Socio-Economic Evaluation of the Terra Cha Irrigators Community by using a Geographic Information System - Spain

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Abstract

This paper presents a method to acquire data before the improvement an irrigation area. This method was applied to the irrigation management unit: the irrigators community. The farms comprised in the area were analysed from a technical and socio-economic perspective.

The first step in the proposed method was the design of a survey that included 59 questions, grouped into 9 sections, according to subject: title, ownership, water management, irrigation, irrigators communities, cultivation techniques, economic factors, sustainability, and opinion. The present case study surveyed 193 farms, divided into three sectors by the National Colonization Institute (NCI) according to different features. The survey returned several variables that established population groups for further analysis, among which farming activity and monthly income. In addition, a Geographic Information System (GIS) was developed to represent and analyse water management.

The main result of this study was the knowledge of the current situation in the studied irrigation area. Earlier studies did not have such an ambitious objective. The integration of the results of the survey into GIS verified farm specialization and spatial clustering in the zones with the best environmental features. Some knowledge of the area is required to interpret the descriptives of the variables contained in the survey because the opinion answers were biased.

The Geographic Information System developed in this study supports decision-making during the irrigation modernisation process. GIS serves as a basis for future implementation of a model of sustainable water management. The use of GIS was very useful in other irrigation areas, especially in programmes of advice to irrigators and in programmes of management of irrigators communities.

Key Words: *water management, survey, irrigation, evaluation*

1. Introduction and objectives

The demand for water resources is steadily increasing throughout much of Europe. Therefore, the development of legislation is essential to respond to this challenge and to preserve water resources for present and future generations.

The water policy in Spain underwent major changes at the national and European levels from the approval of the Law on water use “Ley 29/1985”, to the approval of the decree “Real Decreto 329/2002”, April 5, on the National Irrigation Plan (NIP). The approval of the Basin Water Plans and of the European Directive establishing a framework for Community action in the field of water policy reveals the need to rationalize the agricultural uses of water. Irrigation must be improved and modernized to achieve rationalization.

J. Cancela, X. Neira, T. Cuesta, C. Alvarez, and R. Crecente. “Socio-Economic Evaluation of the Terra Cha Irrigators Community by using a Geographic Information System - Spain”. Agricultural Engineering International: the CIGR Journal of Scientific Research and Development. Manuscript LW 04 003. July, 2004.

The projects of irrigation improvement are implemented for Irrigators Communities (IICC), which are the basic entities of water management. In these communities, water is collected from the same tap by a group of users for agricultural purposes. The main current social, economic and environmental factors of each Irrigators Community must be studied separately before developing the improvement project.

The assessment of the current situation of irrigation in the three irrigation areas of Galicia was never studied in a global manner. The only antecedents in this field were the PhD dissertations on irrigation water management in the zones of Terra Cha and Monforte de Lemos (Neira, 1993 and Cuesta, 2001).

The zone selected for the analysis of irrigation in Galicia was Terra Cha because the information available focused mainly in this zone, and because a high number of owners in this zone are current irrigators. The irrigation area of analysis was established in the colonization process developed by the National Colonization Institute (NCI). During the 1950s, this institution defined a number of colonization areas, and provided for actions directed to the reform of the agricultural business, the exploitation and development of the natural resources (particularly, works for irrigation development), and the improvement of the rural environment in these areas. The colonized areas were established in non-used areas that enabled the establishment of competitive farmers after the planned transformations. The farmers chosen to settle in the colonized zones came from depressed agricultural areas or had been evacuated from villages that had been flooded by dam construction projects.

The present study aims mainly to find a method to evaluate the current situation of an irrigated area that belongs to an irrigators community, prior to the implementation of modernization and improvement projects in the area, as established in the National Irrigation Plan. The evaluation method must enable the determination of the socioeconomic parameters of an irrigation area with the aid of new technologies. The analysis of farm viability and the opinions of the people directly affected by the improvement project were included in the evaluation. The evaluation that precedes any action on the improvement or modernization of an irrigated area serves as the support to the high investments required. Evaluation can prevent economic failure or occasional environmental failure. The present study contributes to integrated water management by providing information and decision criteria for the irrigated areas, based on the Geographic Information System (GIS) developed. The application of the suggested method was conducted in the colonization area established by the National Colonization Institute in the region of Terra Cha, Spain. The irrigators communities of this region currently undergo a process of improvement and modernization.

2. Characterization of the area

The colonization area of “Terra Cha” is located in the region with the name “Terra Cha”, in the middle of the province of Lugo. The area consists of three sectors. Sector I “A Espiñeira”, is located in the municipality of Cospeito, and covers 351 hectares of performance. Sector II “Arneiro-Vega de Pumar”, is located in the municipalities of Castro de Rei and Cospeito, and covers 1502 hectares. The last sector in the area, sector III “Matodoso”, is located in the municipalities of Castro de Rei and Cospeito, and covers a total of 1039 hectares (Cancela et al., 2002).

The water distribution systems used for irrigation are different for each of the seven irrigators communities in the colonization area. Networks of ditches, buried pipes, or a

combination of both are used. The distribution system branches from the rivers Miño, Lea, Anllo, Támoga, and Pequeno. Water is delivered during the day. Table 1 shows the irrigated areas according to the different irrigation systems used.

Table 1. Irrigated areas by Irrigators Community (Cancela, 2004)

	Sprinkler	Surface	Total area
Irrigation	881.71	895.22	1776.93

The cropping pattern in the area consisted in silage corn and pasture. Silage corn showed a lower percentage in the area. Silage corn crops increased during the last few years and currently cover 20% of the surface area (Gómez, 2003).

Climate data were taken at eight weather stations in the region. This region has a fresh climate (with an average temperature of 11.35). The dry period extends from June to September. Average annual rainfall is 1220 mm, and average daily evaporation is 3.41 mm/day, determined by using Penman-Montheith method (Gómez, 2002).

The study of the soils and of the geomorphology of the area was based on earlier studies (Castelao, 1989). The parent materials are tertiary sediments and recent alluvial sediments. Therefore, three types of soils can be distinguished: Fluvisols, Gleysols and Cambisols. Fluvisols are characterized by their proximity to river beds, as compared to the hydromorphic features of Cambisols, which show steeper slopes. Gleysols are located in areas with steeper slopes than the other types of soils. Soils show a limited depth, with an impermeable layer at barely 40 cm. The distribution of soils in the study area follows: 68% Cambisols, 22% Gleysols, and 10% Fluvisols.

3. Materials and methods

For the analysis of the study area, both the survey to owners and GIS were considered.

3.1. Survey

The survey was designed to try to cover the most relevant aspects in the study of farms in order to enable the application of the survey to any irrigation area in the world.

The initial information for the design of the survey consisted exclusively of the census of the 193 irrigated farms created by the National Institute of Colonization. Additional information included the sector in which each farm was located, the irrigated and rainfed areas, and the location of the plots of each owner. The problem with initial information was the lack of adjustment with the present moment because the most recent information dated from 35 years ago, in the case of the sector established last (Cardesín, 1987)(INC, 1956).

The process started with the provisional design of the survey and in-field validation by surveying 10 owners (Rodríguez et al, 1996)(Cuesta, 2001)(USDA-NASS, 1998)(Borges, 1998). The results obtained in earlier studies suggested the total cost and time required for the final survey. Some confusing questions had to be changed and some key questions that were not included in the first design had to be included. After the design of the pre-survey, the

decision was made to survey the whole of the 193 farm owners in the area, due to the complexity of some items, such as the age of landowners, the productive direction of the farm and the type of farming activity (part-time or full-time).

Eight operators attended training meetings with the designers of the survey in order to learn how to perform the field survey. A guide to the survey was delivered to operators. Each operator was in charge of one geographic zone, which included 24 farms. The quality control of the survey was conducted by telephone, by randomly calling 10% of the surveyed farmers. Field work was planned to be performed within one week, and considering the limited accessibility of farmers during certain periods of the day.

Survey tabulation was performed directly in SPSS, v. 11.5 (Statistical Packages for the Social Sciences). This software enabled coding with value labels in addition to the statistical analysis. Tabulation errors were detected and corrected. Then, descriptive analyses of the different variables returned by the survey were conducted. Data were divided into two groups, based on the categoric variables 'farming activity' and 'income level'.

3.2. Geographic Information System

A GIS can be defined as "a set of maps of the same portion of land, where a specific place has the same location in all the maps included in the information system" (Bosque, 1992). This definition could be completed by including the software and hardware required to run the system. GIS is also a system to support decision-making.

The need to use GIS in the integrated development and management of soil and water resources, particularly in the development of decision-making models, was suggested in the conclusions and recommendations of the 18th ICID Congress - Montreal, 21-28 July, 2002 (ICID, 2002). GIS enables the integration of graphical and alphanumeric information, which can be subjected to search, analysis or visualization of results in the shape of thematic maps (Mondragão-Rodrigues et al. 1998). The study developed by López-Piñeiro (2000) was an antecedent to the use of GIS in the characterization of irrigated areas.

The graphical corrections required to obtain the updated base cartography were made on the initial cartography from the Centre for Cadastral Management and Tax Cooperation (CGCCT). ArcGis software was used to generate the coverage of rural parcels in the study area. Based cartography was coded in ArcView 3.2., by using the data available from the cartography of the National Geographic Institute (Instituto Geográfrico Nacional, IGN) at scale 1:25.000, the cartography from the NIC, and the cartography of the Survey on Infrastructure and Local Equipment (EIEL) of the province of Lugo.

The final GIS enabled the integration of the data acquired in the survey to farmers by means of a univocal field. The code used refers to the colonization sector and lot of each farm.

4. Results and Discussion

The initial results of the data from the farm census allowed us to obtain the current characterization of the farms, based on the grouping variables: Farming activity (Fig. 1a) and Income level (Fig 1b). The frequency histograms showed that 75% of the surveyed farmers are active farmers. These farmers were the main subject of study.

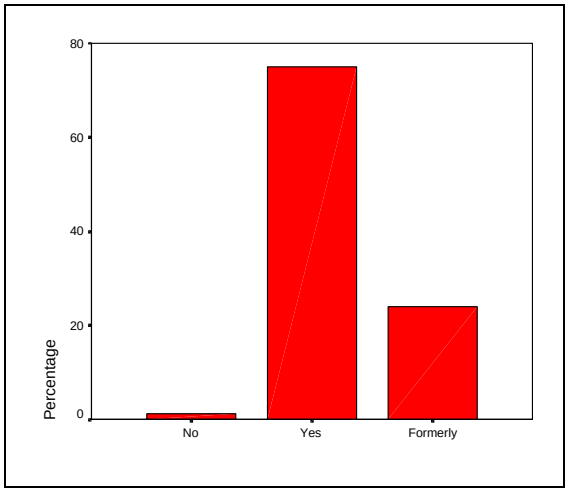

Figure 1a. Farming activity

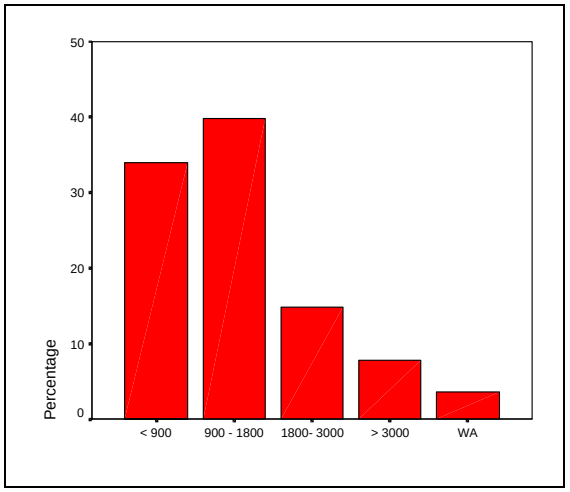

Figure 1b. Income level (€/month)

4.1. Farming activity

126 out of the 193 surveyed farmers still develop farming activities. The parameters analysed in each farm were divided into categoric variables and numeric variables. The categoric variables were: age, level of education, ownership of a well, water analysis, household wastewater treatment system, farm wastewater treatment, irrigation system, and criterion for liquid manure application.

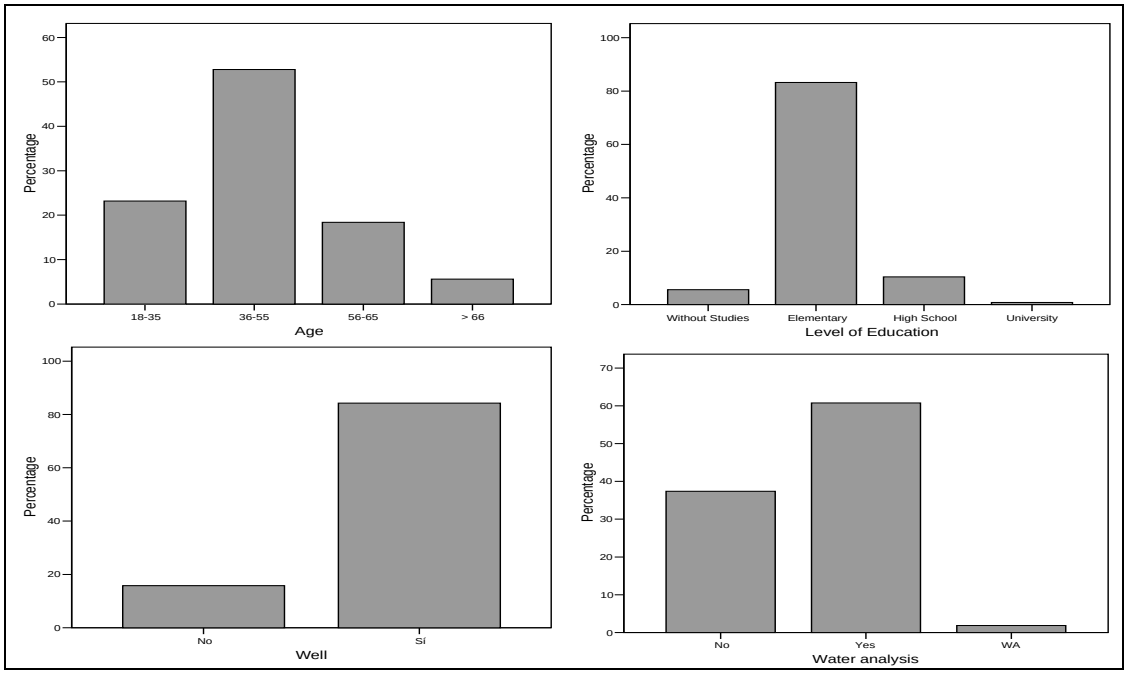

Figure 2. Frequency distribution of the main studied variables

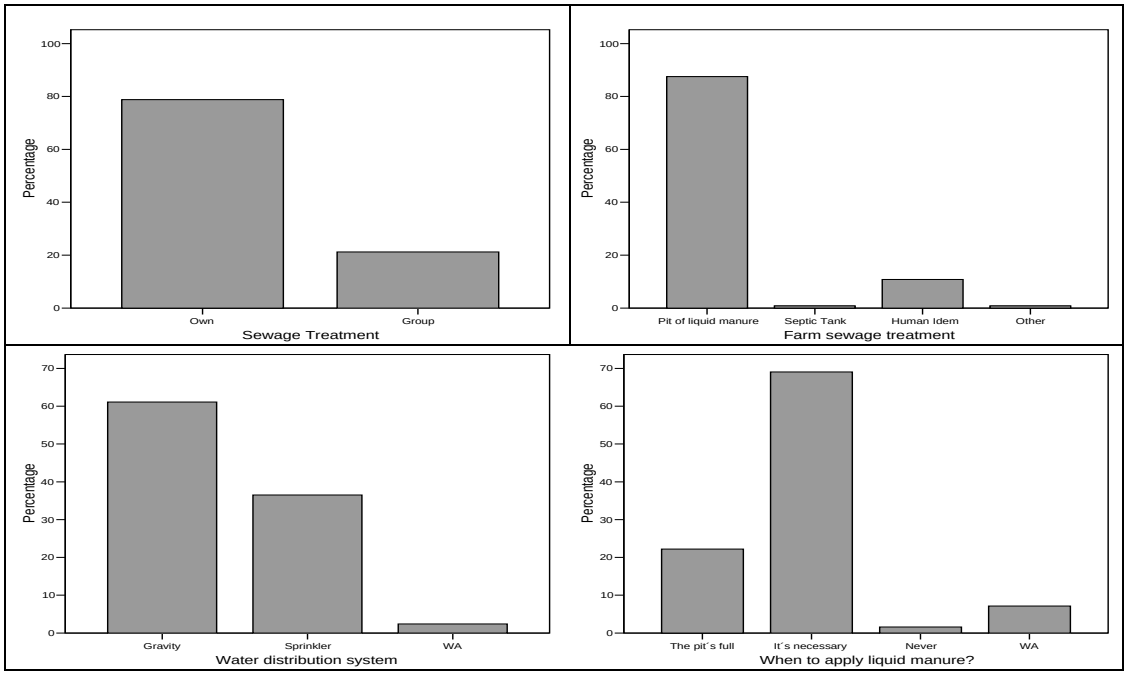

Figure 2. Frequency distribution of the main studied variables (Cont´d)

76% of current farm owners are younger than 55. Therefore, the continuity of the majority of the farms is guaranteed. Only 11.2% of the owners belonged to a level of education over the basic level. The irrigators communities used two water distribution systems: gravity and sprinkler. Gravity irrigation represented 60% of the total.

Knowing the opinion of the farmer is essential to improve the irrigation system. To solve the problem, the following variables were considered: willingness to increase the irrigated area, willingness to use water meters, and economic support for training and technological innovations (Fig. 3).

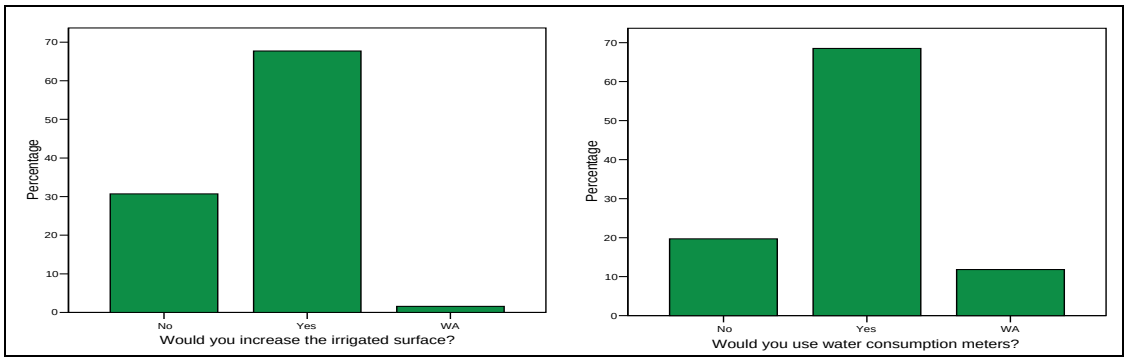

Figure 3. Frequency distribution of the variables of opinion

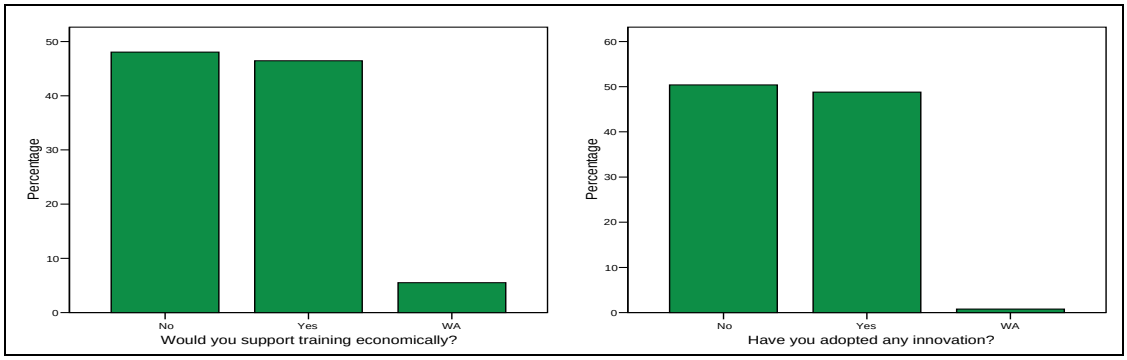

Figure 3. Frequency distribution of the variables of opinion (Cont´d)

Almost half of the farmers improved technology in the last few years, and 68% of farmers increased the area of their farms. The farmers who seek higher productive competitiveness can be distinguished based on these data.

4.2. Income level

Income level was critical in the evaluation of irrigated farms. The four categories established for the variable "Income level" were combined with the variables: level of studies, willingness to increase the irrigated surface, and type of irrigation system. The combination of these variables led us to the conclusion that the surveyed farmers with the lowest income show a negative attitude towards the increase of the irrigated surface area.

The farms using gravity irrigation systems correspond to a level of income lower than 3000 € a month, while the farms using sprinkler irrigation systems correspond mainly to a level of income higher than 3000 € a month (Fig. 4).

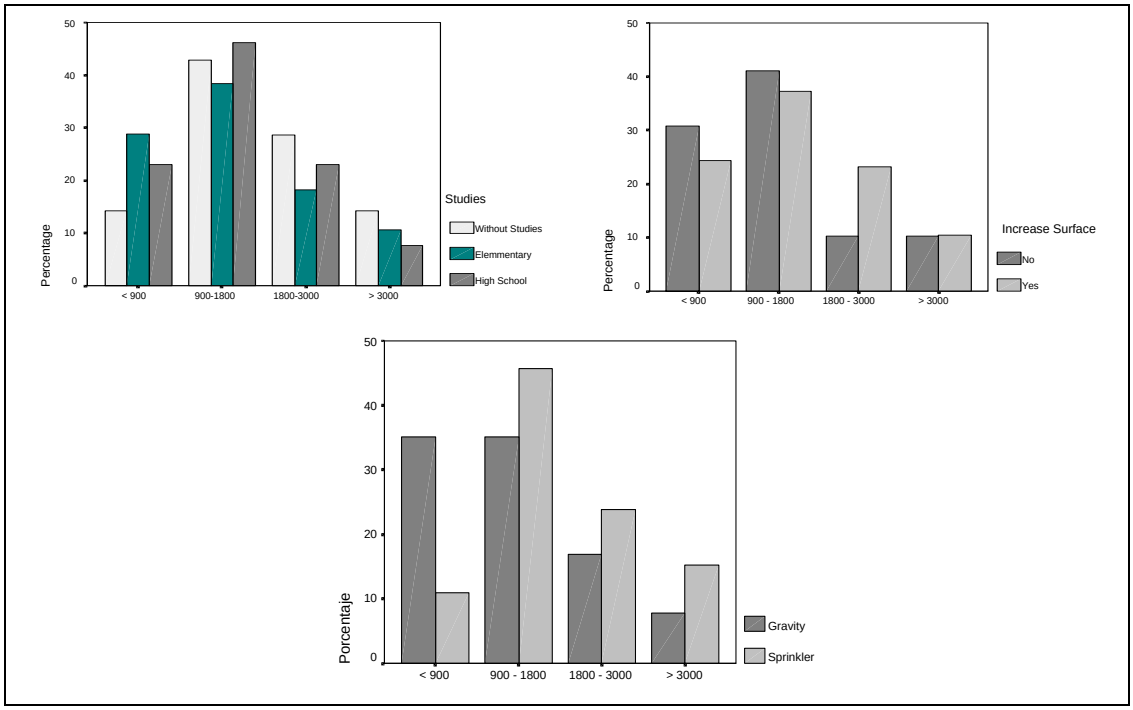

Figure 4. Frequency distribution according to the variable 'income level'

The analyses based on categorical variables were completed with descriptive analyses of quantitative variables. Mean values, maximum and minimum values, and the standard deviation were obtained for the group of farms that still develop a farming activity (Table 2).

Table 2. Descriptives of the quantitative variables

Feature	Minimum	Maximum	Mean	Stand. Dev.
Total area (ha)	4.00	60.00	17.04	9.61
Total irrigated area (ha)	2.00	44.00	10.92	6.84
% of Income devoted to the farm	10	100	85.17	23.45

4.3. Geographic Information System

GIS cartography showed general information about the study area, among which: physical environment (hydrographic network, soils, ...), ownership, and irrigation network.

The combination of the data obtained in the survey and GIS, allows the user to know the location of the parcels that belong to each farm, and the attributes associated to each parcel (Fig. 5).

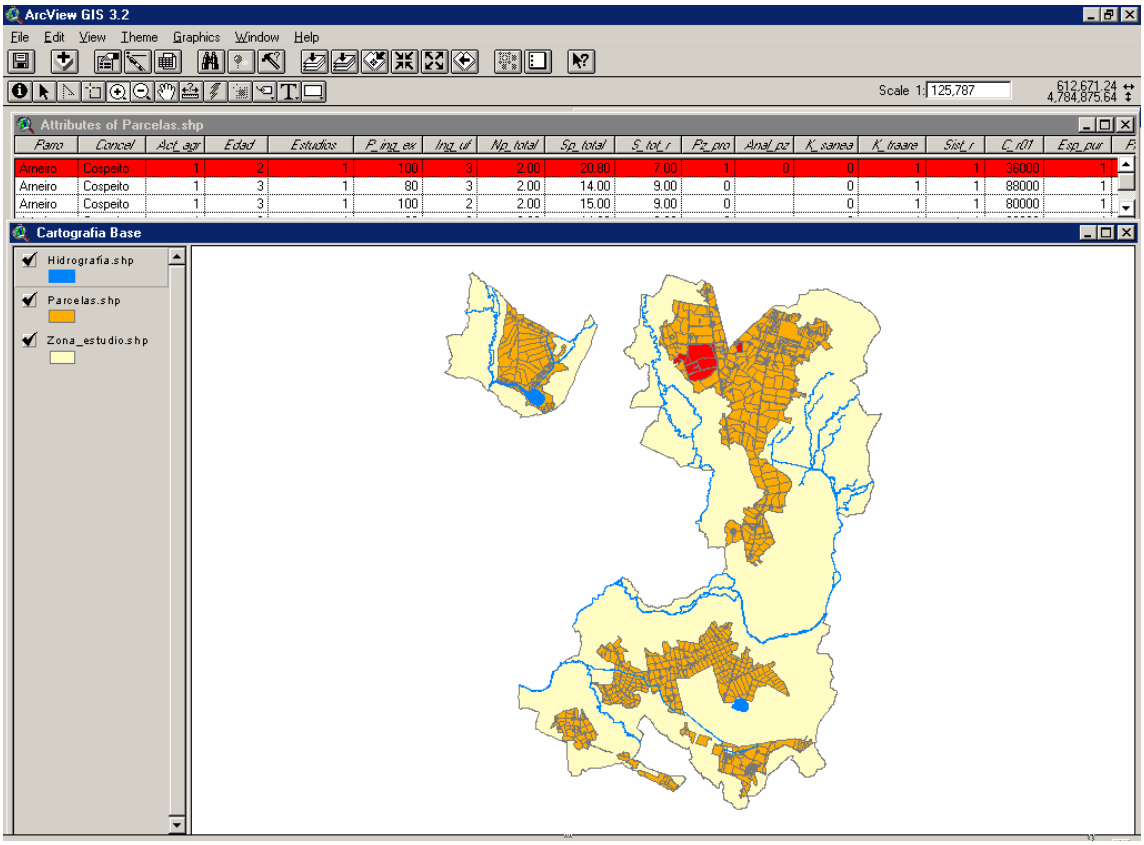

Figure 5. Distribution of the land owned by one farmer

The features of the physical environment of the Terra Cha were included in the GIS database. Land information can be used for decision-making in the design of criteria for action. Information can also be used to create thematic maps containing initial information to know the study area (Fig. 6).

Queries about the parameters considered can help to make decisions about where the irrigation modernization or the improvement of the sewerage network is a priority, etc. (Fig. 7). The analysis of the GIS revealed which areas or farms must be modernized with the highest probability of success. This analysis considered several variables together, such as the parcels where irrigation is still used, the improvements performed in the farm by the farmer, or the age of the owner (Fig. 8). The viable farm size was characterized by the use of sprinkler irrigation systems, with a mean surface area of 20.6 ha per owner. The age of the main farmer in these farms ranged 36 to 55 years, and the gross monthly income ranged between 18000 and 30000 euro.

Other uses of GIS enable the creation of indices, based on the parameters measured in the survey to farmers (Rodríguez et al, 1996).

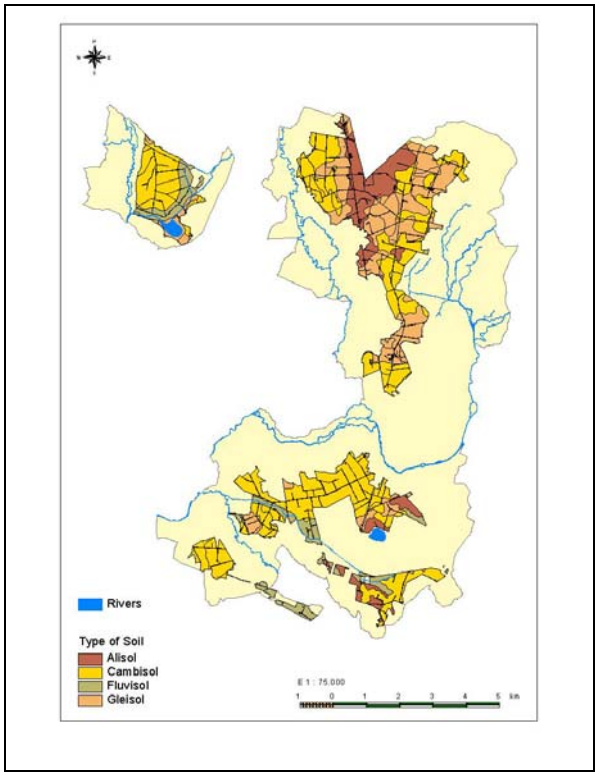

Figure 6. Type of soil

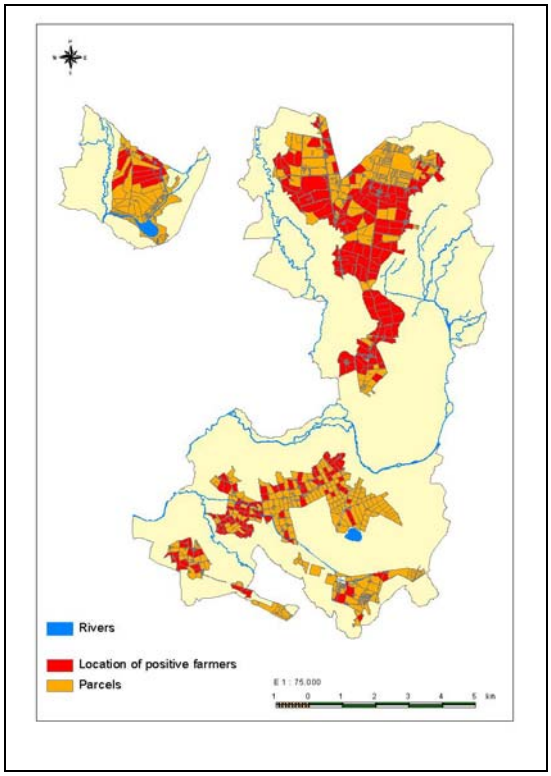

Figure 7. Increase Surface

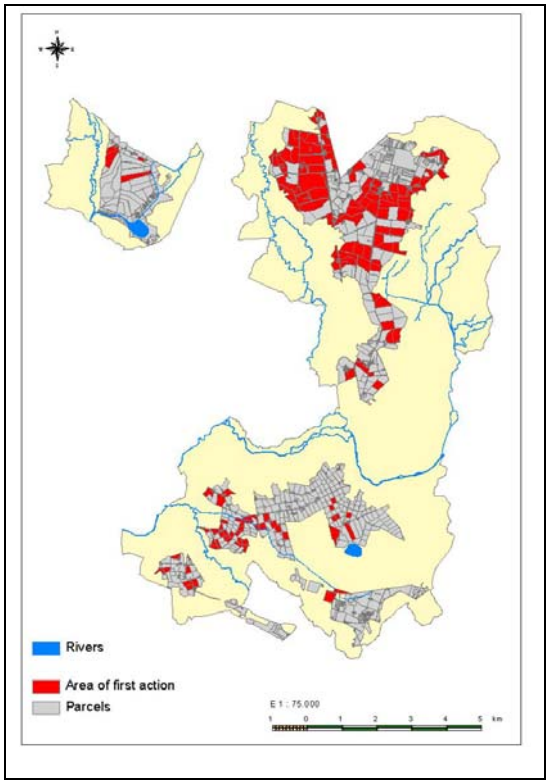

Figure 8. Area of first action

5. Conclusions

The first draft of the preliminary evaluation of the Terra Cha irrigation area consisted in the implementation of GIS. The versatility of GIS for updated and increased information constitutes an advantage for the management of the future water system in the area.

The strength of the combination GIS + Survey in the initial evaluation of any irrigators community was proved. This strength is based on the different operations that it enables: queries, cartographic operations and generation of indices, among others. GIS offers the basis for the irrigation modernization planned in the National Irrigation Plan, and for the first stage of sustainable water management.

The variables studied in the survey and the analysis of the spatial distribution of results led to the conclusion that not all the surveyed farmers are willing to improve the current irrigation system. Some farmers are not supported by a generational change that allows them to face the modernization of their farms. Figure 8 shows the irrigation areas that should be modernized in the first stage of the intervention. Moreover, the improvement action must face another problem: the discontinuity between viable farms and isolated farms. Isolated farms pose a problem for the design and creation of a plan to improve and modernize irrigation that is appropriate from the technical and economic perspective.

The updating of the system and of the information could be performed according to the American system, which demands the compulsory submission of the survey within a period of 15 days. The USDA performs the survey annually and obtains satisfactory, low-cost results.

The integrated water management in the studied catchment, that is to say, the extension of GIS to the set of water uses (industrial, urban and agricultural), constitutes the measure to adopt in the area, in compliance with current legislation.

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