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# WEB MAPPING SERVICE TO DELIVER PASTURE RESOURCES CARTOGRAPHY OF THE MURCIA REGION (SPAIN)

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## ABSTRACT

This paper presents the use of web mapping technology to deliver a preliminary cartography of pasture resources of the Murcia region, and to offer GIS functionality via internet/intranet. This cartography has been obtained within the context of a national SEEP-INIA project 'Characterisation, cartography and evaluation of Spanish pastures'. Shrubland communities in natural pastures represent the largest contributors to animal feed resources, whereas in cultivated areas sub products from cereals and horticulture crops (both, herbaceous species and trees) are the main fodder resources. Proper integration and management of livestock, crops, and degraded natural resources, remains one of the major tasks to develop new agrosilvopastoral systems. A model at 1:200,000 scale was obtained to estimate livestock stocking rates in relation to the units mapped, its potential biomass and energy production and its bioclimatic conditions and fluctuations.

## INTRODUCTION

Nowadays there are a lot of solutions and applications to disseminate cartography and GIS functionality via internet. During last years, the performance, functionalities, and quality of results provided by these solutions have improved significantly. The poster which refers this paper shows the use of this technology to disseminate the work done and results obtained in a project which falls within the context of the SEEP project 'Characterisation, cartography and evaluation of Spanish pastures', financed by INIA with the collaboration of Spanish Autonomous Communities. The intention of the project is to map, on a national level, the pasturelands existing in Spain and to determine their production capacity, quality and seasonal fluctuations, in order to optimise the management of an extensive stock rearing activity in equilibrium with pasture resources.

## MATERIALS AND METHODS

We have used Esri ArcIMS software to disseminate the generated cartography, which offers an scalable solution based in standards, and provides two web clients (based on Java and Html) that can be customized by user. In carrying out the cartographic exercise, we have followed the general methodology described by Broca *et al.*, (2001). To delimit the large surface units (unproductive, agricultural, wetland and water, pasture with a dense tree cover and pasture with sparse tree cover), we used the level 1 field of the Vegetation Cover Map from the III National Forest Inventory (1:200,000) drawn up by the Spanish Environment Agency .

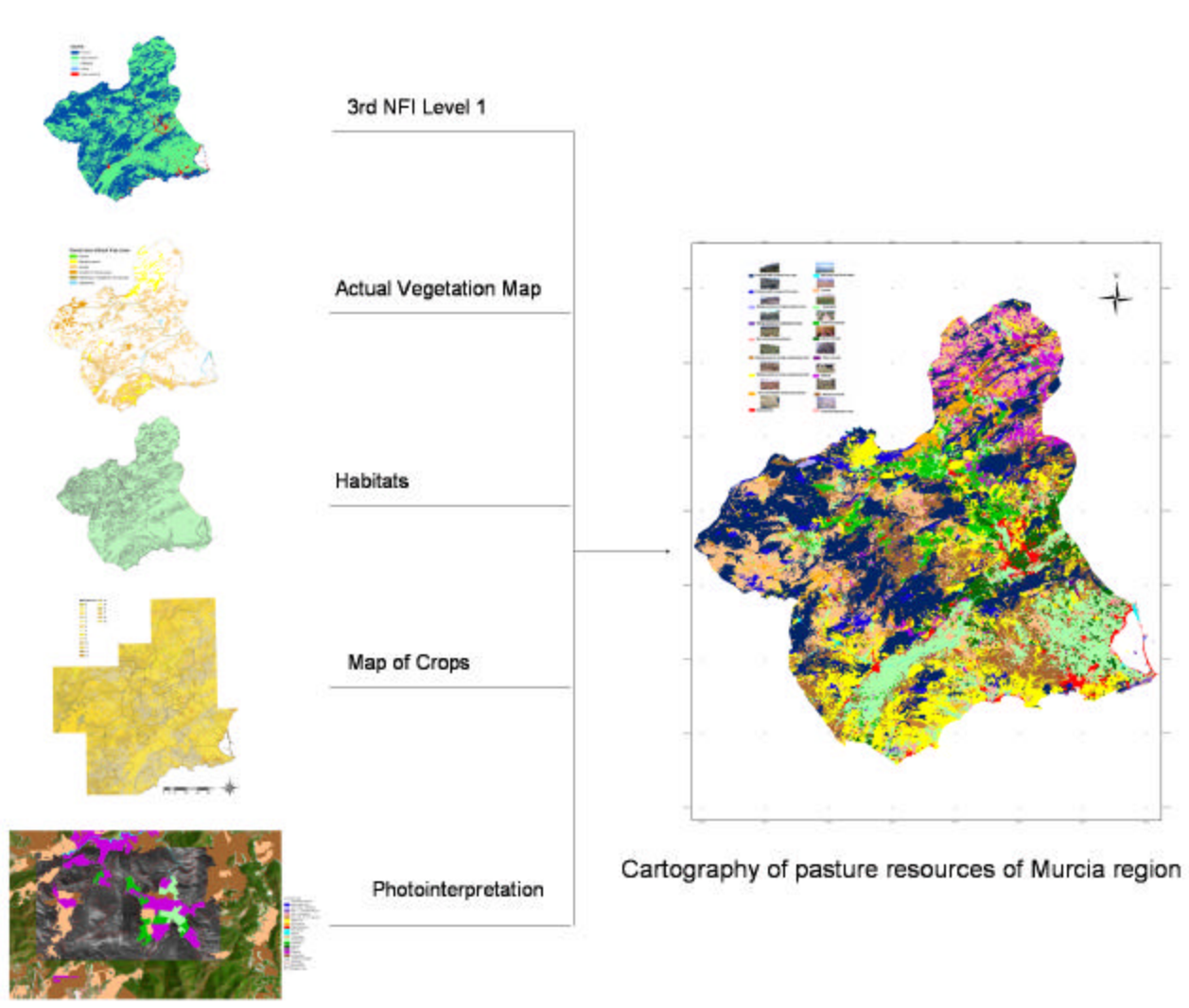


Figure 1. Cartography generation of pasture resources of Murcia region (Spain)

To analyse the forest area without tree cover, which comprises scrub of various types and grazing land, we referred to the Actual Vegetation Map (Alcaraz *et al.*, 2000) and to the National Habitat Map, while other units (esparto grass) were taken from the Map of Crops. All these were cross-referenced by aerial georeferenced photography covering the province of Murcia. In addition, bio geographical and bio climatic criteria were applied to obtain the precise delimitation of the main pasture in the province. The phytosociological associations and habitats included in Directive 42 / 93 were also included. The final denomination of the units was made according to the nomenclature of Ferrer *et al.*, (2001) for Spanish pasturelands. The potential production of metabolisable energy (ME) in each plot was calculated as a function of the bio climatic floor level, the plant community, mean rainfall and the equations determined by Passera *et al.*, (2000). Given the large number of plots making up the basic map a spreadsheet was developed to make these calculations automatically. For the rainfall data, the historical data covering 30 years from weather stations belonging to the National Meteorological Institute were used in conjunction with the Spatial Analyst extension. The equations used for biomass production in forest pastures were of the multiple linear type ( $y = a + bx + cz$ ), where  $y$  is the energy in MJ ha<sup>-1</sup> y<sup>-1</sup> of each unit in each bio climatic level,  $a$ ,  $b$  and  $c$  are constants obtained by regression techniques,  $x$  is the mean annual rainfall of the unit and  $z$  the mean cover of the unit (Passera *et al.*, 2000). For agricultural pastures, the metabolisable energy was estimated from the data concerning the agricultural by-products produced and their corresponding tables of nutritive value. Once the energy that can be generated in a sustainable way has been calculated, this can be expressed in terms of the potential ovine or caprine stocking capacity by taking into account that a sheep of the Segureña breed in production and with a live weight of approximately 45 kg needs about 5033 MJ ME y<sup>-1</sup>, while a Serrana goat needs about 5189 MJ ME y<sup>-1</sup>.

Assuming that low temperatures and the absence of rainfall (winter months with mean temperatures below 7.5 °C and dry months with a water deficit greater than 20 %) interrupt growth, seasonal graphs of natural pasture production were

drawn up, while, at the same time, we took into account the production calendar of the main agricultural by-products to obtain a similar seasonal production graph.

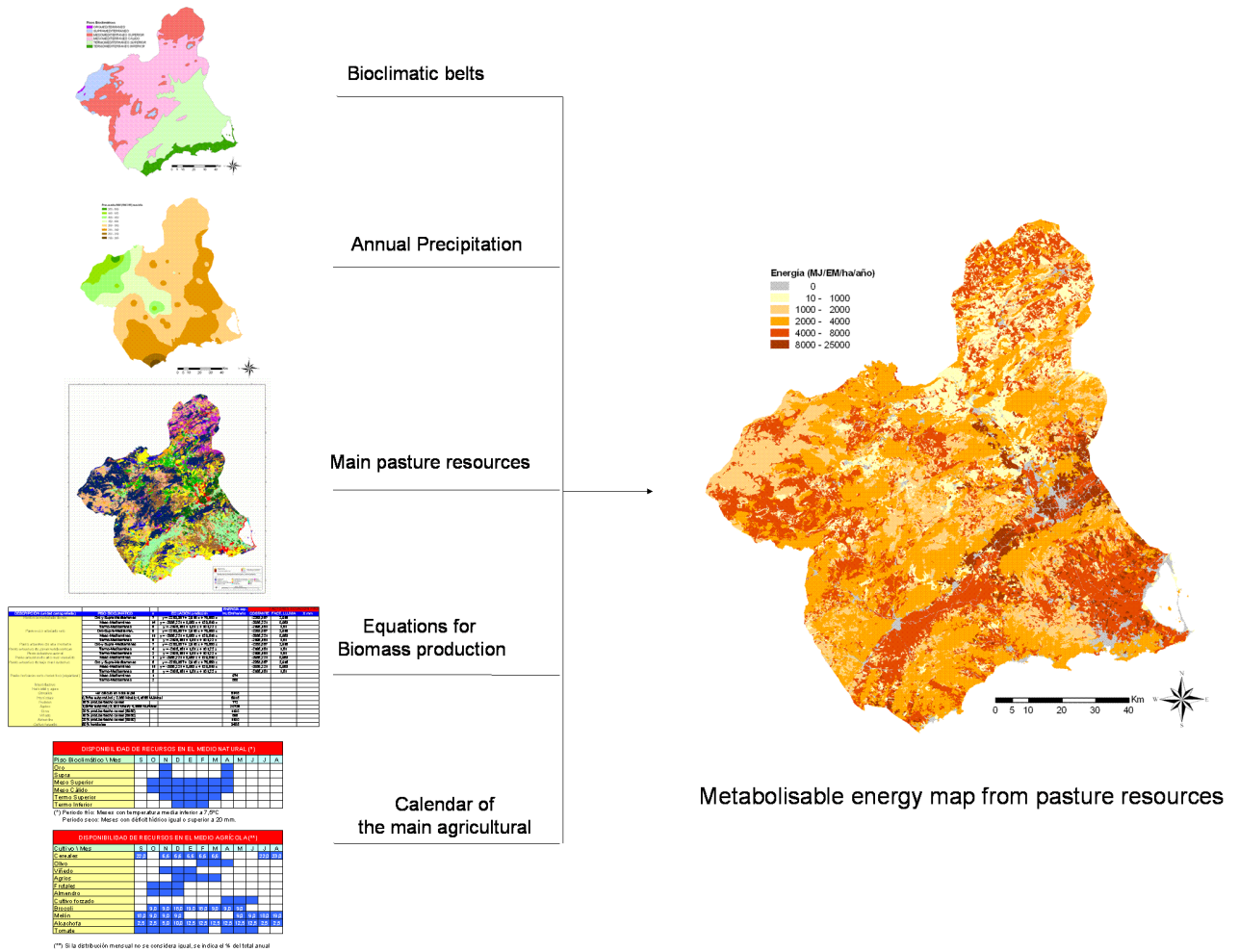


Figure 2. Generation of the map expressing the potential production of metabolisable energy from pasture resources of Murcia region ( Spain)

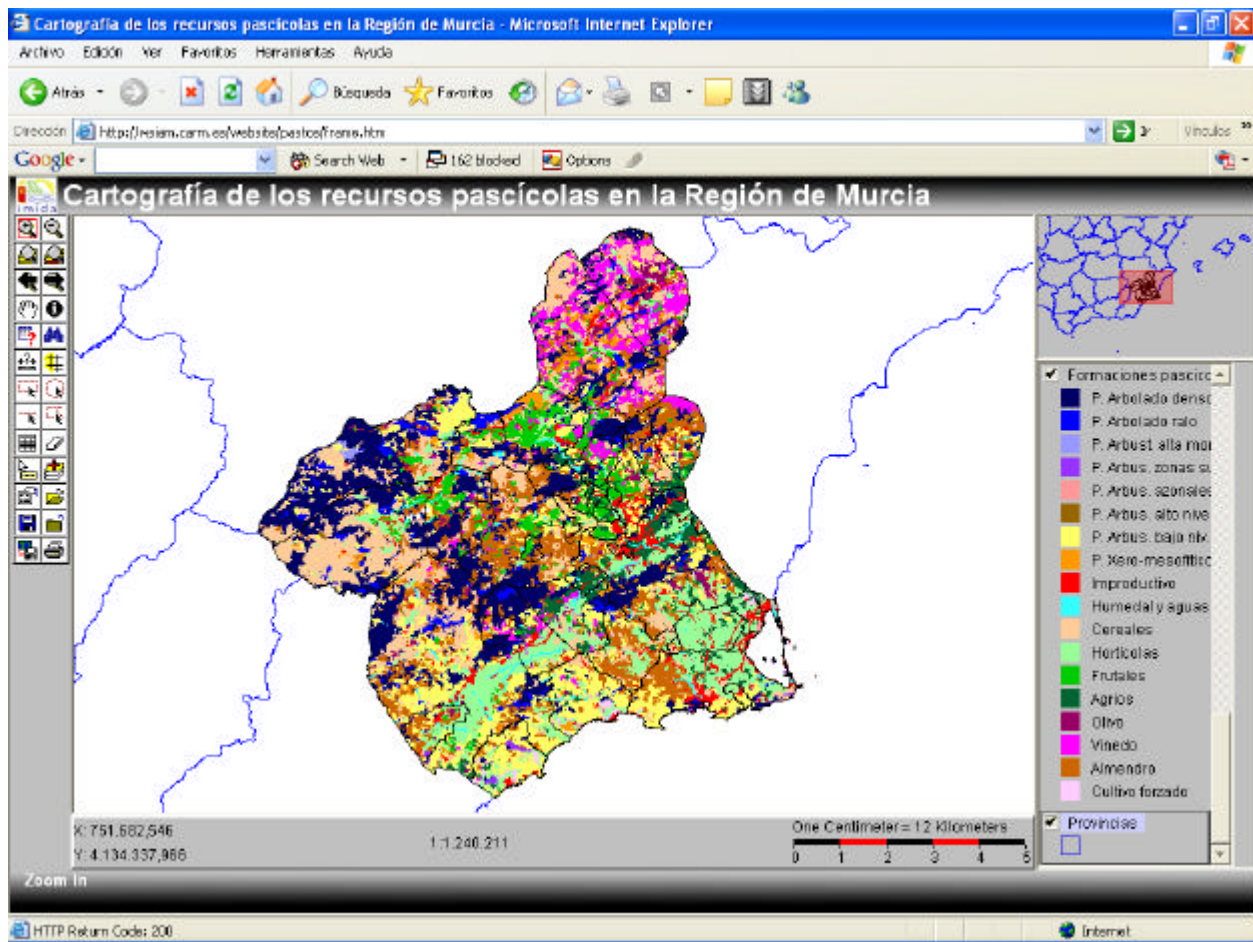


Figure 3. Screenshot of the web mapping service for delivering cartography of pasture resources in Murcia.

## RESULTS AND DISCUSSION

Forest formations cover almost half (45 %) of the Region of Murcia (1,131,390 km<sup>2</sup>). The main units are extensive pastures densely covered by trees (23.4 % of the province) and bushy pastures of a low evolutive level (14.2 %). The surface covered by climax vegetation in the province is less than one percent, which gives some idea of the general degradation which it has suffered. Agricultural crops cover 46 % of the province, with cereals (14.1 %), almond (12.0 %) and horticultural crops (11.6 %) being the most widespread.

The greatest potential stocking capacities are to be found in areas where there is an abundance of agricultural by-products, particularly those resulting from irrigated crops (2-5 sheep ha<sup>-1</sup> under citrus and 1-2 sheep with horticultural crops) and dry land cereal (1-2 sheep ha<sup>-1</sup>). In vineyards and almond plantations the corresponding load is very low (0.25 sheep ha<sup>-1</sup>) due to the low production of forage resources (dry leaves and weeds during a short period of time). Forested zones present noticeably lower potentials (0.25-0.75 sheep ha<sup>-1</sup>) since productivity is low. The highest potential stocking rates (0.50-0.75 sheep ha<sup>-1</sup>) in forest areas are to be found in intermediate zones with a mild climate and rainfall of 350-400 mm y<sup>-1</sup>. In semi-arid coastal areas (200-300 mm) stocking rates are lower (0.25-0.50 sheep ha<sup>-1</sup>) because of the low rainfall, while in higher areas inland (> 1200 m) low temperatures in winter have a limiting effect and the same stocking capacities apply. There is a substantial area of Murcia that is badly eroded (badlands); this area has a very low stocking capacity and should be excluded from grazing.

Sheep grazing activity has increased greatly during recent years in the mild coastal areas of the province, where there are extensive areas dedicated to horticultural crops. For example, in the Campo de Cartagena area a mean stocking rate of 1.18 sheep ha<sup>-1</sup> can be sustained with a mean flock size of 464 sheep. In contrast, other areas with a long history of grazing, (e.g. in the north-west of the province) support much lower stocking rates (0.52 sheep ha<sup>-1</sup>) and smaller sized flocks (average of 265). In this area the resources are basically the by-products of cereal crops (straw, harrowing, fallow lands and poor harvests) and the shrub land communities of forest areas. In short, the intensification of sheep grazing activity is evident in the region, as it is in many other parts of the EU.

The feed-deficits that occur at certain times in some areas mean that feed concentrates have to be provided, thus increasing final costs. In the north-west, for example, there are times during the coldest months without plant growth and with few resources, which may also occur during colder than usual autumns; however, during those cold periods, horticulture by-products from the Campo de Cartagena could be used. In this coastal area, on the other hand, there are feed-deficits at the end of winter and during early spring, when the land is in full agricultural production. At such times, the process can be reversed and feed can be provided from forested areas such as the north-west. There may also be periods of shortage during the summer, when the land is ploughed and prepared for autumn seeding.

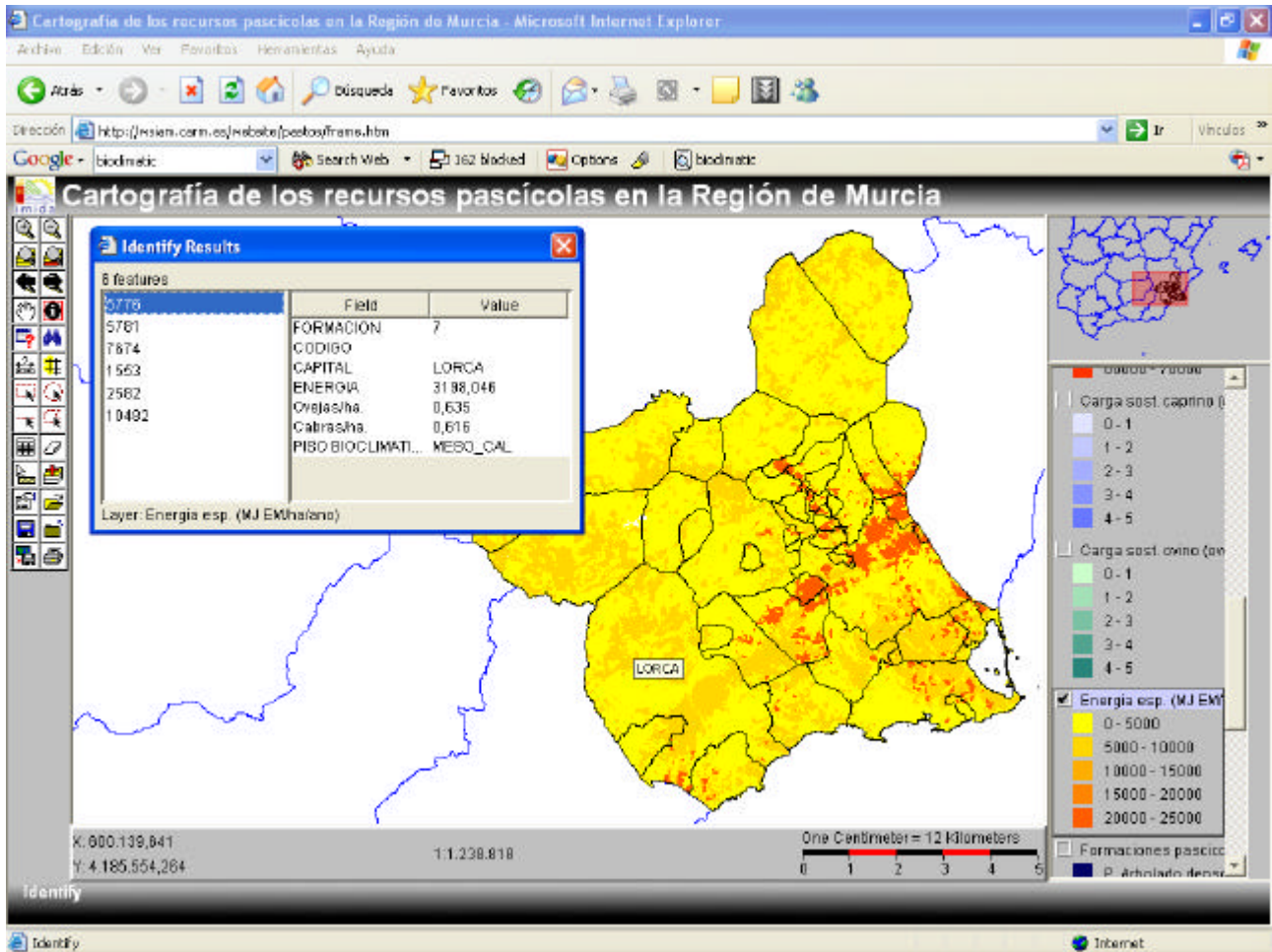


Figure 4. Web mapping service displaying the metabolisable energy map from pasture resources.

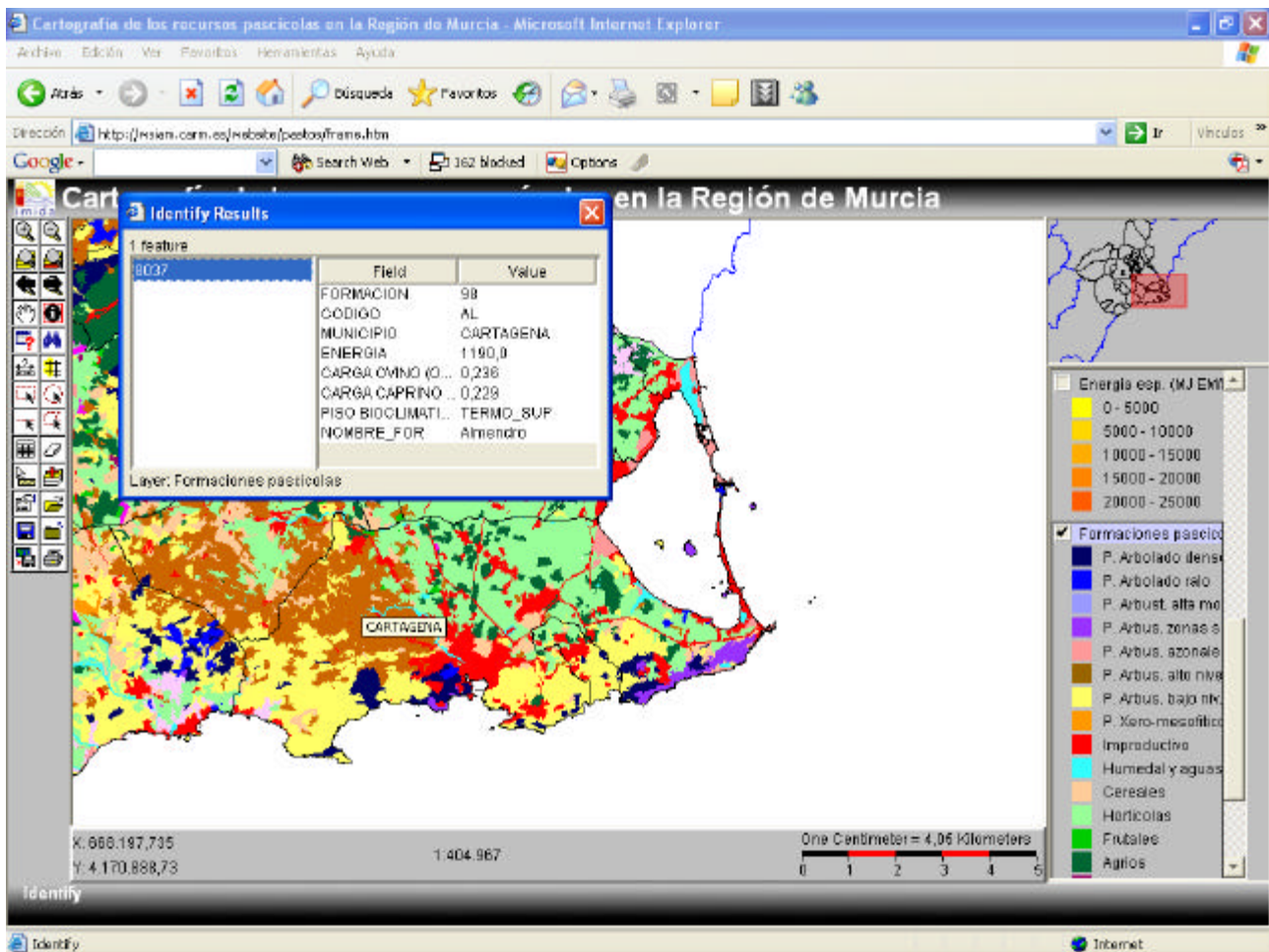


Figure 5. Example of getting information using the identify tool.

## CONCLUSIONS

The use of web mapping technologies to disseminate cartography and GIS functionality via internet/intranet is offering new possibilities to share and distribute cartography in an easy and efficient way. Within the context of our project, you can visit our web mapping service at link <http://wsiam.carm.es/website/pastos/default.htm> to consult the cartography obtained. This project makes clear as the integration of vegetation mapping with biomass production models in GIS is of enormous value in the management of an extensive and sustainable livestock programme. It permits an understanding of resources distribution, which, combined with a knowledge of seasonal availability, facilitates the planning of animal feed distribution, the provision of feed representing almost half of the costs involved in bringing sheep / goats to market.

In Murcia Region as a whole, potential stocking rates are low, exceeding 1 sheep ha<sup>-1</sup> only in those zones that generate a large quantity of agricultural by-products, whether resulting from cereals, fruit pulp or horticultural products. Densities only reach 0.25-0.75 sheep ha<sup>-1</sup> in forest zones. Although there is a clear tendency towards feed intensification, grazing forest areas are still of importance and may contribute to the conservation of the environment and natural habitats, many of which are of priority interest for the EU. An alternative to the provision of supplementary feed during shortages might be to take advantage of the network of livestock transit tracks that still exist, which would facilitate the complementary provision of feed. Their recovery and use, furthermore, would contribute to the creation of biological corridors which connect different habitats.

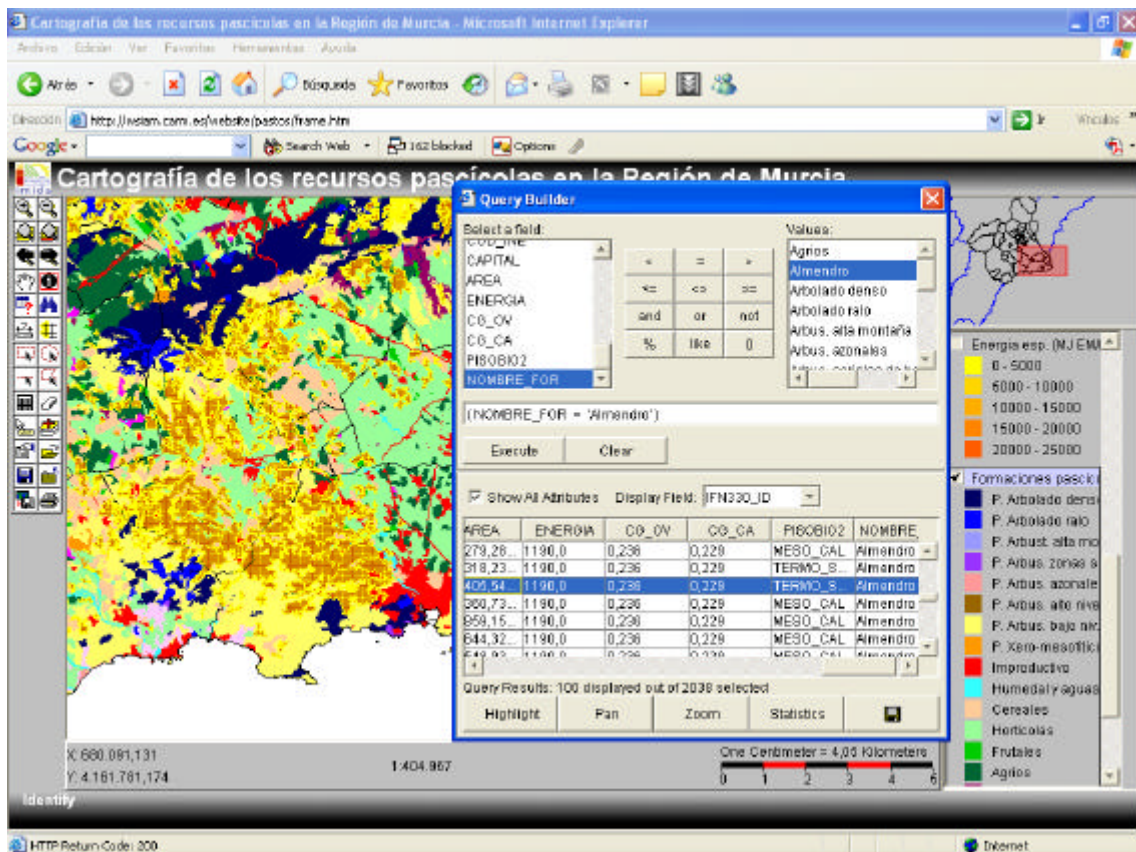


Figure 6. Example using the query builder to find information related to cartography layers.

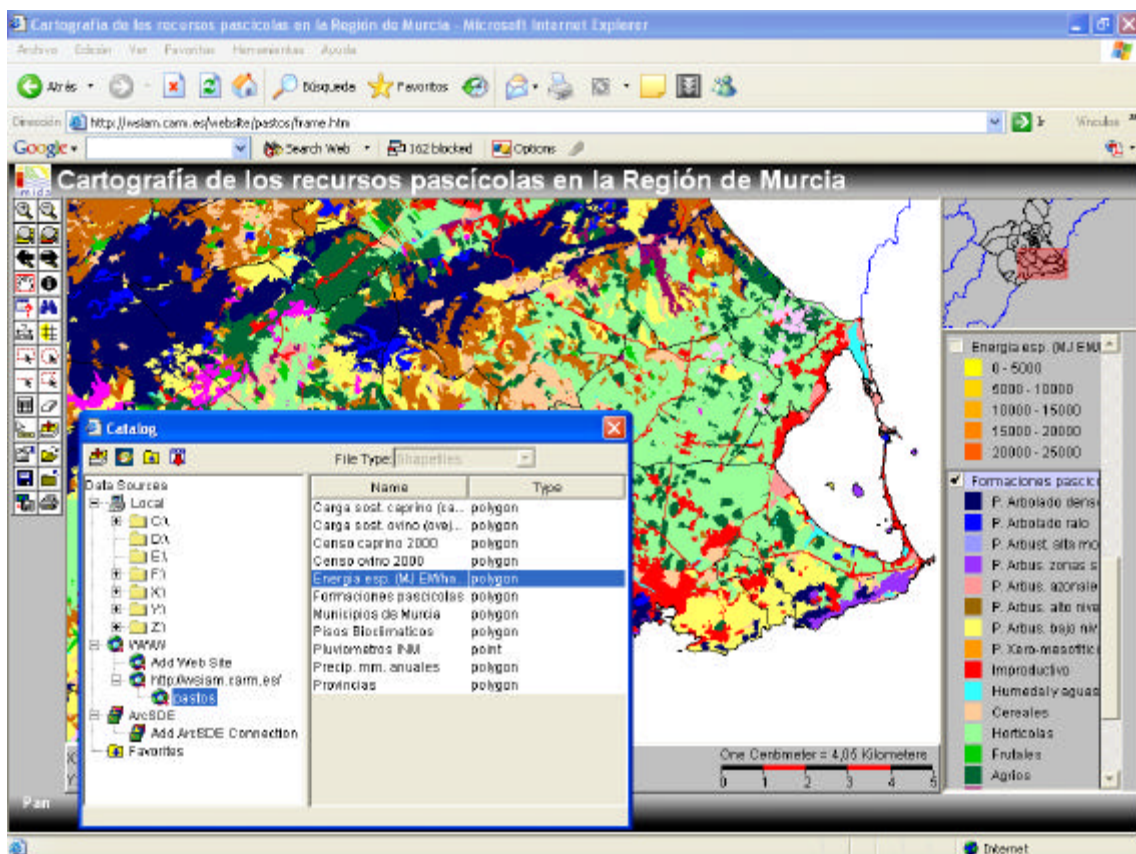


Figure 7. Loading local or external cartography from different sources.

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