	64,92	94,64	20,46	--	--

The municipalities of more extension are also what more olive grove surface present. This is the case of Baena and Castro del Río olive grove that represents 43% and 26% of the whole studied crop. The rest of municipalities present less surface although it is necessary to emphasize that in all of them the olive grove take up more than 60% of the territory except in Zuheros where the uneven orography impedes the development of this grove.

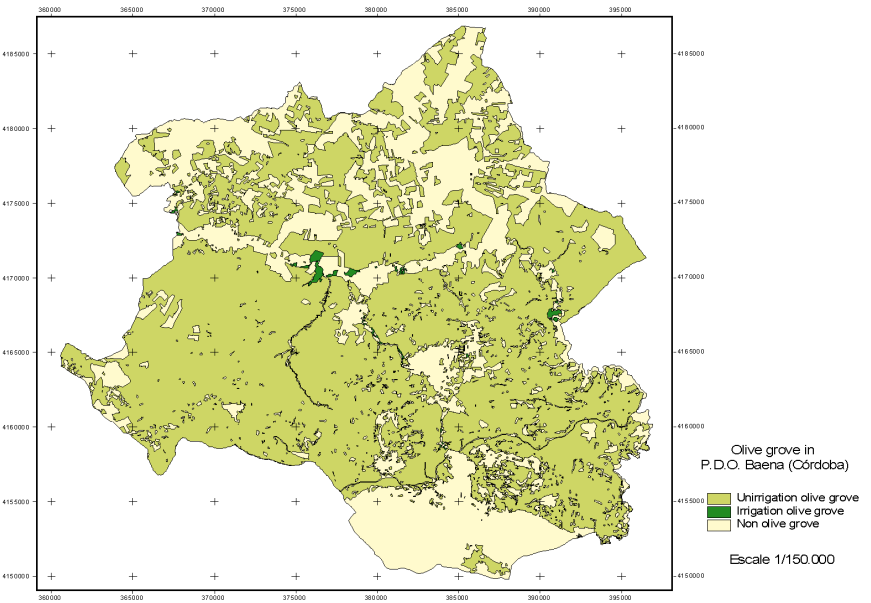

Figure 1: Olive grove distribution in P.D.O. Baena.

3.2 Agrarian Classes distribution

More than half of the surface, 54%, consists of class I, II and III soils with good aptitudes for the agricultural activity (Menéndez and Rodríguez [3]). Other 19% are IV class soils that only allow the growing of some species with lower yields.

The rest of the surface belongs to V, VI, VII and VIII classes which present edaphic and/or climatic limitations that restrict the agrarian uses (Figure 2).

Table 2: Agrarian classes distribution in P.D.O. Baena.

Surface (ha) / Classes	Baena	Castro del Río	Doña Mencía	Luque	Nueva Carteya	Zuheros	Total	% Total
I	315	0	0	79	0	0	394	0,46
II	6.670	3.463	254	2.228	1.365	454	14.434	16,99
III	11.336	8.692	809	5.698	2.922	2.479	31.936	37,59
IV	9.416	6.123	0	437	1	0	15.977	18,80
V	25	9	0	141	0	123	298	0,35
VI	7.745	3.351	190	2.912	2.338	324	16.860	19,85
VII	406	84	169	2.214	259	773	3.905	4,60
VIII	337	267	96	347	32	76	1.155	1,36
Total	36.248	21.989	1.518	14.056	6.917	4.229	84.959	100

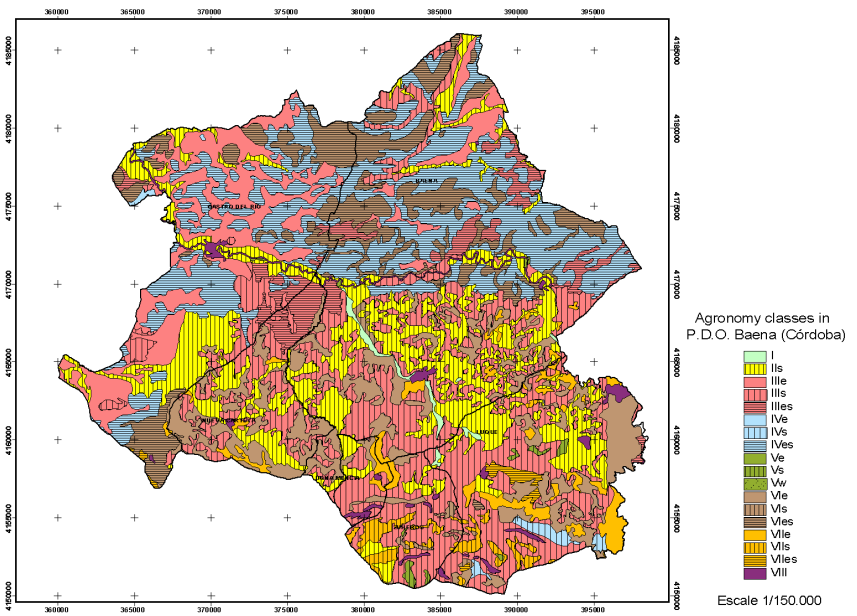

Figure 2: Agrarian classes distribution in P.D.O. Baena.

3.3 Slopes distribution

Most of the soils present slopes lower than 20%, therefore, they don't present great limitations for the agrarian activities. 16% of these soils don't need any conservation measure while 53% of them need advanced cogoverning measures

and 27% need severe and systematic measures. The remaining territory doesn't allow an agrarian use (Figure 3).

Table 3: Slopes distribution in P.D.O. Baena.

Surface (ha) / Slope	Baena	Castro del Río	Doña Mencía	Luque	Nueva Carteya	Zuheros	Total	% Total
<3%	5.891	5.272	22	1.759	569	287	13.800	16,24
3-10%	20.784	12.920	787	5.567	3.607	1.556	45.221	53,21
10-20%	9.274	3.737	478	5.185	2.623	1.638	22.935	26,99
20-30%	290	61	195	1.285	114	629	2.574	3,03
30-50%	10	0	35	285	4	118	452	0,53
>50%	0	0	0	0	0	0	0	0
Total	36.249	21.990	1.517	14.081	6.917	4.228	84.982	100

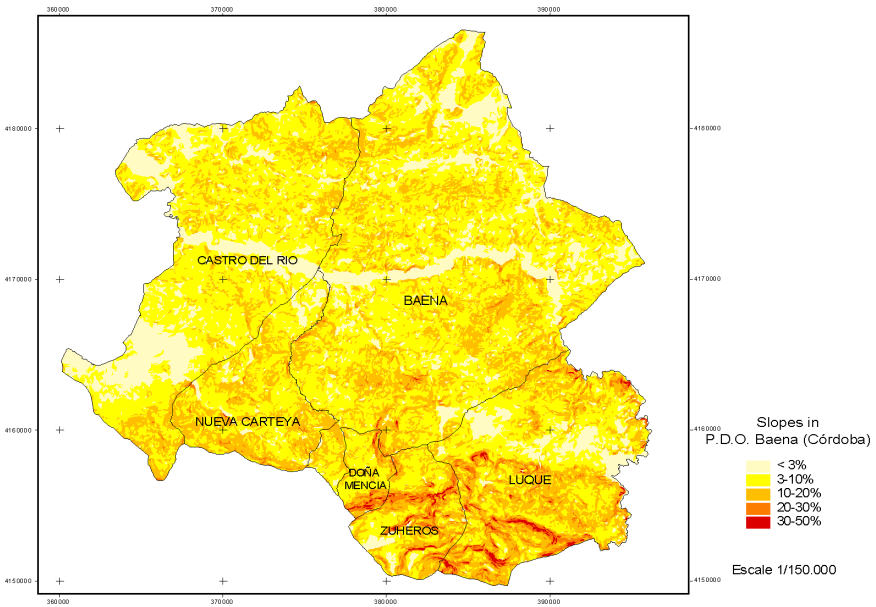

Figure 3: Slopes distribution in P.D.O. Baena.

3.4 Altitudes distribution

The altitude factor influences fundamentally in the viability of the crop because it can modify the climate (León [2]). 75% of the studied surface present altitudes lower than 500 meters. In this group, the most important stratums are the 300-400 m interval with almost 30% of the total surface and the 200-300 m one with 20%. The territories higher than 500 m don't present much surface (Figure 4).

Table 4: Altitudes distribution in P.D.O Baena.

Surface (ha) / Altitude (m)	Baena	Castro del Río	Doña Mencía	Luque	Nueva Carteya	Zuheros	Total	% Total
<100	0	0	0	0	0	0	0	0
100-200	0	1.066	0	0	0	0	1.066	1,25
200-300	7.115	9.374	0	0	378	0	16.867	19,85
300-400	15.863	7.723	4	922	1.307	0	25.819	30,38
400-500	9.426	2.615	269	5.216	2.455	109	20.090	23,64
500-600	3.070	781	562	2.392	2.071	546	9.422	11,09
600-700	672	396	341	1.714	498	385	4.006	4,71
700-800	103	36	160	1.361	208	164	2.032	2,39
800-900	0	0	58	772	0	307	1.137	1,34
900-1.000	0	0	62	705	0	961	1.728	2,04
1.000-1.200	0	0	62	930	0	1.439	2.431	2,86
1.200-1.400	0	0	0	69	0	316	385	0,45
>1.4000	0	0	0	0	0	0	0	0
Total	36.249	21.991	1.518	14.081	6.917	4.227	84.983	100

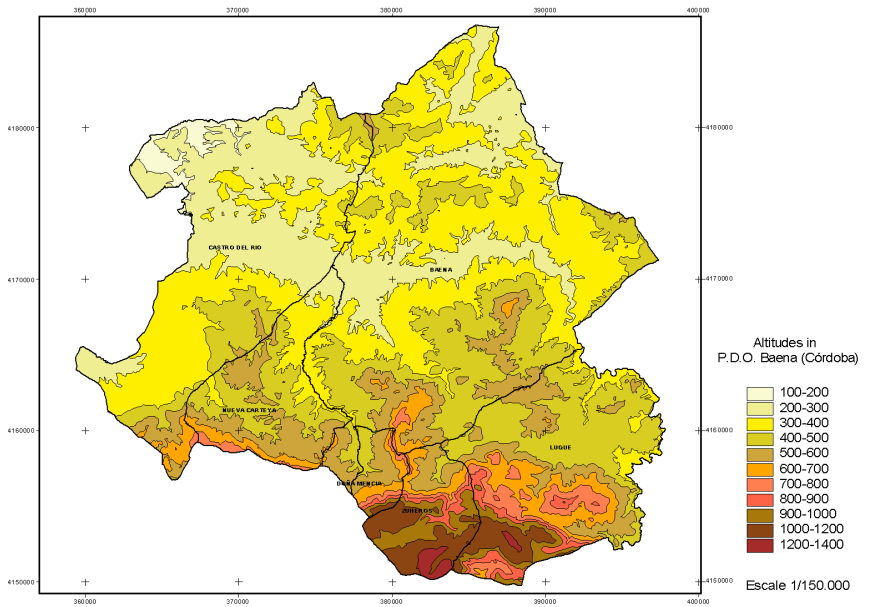

Figure 4: Altitudes distribution in P.D.O. Baena.

4 Comparative analysis between the current use and potential one

4.1 Evaluation of the olive grove

The agrarian evaluation of P.D.O. Baena has been made with the previously mentioned soil's variables. Although the definition of agrarian classes contains

the slope, this factor has been studied independently because it influences directly in the erosion risk, soil wastage and mechanization (Figure 5).

The result of this analysis shows five imbalances grades:

A: Strong imbalances areas for higher growing intensity of use than potential.

B: Light imbalances areas for higher growing intensity of use than potential.

C: Areas without imbalances.

D: Light imbalances areas for lower growing intensity of use than potential.

E: Strong imbalances areas for lower growing intensity of use than potential.

4.2 Strong imbalances areas for higher growing intensity of use than potential

The olive groves of this group grow in soil of the agrarian classes number V, VI, VII and VIII. In them there are great edaphic limitations like the erosion. These zones present not much surface with slopes higher than 20%, slope limit for agrarian use, so the problems caused by the erosion and the soil wastage is not very stringent.

Table 5: A grade surface (ha) in P.D.O. Baena.

	A Grade		
	Surface (ha)	**% Olive grove**	**% Total**
Olive grove	14.283	25,58	100

4.3 Light imbalances areas for higher growing intensity of use than potential

This group contains the whole unirrigated olive grove located in the IV class and with slopes lower to 20% and the irrigated olive groves located in the III and IV classes with slopes lower than 10%. The first ones present limitations for the systematic mechanization although the occasional ones can take place.

Table 6: B grade surface (ha) in P.D.O. Baena.

	B Grade		
	Surface (ha)	**% Olive grove**	**% Total**
Olive grove	11.061	19,81	100

4.4 Areas without imbalances

The grade C surfaces contain all the unirrigated olive groves growing in II and III classes and the irrigable ones located in I and II.

Table 7: C grade surface (ha) in P.D.O. Baena.

	C Grade		
	Surface (ha)	**% Olive grove**	**% Total**
Olive grove	30.347	54,35	100

4.5 Light imbalances areas for lower growing intensity of use than potential

The olive groves classified with grade D are those witch grow in the class number I because these soils present the best characteristics. In these soils, the crop can improve with irrigation.

Table 8: D grade surface (ha) in P.D.O. Baena.

	D Grade		
	Surface (ha)	**% Olive grove**	**% Total**
Olive grove	145	0,26	100

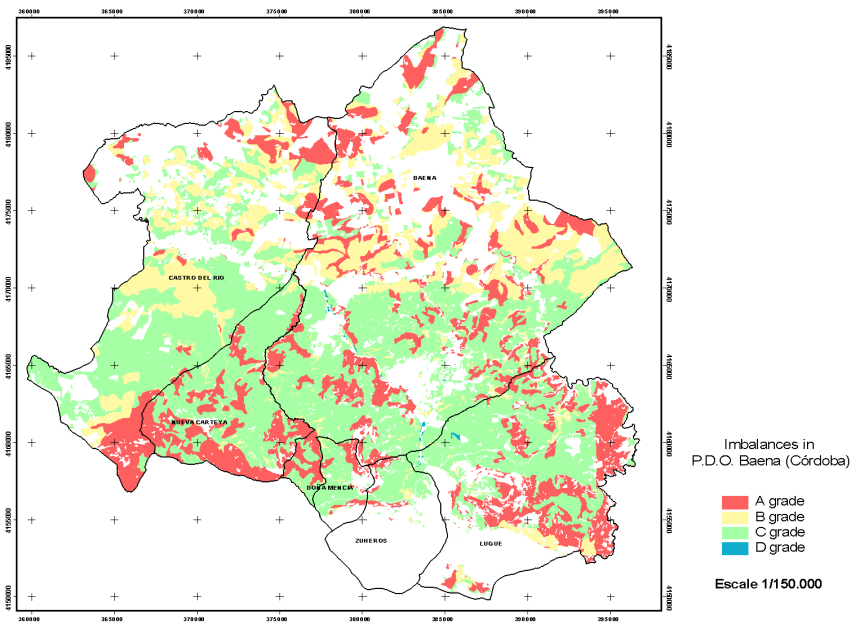

Figure 5: Imbalances distribution in P.D.O. Baena.

4.6 Strong imbalances areas for lower growing intensity of use than potential

This group contains all the non cultivated soils that grow in soils witch support a higher level of exploitation. As the study only consider the olive groves, it's impossible recognize these areas.

5 Corrective measures

5.1 Strong imbalances areas for higher growing intensity of use than potential

When the slopes are not very high, it is recommended the total abandonment of the mechanization and the establishment of a permanent vegetable cover or a seasonal one during the winter months if there are problems with the water (Pastor et al. [4]). For higher slopes it is recommended the reforestation. With irrigable olive groves is essential to apply minimum irrigation with trickle irrigation method (Figure 6).

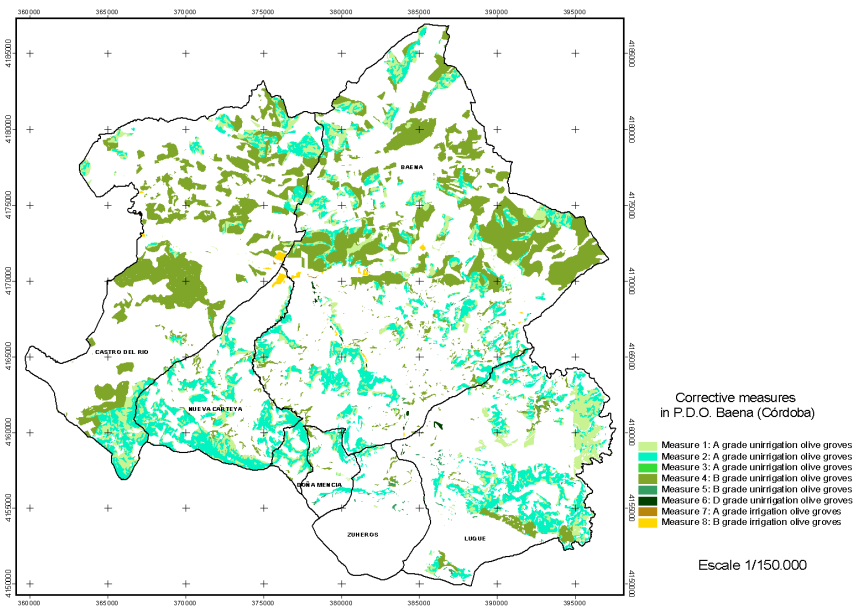

Figure 6: Corrective measures distribution in P.D.O. Baena.

5.2 Light imbalances areas for higher growing intensity of use than potential

In this case, the most advisable measure is to set a minimum mechanization with some mechanical measure of control. If the erosion problems are accused, it is

recommended the total abandonment of the mechanization and the establishment of a natural or artificial permanent vegetable cover, with leaves and rest of pruning of the own olive grove. Another solution is the application of herbicides in bare soils, although it is only advisable in soils with low slopes where the vegetable cover is not viable (Barranco et al. [1]). With the irrigation groves it's necessary to implant a trickle irrigation to diminish problems with the soil's fertility (Figure 6).

5.3 Light imbalances areas for lower growing intensity of use than potential

In this case is recommended an increase of the crop density with the installation of trickle irrigation. As cultivation system it's recommended a vegetable cover during the winter months if there is enough water or herbicides in bare soils (Figure 6).

6 Conclusions

The developed of this methodology obtains good results in the study of the imbalances among the current use of the soil and the potential one. The proof of this it's observed in the exposed example of the P.D.O. Baena where the differences imbalances grades can be shown. With that information it's possible to create a planning and exploitation model to correct the general problems and other more specific for each concrete situation.

Also, this methodology is open to the possibility of including any other type of agrarian information without modifying its basic structure.

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