**APPA-GIS. A GIS that models the industrial cluster linked to the horticultural production in Almeria**

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**Abstract**

The Almeria horticultural intensive production, with a concentration around 27000 H. of greenhouses, requires a great quantity of inputs, essentially of industrial type as agrochemicals, plastics, agro-machinery, packing elements, greenhouse structures, irrigation systems,… These are offered by a complex cluster of auxiliary industries and commercial companies located in the area., which development last years have been large and disordered. The mixed development of urban, agrarian and industrial areas has given birth to a complex agro-industrial system extremely dynamic from the productive, economic and social points of view.

In order to know and manage better this agro-industrial complex, our research group proposed to develop a system, APPA-GIS, that describes the different active agents in this agro-industrial system, cataloguing the different actors and locating them spatially.

First, we developed an abstract model of the system using Material Flux Diagrams, MFDs; which model the use of the different inputs and outputs of the system; detecting the different types of companies associated to this processes. Later, we searched the different companies of each type of agent, taking account of their special characteristics as production or location; generating the a GIS that presents the distribution of the agents and their production. Active agents are classified in two main groups:

- **Pre-production.** These agents supply inputs to farmers.
- **Post-production.** Those that manages the outputs of the farmers, commercializing their productions or recycling different wastes.

**Keywords:** Agricultural GIS, Auxiliar Industry of Agriculture, Industrial Cluster Modeling

**Introduction**

The objetive of this work is describing the development, implementation and exploitation of a GIS about the active agents in plasticulture in the territorial area of the province of Almeria (APPA-GIS). We understand that active agents are enterprises linked to the auxiliary industry of agriculture. This system operates through a web page, being, in this way, a webGIS, which presents the contents of the repository, where, through an easy and friendly navegation, the user will be able to select a municipality, region, or the whole province of Almeria, and in this way the user will be able to look for and/or carry out consultations about any of the active agents available on this territorial area.
Methodology

The purpose of this work, as it was previously commented, is describing the development of a GIS about the active agents in plasticulture (around the under plastic production) in the territorial area of the province of Almeria (APPA-GIS).

The activities carried out will be listed and the techniques used for each activity will be detailed.

In the following point “System Architecture”, the general architecture of the tool will be presented.

The work can be divided in different lines of action:

+ Compilation of the information about active agents.
+ Taking decision about the structure of the computer system to be developed.
+ Configuration of the GIS APPA-GIS.
+ Preparation of an exploitation system of the GIS.

The set of activities carried out is summarized as follows, indicating the objectives for each activity during the development of the project.

1. Analysis of requirements.
   This activity supposed determining the objectives of the project seeing the initial conditions and evaluating the effort carried out, as well as the methodological base. Main point was detecting the type of results the system had to give to its users [Cajamar2000, 2001, 2002].

2. Bibliographical study on the industrial cluster and the technology to be used.
   In this point, work was done in two ways: one looking for information on the applications of GIS in industrial clusters modelling and another on the auxiliary industry of the protected agriculture, which is the dominion of the application [Cajamar 2000, 2001, 2002] [Tecnova].
3. Selection and study of the most adequate GIS tools to be used.  
A study about different GIS tools that could be of support for our systems; those offering function of analysis, visualization, consultation of data, edition of geographic and alphanumeric data, etc. that were pre-selected in the previous activity were analyzed. These tools, shown in table 1, can be classified in two groups, on the one hand those that need a payment license to operate, such as ArcGis of ESRI, MapInfo of Geomedia, and on the other hand those of free distribution, such as Mapserver or gvSIG. The tool finally selected, for the development of our system, has been ArcGis, for different reasons, meanly because it is one of the most extended and more used in the GIS field and offers a wide technical support.

Table 1. Analyzed GIS environments.

<table>
<thead>
<tr>
<th>SIG SOFTWARE</th>
<th>Windows</th>
<th>Mac OS X</th>
<th>GNU/Linux</th>
<th>BSD</th>
<th>Unix</th>
<th>Web Environment</th>
<th>Software Licence</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArcGIS</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No Free</td>
</tr>
<tr>
<td>MapInfo</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No Free</td>
</tr>
<tr>
<td>Geomedia</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No Free</td>
</tr>
<tr>
<td>MapServer</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>LAMP/WAMP</td>
<td>Free: GPL</td>
</tr>
<tr>
<td>gvSIG</td>
<td>Java</td>
<td>Java</td>
<td>Java</td>
<td>Java</td>
<td>Java</td>
<td>No</td>
<td>Free: GPL</td>
</tr>
</tbody>
</table>

4. Searching data about the agents.  
Different active agents linked to plasticulture, in the territorial area of the province of Almeria, were searched and classified. As it was mentioned in previous points, active agents are the different types of sub-sectors or companies related to plasticulture [Tecnova] [Horticom] [Infoagro] [YelloPages]. The search, data and information (company name, address, telephone, fax, webpage...) collection, was performed on the active agents that were found in the previous activity; all these data has been added to the database of the system.

5. Development of the MFDs.  
A diagram was designed to represent the complex framework of interrelations among the producers, commercialization companies, industrial related companies and auxiliary services of agriculture. We have modelled this complex relation using a variation of the Data Flux Diagrams (DFDs), developed by our team and denominated Material Flux Diagrams (MFDs).

6. Design and implementation of the alphanumeric database.  
Once all the data on the active agents had been found and collected, they were analyzed, deciding the data to be stored in the GIS alphanumeric database, their format and how they were going to be ordered linked to the different agents detected. We assembled a hierarchy of agents that let us to uniform the data structures of the different agents. Then the database was designed, according to the decision already taken, and the data collected on the active agents were loaded inside it.

7. Design and implementation of the geographic data base.  
This activity supposed the digitalization of the space components of the geographic data and the georeferenciation of them through the ArcGis tool. This activity entailed obtaining the layer that was used as bottom of the GIS, that is to say, the vector layer of the province of Almeria (polygonal layer) which contains all the municipalities of the province of Almeria with their
municipal boundaries and other layers as rivers, dual carriageways, secondary roads (linear layers), districts (layer of points), ... in order to facilitate the future location of the companies when geo-referring and/or consulting them. Apart from these general layers, some specific layers which give sense to this GIS project were created. That is to say, a layer for each type of active agents in plasticulture (in the area of the province of Almeria) was developed (mainly as layers of points) \[GoogleMaps\] \[ZonumsGmaps\].

8. Selection and study on the tool for the generation of interactive maps.
The basic idea was constructing interactive sensitive maps that would allow to locate the available resources and to connect with the abundant information associated to them. The main problem is that the user it is not at the lab where the system is located and that usually he/she do not have access to the Arc-GIS system in his/her computer. The geographic information generated by our system (as layers or “shapefiles”) must be transferred to computers using simple web browsers. Once developed and generated the geographic information by the ArcGis tool, the last phase consisted of designing a suitable way of transferring the results, in order to be seen through the web. Among the different possible tools to carry out this activity, we analyzed: Geoclip, MaviewSVG, Webview and Imagemapper. Finally the Geoclip tool was selected, because it is free and light. \[Geoclip\]

9. Selection and study on the web technologies used for the operation of the system through a web page.
Different technologies for the operation of the system, though Internet, were analyzed and it was selected the most suitable for the operation of our system and we went deeply into its handling: HTML, PHP, Javascript and CSS.

10. Design of the exploitation web page.
The design of the web page was afforded from a usability and efficiency point of view. We made a draft of it and was tested with possible users (presentation of the information and the elements that were desired to be present through the web page), finishing the design of the web.

11. Implementation of the web page.
Once the design of the web page was determined, its implementation with the tools selected for the operation of the system was carried out.

12. Test and verification of the implementation of the web page.
In this stage the operation of the page was tested and validated, carrying out the verification of the different modules, changing those whose presentation was invalid (in this step we tested just the web page, not it connexion with the GIS).

13. Test and verification of the full system
The final tests were performed and the global operation of the developed GIS. It whole functionality was verified. Later a second verification of the modules that did not present a correct operation was carried out.

**System Architecture**

In order to develop APPA-GIS, it was necessary to collect a big amount of information of different types. On one hand information about the 102 municipalities that conform the whole
province of Almería was collected, picking information up from a lot of towns, villages, districts, dual carriageways, motorways, sections of secondary roads, rivers, ramblas and natural spaces; on the other hand data and information from more than 400 companies with activities related with plasticulture was collected. These companies are spread all through the province of Almería. The name, address, telephone and description of the activities of these companies were stored.

Considering the large amount of information that had to be collected and the numerous activities carried out, the diagram of figure 2, allows to follow the process of development of the tool.

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**Fig. 2 APPA-GIS architecture.**
Developing database includes the design and implementation of them data bases, loading data inside and validating them. The construction of the interactive maps includes the conversion of the format of the files of the databases generated in the previous tasks to compatible file formats.

These files allow the generation of maps with dynamic content that can be published in the web. Finally, the task of developing the working system includes the design and implementation of a web to exploit our system. This web page allows users to interact with hidden GIS system and carry out enquiries about companies related to plasticulture in the whole province.

**Development and results**

In the main page of the web APPA-GIS, shown in figure 3, the user can choose among the different options that the main menu of APPA-GIS offers him. If you select the option: “¿Qué es APPA-GIS?” (What is APPA-GIS?), you are transferred to a page that briefly describes the APPA-GIS project and enumerates the aims pursued by it.

![Fig. 3 Main page of the web APPA-GIS](image)

If you select the options of the menu “Búsqueda de agentes activos” (Search of Active Agents), it will show a page where you can select the municipality, the region or the whole province where you can carry out the search of active agents. This is shown in figure 4.

And finally, if you select the last option of the main menu of the web APPA-GIS “Diagrama de agentes activos” (Diagrams of active agent), it will show, in the working area of the web APPA-GIS, the DFM (Material Flux Diagrams) with the interrelations that take place among farmers (producers), commercialization and industrial companies, and agriculture auxiliary
services, as shown in figure 5. In this section you can consult about any active agent by pressing on the rectangular key that represents it.

Fig. 4 Page of the web APPA-GIS “Search of Active Agents by area”

Fig. 5. Page of the web APPA-GIS “Diagrams of active agents”
Discussion and future works

As it has been shown in this work, it is evident the advantages that the use of GIS provides, mainly because it is very useful to combine the potentiality of the graphics section of a system with an interactive automatic data bank. In our case, this let us to order a sector of increasing importance, as the auxiliary industry of agriculture, which has been developed in disorder. The system let us to assess, between other uses, the implantation of new industries and evaluate best suppliers. This general view of the auxiliary sector can offer great advantages ordering and optimizing the sector, and it is a new approach to the management of the sector. We would wish to emphasize the wide range of agricultural applications that the GIS can have, and it is even more important to promote its use in civil service, private companies and research centers.

Finally, taking into account the work developed, here are the main lines proposed for next works:

- Carry out a field work to improve and extend the repository about the active agents of APPA-GIS
- Incorporate to APPA-GIS other extra functionalities, such as B2B business zone for the electronic commerce. These would provide the buyers advantages such as the reduction of the price of the process (less commercial visits, faster negotiation process, etc), and possibility of receiving a greater number of offers.
- Develop a layer with orthophoto and extend the level of topographic detail for the optimization of the APPA-GIS.

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