Aerial Archaeology in Spain: historiography and expectations*

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This paper has a double objective: to critically revise the Spanish historiography of Aerial Archaeology, marking its late development, and, on the other hand, to establish a base for future national, regional or even local investigations in this field. Both objectives will be brief, but we hope they will motivate those who manage the necessary resources, and those who could acquire the necessary technical capacities to carry out archaeological projects that are science-based, or at least, projects helped for this indispensable methodology. Spanish investigators and foreigners should work together to put an end to the paradox that supposes the aerial sureying contempt in a country that offers so excellent weather conditions, vast cultivated fields,[1] and large areas without heavily built-up urban environments.

1 A brief revision of the Spanish Aerial Archaeology

As we know, World War I supposed a point without return for the aerial photographs technical and practical development, even with archaeological ends. We want to remember that previously, and especially with military ends, were applied photogrametry techniques for mapping and cadastre management. Spain was not away of these pioneer movements, as demonstrate some publications that go back to 1862,[2] or the fact that since 1902 the officials carrying out aerostatics ascensions must have had in their equipment the photographic camera. The first aerial photographic recognition carried out by the *Ejército del Aire* took place in the north of Morocco, in the context of the 1913's colonial wars (Fernández García 2000, 17). The civil applications began in 1923 with the first attempt from the *Ministerio de Hacienda* and from the *Instituto Geográfico Nacional* (IGN) of using the aerial pictures for making the cadastre. These works were interrupted by Primo de Ribera's dictatorship, recaptured during the Second Republic and again off with the Civil War, although this tragic period meant a development of new methodological development of the aerial photos and their applications. The Spanish files deserve a deep revision of its archaeological documentation during these initial phases, although at the moment it seems that we can consider the first flight with archaeological purpose to be the one made by Montalbán in 1929 around the hinterland of the ancient site of Lixus (Larache, Morocco).[3]

The material and human destructions caused by the Civil War and the absence of quick reconstruction, forced Franco's dictatorship to appeal to the United States Army to obtain the covering of the national territory. The Americans made it in two times using vertical pictures: the first named *serie A* (1945-46) and the second, *serie B* (1956-57). These files are obviously privileged ones because were filmed before the uncontrolled growth's deep transformations in the 60s and 70s (in strong contrast to other European countries where agricultural changes had begun before) but they have hardly been studied for archaeological purposes. One century later, according to the article by the general Terrero, several political changes had reduced the innovative will of the pioneer minority. In fact, we can say that until the decade of the 70s, the activity of the Spanish Aerial Archaeology grew up not much more than two notices, for a total volume of five pages.[4] As we will see shortly, this panorama has varied in the last years, although it is still far behind the guideslines of other European countries.

A new period started thanks to an initiative from *Casa Velázquez* (Madrid) where it was able to congregate different archaeologists and other specialists, Spanish as French as well, in a multidisciplinary project dedicated to the study of the Spanish territory from different perspectives, and with the goal of ending with the traditional "*méconnaissance des services que pouvait rendre ce type de documentation, qui avait arrêté les chercheurs et les organismes"* (Bazzana y Humbert 1983, 5). This volume summarizes the result of four campaigns of aerial surveys in different Spanish landscapes, using the possibilities of the oblique and low height pictures. The quality of the results, the clear theoretical positions

* To Xavier Dupré Raventós, *in memoriam*

[1] 6.8 millions ha. just of cereal fields in 2005 (the area of the entire country of Switzerland is 4.1 million ha.). *Ministerio de Agricultura, Pesca y Alimentación, Subdirección General de Estadística agroalimentaria*. Internet site http://www.mapa.es

[2] Antonio Terrero (1862): Fototopografía, es decir, aplicaciones de la fotografía al levantamiento de planos topográficos. *Asamblea del Ejército y la Armada*, year V, 2nd time, III, p. 31-46.

[3] The aerial survey review and its photographs have been recently found by Carlos Cañete Jiménez. The research grup managed by Carmen Aranegui Gascó works since several years on this site, and it's preparing its study and publication.

[4] Almagro Basch, M. (1943): La colaboración de la aviación española en el campo de la Arqueología. *Ampurias*, 5, p. 247-49. Martínez Santa-Olalla, J. (1945): Aviación y Arqueología. *Boletín Arqueológico del Sureste Español*, 1, p. 45-48.

and the important source of experiences make this an indispensable reading for any future research project in the Iberian Peninsula.

After this publication other studies using aerial photographs were easier to find, although non was a complete survey project. Frequently the research groups agree with an illustrative or too sporadic use of beautiful pics, highlighting nevertheless those examples by Sánchez-Palencia and Orejas Saco del Valle (1991), Sánchez-Palencia and Fernández-Posse (1992), Ibáñez González and Polo Cutando (1993) or Ariño Gil and Rodríguez Hernández (1997). Anyway, in all these studies the use of vertical photography is more frequent, thus the potential of oblique photography has hardly been explored. We can also find some reviews of the existent bibliography and the history of the discipline, with the addition of theoretical views. The one by Orejas Saco del Valle (1995) should be highlighted. In their analysis of the Spanish delay, they stress the study strategies used by the researchers to the present. These local and even simple approaches make unnecessary data obtained through aerial pictures. We agree with this CSIC investigator when she points out the need to overcome the survey (aerial and terrestrial) just as the way of finding new digging locations (op. cit. 20). The curiosity for understanding the landscape as the result of the complex dialogue among the forces of traditions and the desires of intervening in the world to modify it, will be the road that takes us to feel the aerial prospecting approach as a basic need. The Spanish archaeology also requires forgetting the methodological hierarchy that considers that surveying is just the first phase (and subordinate) to the later excavation. In this way, Aerial Archaeology is very near to the Landscape Archaeology and like this one, it should adopt a diachronic perspective.

It is true that the Spanish archaeologists have some manuals in Castilian talking about the aerial photograph techniques. The most complete reference in this field would be that of Fernández García (2000). Unfortunately, it does not directly answer archaeological questions, as English, French or Italian publications do. The limited number of scholars on the topic and the little diffused foreigners' works make the absence of a manual on Aerial Archaeology in Spanish dramatic. Maybe a separate mention deserves the work from an archaeologist not straight inside the academic institutions, but that surely overcomes to all other in flight hours and by his important *know how*. Del Olmo Martín[5] has been carrying flights in the area of Castilla-León regularly for almost two decades. Even when obtaining good results, his work has not had enough institutional support.

In definitive, techniques shyly used and terminology frequently confused that hides conceptual weakness. Therefore we think it is necessary to build the awareness of the great potential of Aerial Archaeology in Spain, and to begin the revision of the wide already existent photographic material and complement it with systematic aerial survey in diverse areas of Spain, that remains without studying in a global way from the perspectives that offers Aerial Archaeology. There is so much work to do in the Spanish horizon to reach the high levels of the English *Aerial Archaeological Research Group* or the firm beginnings of the Italian *Laboratorio di Archeologia dei Paesaggi e Telerilevamento dell'Università degli Studi di Siena*.

To conclude this bibliographical review we will mention the available files for those interested to begin using the rich available material in our photographic archives, before undertaking new flights. Besides the already mentioned North American flights, there are another two general flights: the *serie C* (1967-68) and the flight of 1981-84 (scale 1:30000). The photographic archive of the *Centro Nacional de Información Geográfica,*[6] that of the *IGN,*[7] and that of the *Centro Cartográfico y Fotográfico del Ejército del Aire* (*CECAF*),[8] have several partial flights, that have become more and more frequent since the 80s. The oldest file with this type of aerial pictures was that of the *Compañía Española de Trabajos Fotogramétricos Aéreos* (*CEFTA*) which began to operate in 1927. Unfortunately, the company was closed in the 90s and their files have been sold in fragments to different administrative offices.[9] Several companies have

[5] (1990): Fotografía aérea y prospección arqueológica. Revista de Arqueología, 107, p. 60; (1993): Arqueología Aérea en Valladolid. *Actas de la Reunión sobre Inventarios y Cartas Arqueológicas*: homenaje a Blas Taracena: 50 aniversario de la primera Carta arqueológica de España, Soria 1941-1991. Soria, p. 235-237; (1993): Arqueología Aérea en Castilla y León. Revista de Arqueología, 142, p. 6-7; (1993): Arqueología Aérea en Asentamientos Vacceos. *Arqueología Vaccea: Estudios sobre el mundo prerromano en la cuenca media del Duero.* Valladolid. p. 507-528; (1994): Arqueología Aérea de Emplazamientos de Defensa Medievales en la Provincia de Valladolid. *I Congreso de Castillología Ibérica.* Aguilar de Campoo. p 593-609; (1995): La Villa Romana de los Casares (Armuña, Segovia). *Congreso Internacional La Hispania de Teodosio.* Segovia. p. 675-686; (1996): Arqueología aérea en tres ciudades indígenas romanizadas. *Congreso Internacional Los Orígenes de la ciudad en el Noroeste Hispánico.* Lugo. p. 409-428; (1999): Arqueología Aérea en Castilla y León. *Revista de Arqueología*, 215, p. 44-49; (2001): Arqueología Aérea en Clunia. *Revista de Arqueología*, 244, p. 6-9. Internet site http://www.geocities.com/archeoa/aerea/portada.html

[6] Internet site http://www.cnig.ign.es

[7] Internet site http://www.ign.es

[8] Internet site http://www.ejercitodelaire.mde.es

[9] Following Fernández García (2000, 20 note 7), the pictures corresponding to Asturias were bought by the *Departamento de Geografía de la Universidad de Oviedo*; those from Catalonia by the *Institut Geogràfic de Catalunya*; those from the Vasc Country by the *Departamento de Ordenación del Territorio, Vivienda y Medio Ambiente del Gobierno Autonómico Vasco*; those from Valencia by the *Consellería de Cultura, Educació i Ciència de la Generalitat Valenciana*; those from Murcia by the *Consejería de Política Territorial Obras Públicas del Gobierno Autonómico de Murcia*; those from the Canarias by the *Consejería de Política Territorial del Gobierno Insular*; those from Extremadura by the *Consejería de Medio Ambiente, Urbanismo y Turismo de la Junta de Extremadura.*

carried out similar works throughout the 20th century although many of them have disappeared.

2 Analysis of potential for Aerial Archaeology in Spain

As a little complement and contribution to this reflection about Aerial Archaeology in Spain, we will try now to offer some preliminary data about the potentiality of this discipline in this country that can be used as a first reference when beginning a project of this kind. Our proposed objective would be to obtain a first general map of visibility or potentitality for Aerial Archaeology in Spain that allows us to know which are the most susceptible areas for evidencing soilmarks and cropmarks based on the characteristics of the land and on the current land uses; something that has not been done until now. In this way and according to Jones and Evans (1975) and Musson, Palmer and Campana (2005) we can reasonably estimate an index depending on types of cultivations (deepest roots and plough like cereals often are the best ones, and so on). GIS software allows us to carry out geostatistical and spatial analysis, bringing us distribution maps of our index.

For doing this, our working method will be the GIS-based integration and analysis of the available information about the different factors that influence the practice of Aerial Archaeology. However, given our limitations of time and material, we can only access a limited series of data and documents, so we must underline the basic, general and preliminary character of this analysis that is only a first step for the development of future and deeper works of Aerial Archaeology in Spain. We also want to remember that we are not looking for a predictive or archaeological map, but a map of visibility, or rather, of suitability for the practice of the Aerial Archaeology; it is therefore a merely methodological study, in order to guide future investigations.

The basic documents on which we will work are in the first place the maps of land uses of the Corine Land Cover Project produced by the *European Environmental Agency* (EEA)[10] that describe the type of current land use in all the countries of the European Union, based on the analysis of satellite images of the year 2000. On the other hand we use the statistics of the year 2005 of the *Ministerio de Agricultura, Pesca y Alimentación* of Spain (MAPA) about surfaces and yields of cultivations in each Autonomous Community. Finally we also use a Digital Model of Elevations of the Iberian Peninsula with a precision of 90 meters, that allows us to know the general characteristics of the relief and the slopes of each area. In future and within more complete studies other conditions for the development of the Aerial Archaeology should also be considered, such as geology, the rate of soil moisture deficit (Jones and Evans 1975, 3-8), climate and weather...

[10] Internet site: http://www.eea.europa.eu/

The method of the analysis is conditioned by the varied nature of documentation: the information of the Corine Land Cover has the advantage of being cartographic but on the other hand it is quite generic and it hardly details the cultivation types. On the other hand, the statistical information of the MAPA for Communities describes very thoroughly the types of cultivations but it is not cartographic, they are only generic figures. Therefore, they are complementary documentation but of diverse nature, something that will force us to restructure the information in charts for Autonomous Communities, in order to be finallly able to add it. So in this analysis we will create two types of maps, one general and graduated based on the Corine Land Cover and the DEM, and another one with the statistics for communities, based on the sum of the previous map and the data of the MAPA.

The working process has been the following: after clipping from the Corine Land Cover European raster map the part that corresponds to the Iberian Peninsula, we have classified the types of land uses according to its higher or lower capacity for reflecting archaeological marks that can be seen from the air. For doing this, we have created 6 categories that goe from 0 (null visibility) to 5 (best conditions for evidencing soilmarks and cropmarks) based on data from bibliography and, if possible, in our own experience[11] (Fig. 1). This way, after reclasifying the raster map based on these values, we have already created a first map of archaeological aerial visibility of Spain.

After this, working with the Digital Model of Elevations of the Iberian Peninsula we have created a map of slopes and have reclassified the slopes according to the level of difficulty that they add to the aerial survey and to the observation of archaeological evidences (for example creating shades or limiting the minimum height of flight) (Bazzana & Humbert 1983, 10). We have opted for a very generic classification in 4 groups of slopes with its 4 levels of difficulty: slopes from 0 to 15 degrees (in general we can consider that they are not a problem for the practice of Aerial Archaeology), from 15 to 30 degrees (they offer certain problems), from 30 to 45 degrees (they imply important problems) and slopes higher than 45 degrees (we consider that they prevent the effective practice of Aerial Archaeology). Then we have subtracted the map of potentiality obtained from the Corine Land Cover raster and this map of slopes reclassified in 4 groups, so areas with slopes smaller than 15 degrees don't change their level of potentiality for Aerial Archaeology, those from 15 to 30 degrees lose 1 point in this classification, those from 30 to 45 degrees lose 2 points and areas with slopes bigger than 45 degrees

[11] We are aware that this classification, like the following one based on the data of the MAPA contains, as all the interpretations, a certain subjective component, but it is unavoidable and necessary for doing analysis and comparisons, and on the other hand, as we have just sai, we have tried to minimize this subjectivity based on the data from the available bibliography.

CORINE LAND COVER 2000 (Label Level 3) BY EEA	POTENTIAL 0-5
Continuous urban fabric	0
Discontinuous urban fabric	0
Industrial or commercial units	0
Road and rail networks and associated land	0
Port areas	0
Airports	0
Mineral extraction sites	0
Dump sites	0
Construction sites	0
Green urban areas	0
Sport and leisure facilities	0
Non-irrigated arable land	5
Permanently irrigated land	3
Rice fields	1
Vineyards	2
Fruit trees and berry plantations	1
Olive groves	2
Pastures	5
Annual crops associated with permanent crops	3
Complex cultivation patterns	3
Land principally occupied by agriculture, with significant areas of natural vegetation	5
Agro-forestry areas	3
Broad-leaved forest	2
Coniferous forest	1
Mixed forest	2
Natural grasslands	5
Moors and heathland	5
Sclerophyllous vegetation	2
Transitional woodland-shrub	2
Beaches, dunes, sands	1
Bare rocks	0
Sparsely vegetated areas	4
Burnt areas	1
Glaciers and perpetual snow	0
Inland marshes	0
Peat bogs	0
Salt marshes	0
Salines	0
Intertidal flats	0
Water courses	0
Water bodies	0
Coastal lagoons	0
Estuaries	0
Sea and ocean	0

LAND USE IN 2005 IN SPAIN BY M.A.P.A.	Surface (km2)	Percent of total surface	Potential (0-5)
Cereals grain	6.841.004	13,55%	5
Leguminous grain	410.763	0,81%	3
Tubers	72.438	0,14%	5
Industrial cultivations	728.904	1,44%	3
Fodder crops	852.675	1,69%	3
Vegetables and flowers	236.403	0,47%	2
Fallows	3.319.192	6,57%	3
Fruit-bearing citric	306.557	0,61%	1
Fruit-bearing not citric	1.065.513	2,11%	1
Vineyard	1.149.894	2,28%	2
Olive grove	2.456.719	4,87%	2
Other woody cultivations	59.940	0,12%	1
Nurseries	17.596	0,03%	0
Empty hothouses	25.026	0,05%	0
Family orchards	101.054	0,20%	1
Natural grasslands (irrigable)	869.929	1,72%	5
Natural grasslands (unirrigated land)	70.980	0,14%	5
Pasture in high mountain	323.696	0,64%	3
Pasture	4.657.412	9,22%	4
Pasture scrub	1.407.318	2,79%	2
Poplar	132.167	0,26%	2
Coniferous	6.173.958	12,23%	1
Leafy slow growth	3.057.285	6,06%	1
Leafy quick growth	705.068	1,40%	1
Coniferous and leafy	1.477.798	2,93%	1
Scrub	7.505.176	14,87%	2
Barren	1.597.621	3,16%	2
Esparto	225.380	0,45%	2
Waste	911.180	1,80%	3
Unproductive	1.039.334	2,06%	3
Not agricultural	2.152.809	4,26%	0
Inland waters	537.021	1,06%	0
Total surface of Spain	50.487.812	100,00%	

Figure 1

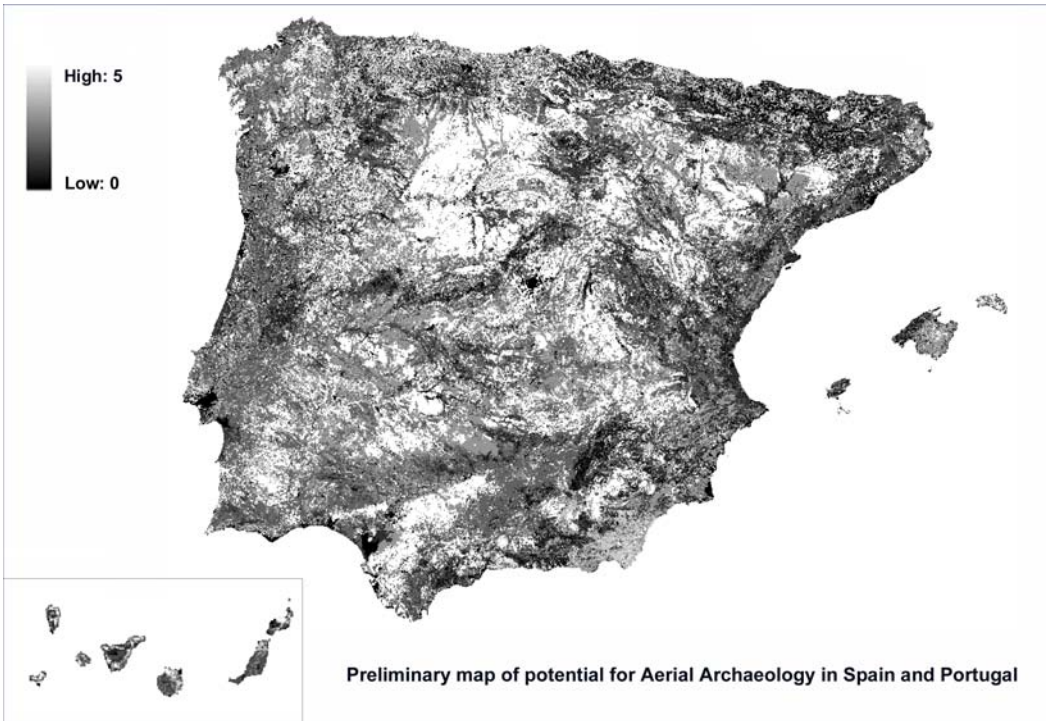

Figure 2

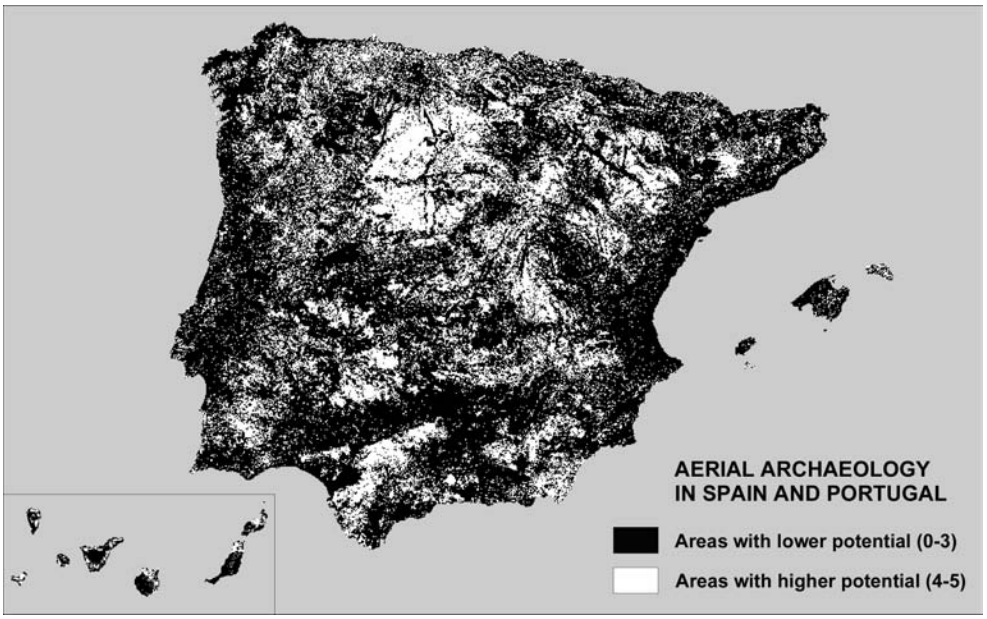

Figure 3

take value 0 (null visibility). This way we already obtained a first general map of potentiality for Aerial Archaeology in Spain (Figs. 2 and 3).

However to be able to do a comparative analysis, we need to study the specific characteristics of each Community. For doing this, the map of potential has been added to a raster map of Autonomous Communities of Spain in order to obtain the number of pixels of each type –from 0 to 5– that contains each Community. By doing this it has been possible to create a chart of mean values and percentages of the best lands (those with values 4 and 5) for Aerial Archaeology in each Community.

On the other hand, we have summarized and classified the data on surfaces of cultivations of the MAPA, again based on a scale from 0 to 5, and we have calculated what percentage they make in regard to the total surface of the Autonomous Community (Fig. 1). This information, more detailed than the Corine Land Cover one, allows us to know, for example, the surfaces used in grasslands, cereals, potatoes and sugar beet, which, as Jones and Evans indicate (Jones and Evans 1975, 4), are the cultivations that allow a better visibility of archaeological marks in the underground. This information helps us further to value an entire wide series of cultivations, kinds of vegetation and land uses. This way we obtained a second chart of mean values and extension of better areas for Communities.

Finally, we calcultated the mean of the values from the two charts: the first one which contains data from the Corine Land Cover and from the slopes map, which would be a first and more general working surface, and the second one, which contains exact surfaces of cultivations. So, the two charts complement each other, despite the limitations that have already been indicated. This way we finally obtained, as is reflected in the charts, graphics and vectorial maps that represent those values in each Community (Figs. 4 and 5).

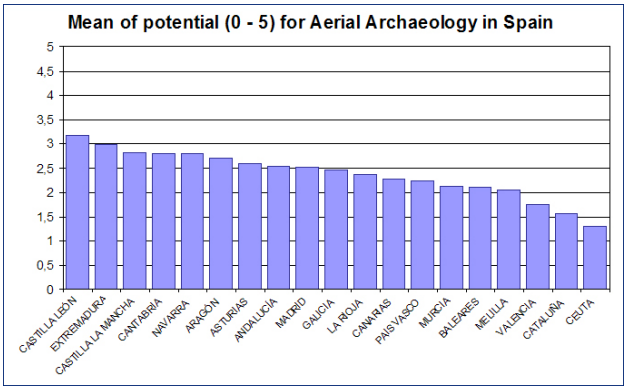

Figure 4

We will now briefly comment on some ideas that emerge from the data and the obtained maps. In first place we have to stress the high potential for Aerial Archaeology for some Autonomous Communities of the inland of Spain such as Extremadura, Castilla La Mancha and mainly Castilla León –where the work by Julio Del Olmo confirmed this great potential–, as much in general potential as in percentage of lands with more aptitude. This result was partly expected, given the conditions of relative plain, dryness[12] and extension of cultivations of cereal in these communities, that converts the inland of Spain into one of the most privileged areas for the practice of Aerial Archaeology in all of Europe. On the

[12] In this analysis it has not been possible to evaluate too many conditions that influence in the emerging of soilmarks. However they would occur more frequently just in this castilian area due to its aridity and the characteristic of the land.

other hand, the high potential that show some communities of the Cantabrian North such as Asturias, Cantabria or Navarra, especially for their high percentage of lands with more aptitude, is more surprising. This may be explained by the fact that this communities, in spite of wide mountainous areas which, as we know, have also been calibrated in this calculation, and that is why their potential mean is not so high, also present a great extension of grasslands and prairies, with a high grade of archaeological visibility from the air. We also find interesting the fact that Communities in the South of Spain such as Andalucia or Murcia don't show a potential mean as high as it could be expected initially, although as we can see from the map, there are some zones with great potentiality. This is due to the presence of mountains such as the Andalusian mountain range, and because of the great extension of cultivations of olive groves that do not allow a good archaeological visibility from air. On the other hand, in general the whole Spanish Mediterranean coast (except areas such as Almería) does not present very favorable conditions for Aerial Archaeology. Concretely Catalonia, mainly in their coastal provinces, and the whole of Spanish Levant, show very low indices of aptitude, probably because of the wide fruit-bearing, coniferous and scrublands extensions. Finally, although we cannot enter the topic here, we point out that almost the whole oriental area of Portugal presents high potentiality for practicing Aerial Archaeology.

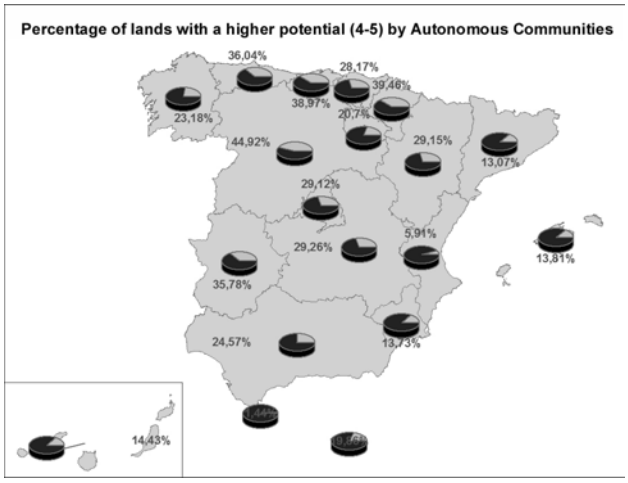

Figure 5

In general the northren half of the Iberian Peninsula seems to present better conditions for the development of Aerial Archaeology, especially the provinces of Álava, Asturias, Burgos, Cantabria, Lugo, Navarra, Palencia, Salamanca, Segovia, Soria, Teruel, Valladolid, Zamora and Zaragoza. Nevertheless, in the south half of the Iberian Peninsula there are provinces with important extensions of good aptitudes lands, such as Albacete, Almería, Badajoz, Cádiz, Ciudad Real, Cuenca, Sevilla and Toledo. In general, we observe that the 24,7% of the surface of Spain, that is, a fourth of the country, has a very good preliminary conditions for the development of Aerial Archaeology, and this is a very significant index for the great potential that our country offers for the development of this discipline.

Of course, all these data and maps are only a first and very general step within the topic, and new and deeper studies that include other variables are necessary. However we think that they can already be used like an initial reference to outline future works. And most importantly we want them to be a stimulus for the necessary development of this discipline in Spain, because we consider that it can have very positive results in a country with good geographical conditions, both physically and in its land uses (we remember, for example that Spain produces almost 18% of cereal of the European Union) and with an important archaeological heritage that in its majority has not been studied through the areal explorations.

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