Abstract

This Master's thesis is dedicated to the development of a complete tutorial to introduce the reader into the operation of a full Geographic Information System; namely, gvSIG 1.12 For that, a practical case study has been created step by step, in which at the end of it, the user will be familiar with the GIS atmosphere. The concepts studied are very broad and its use can be extended to other general purposes within the GISs.

Keywords: Tutorial. Geographic Information Systems (GIS). gvSIG. Location of helipads. Firefighting bases. Information map.

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1. Glossary

GIS: Geographic Information System

Geoprocessing: GIS Operation used to manipulate GIS Data

ArcView GIS: GIS software product produced by ESRI

Latex Software: Is a programming language that is used for typesetting technical data.

Espacial Data Infrastructure: Is a data infrastructure implementing a framework of geographic data, metadata, users and tools that are interactively connected in order to use spatial data in an efficient and flexible way.

Know How: Expertise

GNU Public Licence (GPL): Is a free software license published by the Free Software Foundation (FSF). The GPL allows developers and companies to use and integrate GPL software into their own software without being required to release the source code of their own software-parts.

MiraMon GIS: Is a GIS and Remote Sensing software. It allows visualization, query, edition and analysis of raster (remote sensing images, orthophotos, digital terrain models, conventional thematic maps with raster structure, etc), vector (topographic and thematic maps that contain points, lines or polygons), and WMS layers.

Format SHP: Simply a shapefile, is a popular geospatial vector data format for geographic information system software. It is developed and regulated by Esri as an open specification for data interoperability among Esri and other GIS software products.

Format DXF: Drawing eXchange Format Is a file extension for a graphic image format - Computer Assisted Drafting - software.

Format DGN: DGN is a file extension for a Computer Aided Design (CAD) drawing file format.

Reference System (ETRS89): is an ECEF (Earth-Centered, Earth-Fixed) geodetic Cartesian reference frame, in which the Eurasian Plate as a whole is static.

The coordinates and maps in Europe based on ETRS89 are not subject to change due to the continental drift.

TOC: Table of Contents in the gvSIG software.

WMS Service: Is a standard protocol for serving georeferenced map images over the Internet that are generated by a map server using data from a GIS database

Cadastre: A public register showing the details of ownership and value of land

Attribute Table: A table that is attached to a data layer that contains many characteristics of a feature on a map.

2. Preface

2.1 Origin of the Project

The idea of the present project came from the subject "Sistemas de Información y TICS en Logística" taken in the third semester of the Master in Logistics, Transportation and Mobility. In this subject we got familiar with the Geographic Information System software called gvSIG; because of that I realized how useful can it be, especially if it is used like a parameter of analysis and decision. This is due to the easy use of the interface and how the results are shown in a map, so the interpretation of them becomes easier.

On the other hand I am convinced that for learning the best way is to practice with real cases. That is why I decided to create an example that shows the main properties of the software while it solves a hypothetical problem of location of firefighting bases around Catalonia adjusted to the reality. This topic was chosen because of the importance in the region that has suffered a lot along the history with the wildfires. Thus, I consider with this project I will not only give bases of the usage of the software I will also contribute somehow to the gvSIG free software politic passing my knowledge to the interested users.

Figure 1. gvSIG Organization

Source: gvSIG Organization

2.2 Motivation

A geographic information system (GIS) is a computer system for analyzing and mapping just about anything, moving or stationary. A GIS integrates common database operations, such as query and statistical analysis, with the ability to see how data relates in space and time. The maps produced with a GIS are useful for showing places and the events that occur there [1].

It can also be defined as a tool that allows visualizing data in several different ways in order to see patterns and relationships in a given area or subject. These patterns generally appear on maps but they can also be found on globes or in reports and charts [2].

In a personal opinion these two definitions cover the whole context of the acronym GIS; anyway other than the definitions that can be found in the literature research, what I consider relevant is to know the importance and how to take advantage of it. GIS is important today because it is able to bring together information from multiple sources so that various types of work can be done. In order to do this though, the data must be tied to a specific location on the Earth's surface. Latitude and longitude are usually used for this and the locations to be viewed are attached to their points on the geographic grid.

GIS has many applications in various fields today. Some of which include traditional geographically related fields like urban planning and cartography, but also environmental impact assessment reports and natural resource management among others. [3]

A brief list of some of the representative GIS Applications are shown in the following table

Table 1. Some Representative GIS Applications

Some Representative GIS Applications	
Agricultural crop monitoring and modeling	Legislative district delineation/redistricting
Air pollution emissions inventory	Nonpoint source pollution analysis
Archeology surveys	Oil spill response and management
Census data analysis	Pipeline routing and permitting
Disaster relief assistance	Population estimates
Disease mapping	Property tax appraisal
Drought planning	Public lands and facilities management

Emergency Response (911)	Timber tracking and permitting
Environmentally sensitive areas modeling	Transportation modeling and analysis
Erosion studies	Utility service area delineation
Flood analysis and modelling	Watershed delineation
Hazardous materials spill response	Wetlands resources mitigation
Land ownership mapping	Wildlife tracking

Source: Book GIS Data Sources

Whichever way it's used though, GIS has had a profound influence on geography and will continue to be used in the future as it allows people to efficiently answer questions and solve problems by looking at easily understood and shared data in the form of tables, charts, and most importantly, maps.[4]

Moreover, nowadays all around the world, government professionals, utility engineers, and efficiency-minded entrepreneurs have been quietly investing tens of millions of dollars in attempting to perfect a wide variety of GIS. The routines they have been financing are capable of storing, manipulating, and analyzing complicates electronic maps to increase the efficiency of various large-scale operations including city planning, resource management, emergency vehicle dispatch, and water distribution [5], among others. Regional and state governments should start for example, to use GIS technology to develop country maps, devise the most efficient deployments for public buses, repair roads, collect taxes, chart the spread of contagious diseases, and to nail down new election districts.

According to what it was explained before it can be easy to assume a strong connection between the GIS and the logistics; learn how GIS analysis and logistics suits enable smart decision making in site selection by aggregating data such as road networks, distribution centers and retail outlets to determine the optimal allocation of routes and distribution points among others. [6]

Additionally what drives me to develop this project was not only the intention to transmit the software knowledge, was also to give to the user a hypothetical real case problem that can be solved with the help of the program. The topic chosen was the location of firefighting bases around Catalonia Region; there are two main reasons why this theme was selected. The first one because is a real problem that has been affecting the region during the time, as it is shown in the table below with an average of 7745 affected acres per year in the last 20 years according official information and the second one because after a long research the data founded in the Generalitat de Catalunya Data base

permitted to solve the case with the parameters wanted for the methodology implementation.

Table 2. Affected acres in Catalonia the past 25 years

Year	Wildfire	Wooded Acres	No wooded acres	Total affected acres
1986	563	43335,41	22476,3	65811,71
1987	352	1214,5	730,9	1945,4
1988	646	868,66	2215,47	3084,13
1989	669	2992,23	3003,59	5995,82
1990	591	638,66	468,19	1106,85
1991	782	2495,46	2837,01	5332,47
1992	368	255,72	1297,98	1553,7
1993	791	2693,44	4649,6	7343,04
1994	1217	62574,8	14050,6	76625,4
1995	753	2202,24	4833,61	7035,85
1996	463	531,04	494,67	1025,71
1997	672	624,98	297,71	922,69
1998	961	13714,18	7278,08	20992,26
1999	841	485,89	764,68	1250,57
2000	790	2637,17	5705,09	8342,26
2001	723	993,26	2001,67	2994,93
2002	544	951,73	1147,94	2099,67
2003	701	7408,66	2470,23	9878,89
2004	565	393,26	674,05	1067,31
2005	892	3601,75	1892,17	5493,92
2006	629	1810,66	1594,02	3404,68
2007	578	847,28	764,41	1611,69
2008	421	189,82	387,58	577,4
2009	747	1684,71	1768,26	3452,97
2010	475	260,58	358,3	618,88
2011	594	321,31	699,83	1021,14

Source: Agriculture, food and Environment Ministry. Forest Fire Department 2012

GIS technology, because of its low cost, high reliability, user friendliness and wide usefulness, will be adopted by many users outside the highly developed technological societies [7] .Therefore, it is so modern and useful not only in logistics almost in everything; that inspired me to do the current tutorial, with it, I will be able to show a small piece about how powerful can it be and at the same time I will give the basic concepts for the correct usage of the software.

So, what motivated me was to create a quality Tutorial and at the same time practical, simple and easy to read and interpret, that permit to the user learning about the basics techniques to start in the gvSIG world.

Figure 2. Case Study Process

Source: Gvsig Organization, Agriculture-nutrition-Environment Spanish Ministry

2.3 Previous Requirements

To carry out this document was necessary to apply the previous knowledge in the following topics:

- o GIS: Be familiar with the concepts and terms, so it allows making the guideline of the tutorial in a coherent order, so step by step are connected in a logical order that permits to the user keeping and digesting the information easily.

- o gVSIG: For making a Tutorial and trying to explain concepts in a simple way to be understandable is necessary to master the software in an advanced level. Also for giving to the user, specific tricks for taking advantage of the friendly interface during the whole exercise.

- o Specific Research: For working in the tutorial and a real case study is mandatory to have and prepare the initial information in order to obtain the expected data that let it to be handling for achieve the purposes of the document. For these, its necessary to know exactly what kind of data do you want, how you will find it, under which format you want to work for making it compatible with the PC and GIS you are using and possible places where you can find it.

o   Basic Logistics: In order to present a hypothetical real case study is necessary to have a logistics background for setting the parameters you will give to the software as an input, for instance: The radius firefighting bases coverage, type of helipads, types of helicopters among others.

o   Latex Software: As the main output of the present document is the Tutorial of the gvSIG 1.12.0, the format of it has to be completely organized and structured under specific parameters for obtaining a quality work that can be published at the end, considering the politics of the GVSIG organization.

2.4 Environmental Considerations

The gvSIG Tutorial can be classified and be included in the set of software topics, due to the nature of the project. The scope of the current document is purely academic without considerable environmental implications, however the case study was chosen because the relevant impact in the region not only in environmental terms, also in social and economic terms.

The possible optimum location of firefighting bases in Catalunya, obtained by the gvSIG software tool under some specific constraints can be the first stage (preliminary study) out of a complete project. Of course just with the title of the case study is obvious that if this project is done there will be environmental, economic and social impacts. So the purpose of this chapter is to give a brief description and some tips to be taken into account in the hypothetical case of considering the locations of the bases as a real project.

To be focus where the tutorial (case study) is located within the project life, according to the graph below would be in the first stage called Conceptualization, where the output of the GIS software will estimate the number of helipads around Catalunya that covers in an efficient way the "Priority Protective Perimeters" which are the sites with more fire risks.

Figure 3. An overview of the Generic Model for Project Execution Process
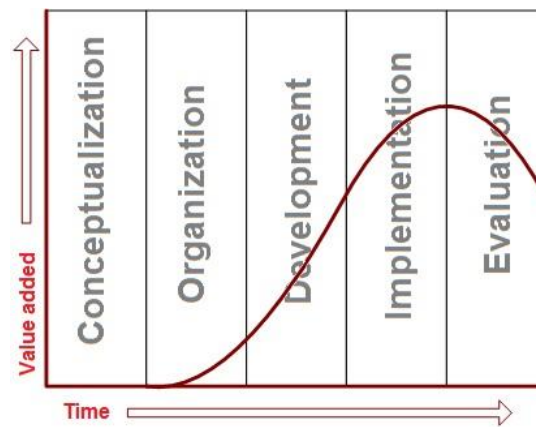
Source: MyMG.

Nowadays is mandatory from all perspectives to speak about sustainability, which according to the oxford dictionary is *"conserving an ecological balance by avoiding depletion of natural resources"* .I will prefer to include also social and economic balance in the definition.

The parameters used for the case are taken from the real information such as roads and places of community interest, so at the end with the output the user will be able to give in theory the exact geographically location of the bases, however it does not mean that in the hypothetical case that any organization (governmental or not) get interested in the solution given, they have to located exactly in those points, they are just referential points.

In that moment will be completely necessary to do an environmental study that classify and describe all the possible impacts of the project.

According to the above and without going beyond the general context of the document, it is proper to give some advices to be consider during the next stages.

Catalonia according to general data taken from the Agriculture and Environmental Ministry in the past 10 years has suffered in this subject; it became the seventh region around the country in the amount of wildfires and the fifth in terms of destroyed acres. So the intention of the tutorial case study is to locate the bases in specific places along the sites where the probability of a forest fire is higher so in the event that these occur the organism in charge can arrive to the epicenter in the minimum possible time so the reaction for sure will be faster minimizing the negative impact of the phenomena.

Hence there will be a reduction in the negative impacts in the environment; actually that is the main reason for implementing the case; moreover these fires in some cases not

only consumed forest and rangeland vegetation, but also adversely impacted wildlife habitat, tourism, water quality, property values, all of which depend on a forested landscape. Although governmental agencies keep records of the total acres burned, structures destroyed and fire suppression costs, data on indirect and continuing impacts of wildfire are rarely calculated. However, these impacts, such as restoration costs, alteration of wildlife habitat or human health effects, are really important components of risk assessment and wildfire management that have to be considering in future studies.

Wildfires create a myriad of environmental, social and economic impacts. Knowledge of both short and long term impacts of wildfire is essential for effective risk assessment, policy formulation, and wildfire management. [8] In the next table I listed some impacts that should be considered in the development and implementation stages of the project.

Table 3. Wildfire Impacts

Wildfire Impacts
Total acres burned
Cost of fire suppression
Damage to homes and structures
Alteration of wildlife hábitat
Damage to watersheds and water supply
Damage to public recreation facilities
Evacuation of adjacent communities
Tourism Impacts
Damage to timber resources
Costs of rehabilitation and restoration
Public Health Impacts
Transportation Impacts

Source: GISF Research

On the other hand as it is obvious but is worth it to be mentioned is that there are some specific rules, laws, ordinances that must be followed (Country and Province). As a suggestion after making a literature research, in addition there is a CIB report from the University of Gavle which is called GIS and the Built Environment; this report will be quite useful for the implementation of the project because it integrates the GIS with the built environment and it can give the guideline of how to build the helipads respecting the environment, in a sustainable way with the least amount of negative impacts to the society involved and bringing benefits to the region.
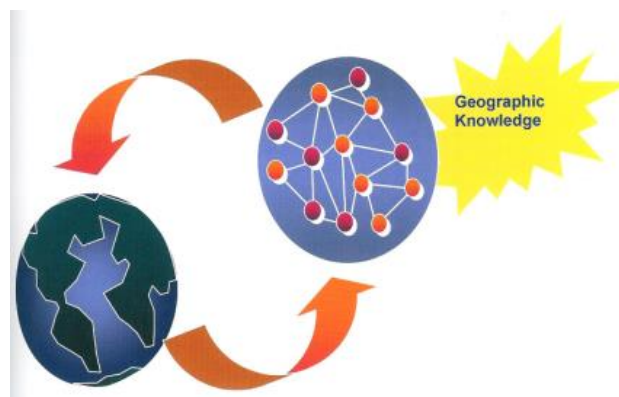
3. Introduction

GIS is spreading from an obscure computer map generating technique typically housed in a Little-understood "GIS shop" to a desktop tool used widely by students, instructors, and professionals in many fields. Describing the average GIS user may soon be like trying to describe the average word processing software user [9]. This is quite interesting and describe shortly how useful is nowadays such type of geographic systems and the future potential they already have.

Geographic Information Systems is an amazing and huge world, however in the current document we will focus just in the gvSIG application which makes part of it. The gvSIG project was born in 2004 within a project that consisted in a full migration of the information technology systems of the Regional Ministry of Infrastructure and Transport of Valencia (Spain), henceforth CIT, to free software. Initially, it was born with some objectives according to CIT needs. These objectives were expanded rapidly because of two reasons principally: on the one hand, the nature of free software, which greatly enables the expansion of technology, knowledge, and lays down the bases on which to establish a community, and, on the other hand, a project vision embodied in some guidelines and a plan appropriate to implement it.

Figure 4. Geographic Knowledge will be available to anyone, anewhere, anytime

Source: Vision by ESRI: Geographic Knowledge will be available to anyone, anywhere, anytime

gvSIG is known for having a user-friendly interface, being able to access the most common formats, both vector and raster. A raster is any type of digital image, such as an

aerial photograph; the data itself however is depicted as rows and columns of cells with each cell is having a single value. This data is then transferred into GIS for be used in making maps. On the other hand a vector is the most common way in which data is shown in GIS, for making it clear in GIS, a point is the location of a feature on the geographic grid, such as a fire fighting base. A line is used to show linear features like different type of roads and a polygon is a two dimensional feature that shows an area on the earth's surface such as the property boundaries around a state.

What it matters in here is that GIS is capable of translating a raster to a vector in order to make analysis and data processing easier. It does this by creating lines along the raster cells that have the same classification to create the vector system of points, lines, and polygons which make up the features shown on the map). It features a wide range of tools for working with geographic-like information (query tools, layout creation, geoprocessing, networks, etc.), which turns gvSIG into the ideal tool for users working in the land realm [10].

It seems very important to clarify that this document is a Tutorial and not a User Manual. The principal difference is that the user manual (user´s guide) is a technical communication document intended to give assistance to the user in the usage of a particular system and a Computer Tutorial is an interactive document created as a learning tool.[11]

Because of the above and taking advantage of the policy of free software, this document pretends to give the basic concepts in the usage of the gvSIG Version 1.12.0. For doing that, a Tutorial has been made including a *hypothetical case study of firefighting bases location around Catalonia* in which a problem is posed and at the end of it, the user itself will get a feasible solution; to reach that the user follows a specific order decided according to the experience of the author, starting with the preparation and research of the initial information, passing through managing attribute tables, creating shape files and an influence areas till the creation of a map in which the solution of the problem will be posted.

This tutorial is made for any kind of person interested in developing new skills in the gvSIG software. That is why the methodology used follows a coherent order in which it is explain graphically step by step every movement within the program, from the easiest and simple parts till the complex ones. As it was said before the gvSIG interface is quite friendly, so for the user will be easy to understand the explanations and follow the case study at the same time because he will be able to compare his results with the ones shown in the figures along the whole Tutorial.

3.1 Principal Aim

Create a complete Tutorial of the GvSIG software Version 1.12.0. Giving to the user the main bases of the GIS program and an overview of the tool, while simultaneously a case study about finding the proper location of helipads for firefighting bases around Catalonia will be solve step by step.

3.2 Secondary Objectives

In order to achieve the principal aim there have been defined five main topics (control points), which are the structure of the Tutorial, therefore each and every one of those represent a pillar of the document, so when they carried out from the user the principal aim would be accomplished.

Secondary Objectives are:

- o Prepare Initial Information for the CaseStudy

- o Manage Attribute Tables

- o Create a New Shape File

- o Create an Area of Influence

- o Create a Map

4. Background

4.1 Starting with the classics

One of the first applications of spatial analysis is registered in 1832 in epidemiology known as "Rapport sur la marche et les effets du choléra dans Paris et le department de la Seine". The French Geographer Charles Picquet represented the 48 districts of the city of Paris by halftone color gradient according to the percentage of deaths by cholera per 1000 inhabitants [12].

In 1854, death and despair engulfed London. In the Soho district, when nearly six hundred people died from cholera in just 10 days, death tolls rang around the clock from the church bell tower. With no known cure, panic spread throughout the city. Dr Jonh Snow, a London physician, knew that to contain the disease, they would have to find the source. Using maps showing the locations of water pumps and the homes of people who died of cholera, Snow was able to show that one pump was causing most of the diseases [13].

Figure 5. John Snow´s 1855 map of the Soho cholera outbreak
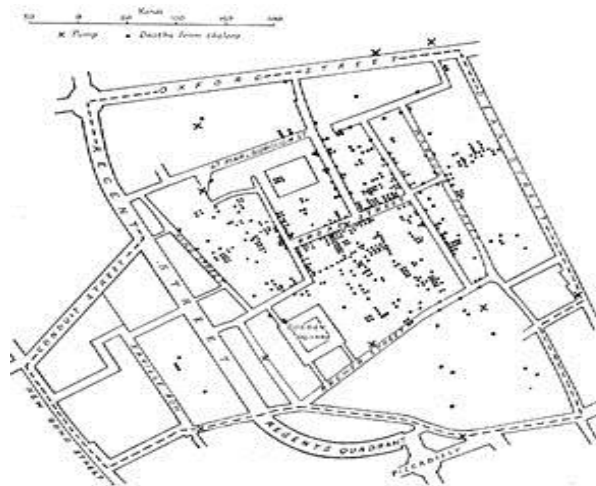
Source: GIS for Health Organizations

The year 1960 saw the development of the world´s first true operational GIS in Ottawa, Canada by the federal Department of Forestry and Rural Development. It was called the Canada Geographic Information System (CGIS) and was used to store, analyze, and

manipulate data collected for the Canada Land Inventory; an effort to determine the land capability for rural Canada by mapping information about soils, agriculture, recreation, wildlife, waterfowl, forestry and land use. The CGIS was an improvement over computer mapping applications as it provided capabilities for overlay, measurement and digitizing/scanning [14].

By the early 1980 the CAD platform was incorporated into the previous system; by the end of the 20th century the rapid growth in various systems had been consolidated and standardized on few platforms and users were beginning to explore viewing GIS data over the internet, requiring data format and transfer standards. More recently, a growing number of free, open sources GIS packages run on a range of operating systems and can be customized to perform specific tasks (as for example the gvSIG software used for finding the location of firefighting bases).

After the brief description of the GIS evolution explained before, nowadays there are three important elements of a typical Geographic Information System that can be summarized as follows:

1. Cartographic capability
2. Data management capability
3. Analytical capability

The *cartographic capabilities* built into a GIS permit the computer-amply aided by skilled human operators- to produce accurate maps and engineering drawings in a convenient pictorial format. Once the digital maps have been constructed and annotated, the computer is used to manipulate the finished product in various specific ways to produce layered maps bristling with colorful attribute symbols.

The *data management capabilities* enable the GIS operators to store and manipulate map-related information in convenient graphic and nongraphic formats. The storage and manipulation of the nongraphic information is often called "attribute processing". Operators who are trained to handle the attribute processing can select the desired map data to produce colorful reports laced with a rich mixture of graphics, tabular information, and pictorial attributes.

The *analytical capabilities* associated with today´s GIS software permit the trained operators to process and interpret spatial, tabular, and graphical data in a variety of useful ways. They can, for instance, measure the distance between two points or determine the areas of the various shapes pictured on the screen. The analytical

capabilities also help the operators plan, design, and manage such important resources as roads, buildings, bridges, and waterways with maximum practical efficiency.

Over the years the primitive graphical manipulation techniques developed by the pioneers have been refined and perfected so that, today, must GIS employ the multicolored "layering". The various layers on the screen are conceptually akin to the acetate overlays used for decades in conjunction with fancy briefing charts, color artwork, and engineering drawings. Trained users can call up and display the various layers in any desired combinations and manipulate their contents to construct composite images [15].

After the "generic background" presented before is time to focus in the project itself. The Current document is basically divided into two main parts or better said one part that includes the other one. In this case would be the tutorial that includes a case study. For this reason I will separate the present chapter into two numerals; the first one will explain some projects and gvSIG tutorials related with herein and the second one will describe the current situation about Catalonia region in terms of firefighting bases and software usage, which is the deep part of the case study.

4.2 Projects and gvSIG Tutorials

After the creation of gvSIG in 2004, the program has been used for different kind of purposes. The idea of free software makes teaching crucial for passing the knowledge from hand to hand. The best way to transmit the "know how" is through tutorials because they give the general bases step by step so the user can compare in every single moment his results with the ones given by the guide. Additionally at the end of it, he can pass the knowledge to other users, which in general terms is the aim of the free software politics.

4.2.1   gvSIG Course 1.11

In the official gvSIG website there is a tab called "user documents" in which you can find all the type of projects in which they are involved; you will find courses made under gvSIG direction, educational material provided by the community (6 different languages) and developers courses.

Out of all this documents there is one similar to the current named as "gvSIG Course 1.11". It was made on 2010 with the version 1.11, previous to the 1.12. It explain step by step different basic things about the software such as: Live DVD, general settings, information view, visual analysis, edition and some another a bit more complex like: Geoprocessing, Raster Georeferences, Espacial Data Infrastructure, I.G Vectorial Access and I.G Raster Access. Most of the information used for this Course came from the Spanish cadastral Information.

The gvSIG Course 1.11 gave me some ideas of how to prepare a Tutorial and also which topics do I consider more important for the first approximation to the software, furthermore the version was not the most recent anymore so it was mandatory to work with the updated version during my tutorial.

This course was given in Curitiba, Brasil from the 21st till the 24th of September of 2010. The document was prepared for the first gvSIG workshop in Brasil. It was with the same structure but at the end they considered to include another chapter called "map creation", which at the end is one of the outputs of a Geographical Information System.

4.2.2   IVER gvSIG Case Study 1.0

Iver is a private company founded in 1992, dedicated to tasks Consultancy specializing in Engineering and Information Technology Systems [16]. Inside the Product Categories managed for them there is the gvSIG as one of the main categories. The gvSIG according to them is "open source software released under the GNU Public Licence (GPL)". The license allows the development of modifications and extensions to gvSIG provided they are distributed along with the source code.

This company to complement the gvSIG free software politic is making online courses for basic and advanced levels; in 2007 they prepared a gvSIG 1.0 case study for "Comunitat Valenciana" in which they started from the very beginning till the creation of maps using data from IDE La Rioja (Independent Spanish Community). In the study case they tried to locate some helipads according to some parameters in La Rioja Region.

The IVER gvSIG Case Study is the closest project I could find in the literature research compare to the current document, because they were referring to the same case study proposed I studied deeply that case for avoiding some mistakes they did and for learning some techniques used for them in the Tutorial.

Basic differences between the mentioned documents are listed below:

- o The Region
- o The data Research
- o Information amount
- o The language
- o Software Version
- o The Initial Information
- o The Methodology used

4.2.3 GIS for Health Organization

Laura Lang the author of the book called GIS for Health Organization published in 2000 by the Environmental Systems Research Institute, Inc. In one of the chapters of her book she formulated a solution using ArcView GIS software to tailor the services of a known Hospital network to the needs of employers by locating specialized rehabilitation centers near them.

Because of the expertise known around the world of the Jewish Hospital HealthCare Services (JHHS), employers know they can trust JHHS to help their employees get better and back to work soon as possible.

The study was done in a specific area – Louisville- at US where the JHHS network offers its services at 35 locations, including hospitals and outpatient centers. This was going so well that they wanted to open more of them, so in that point, the location problem started because they have to choose carefully. They had to consider the location close to its target audience, but without overlapping service areas *(SIMILAR CASE TO THE LOCATION PROBLEM OF THE FIREFIGHTING BASES)*.

To continue providing the best possible occupational health services as it adds new centers, JHHS must first keep track of where patients and employers are located in relation to existing JHHS facilities. They operate nine centers in the greater Louisville; they began by mapping these facilities, services areas and the addresses of their patients.

First the analyst imported outpatient data into ArcView GIS and geocoded it to create the map showed below; green dots represents where patients live, then in purple dots they

added the location of clinics and with the software they determine each clinic´s 3-mile service area.

Figure 6. JHHS´analyst geocoded each patient´s address and Clinics
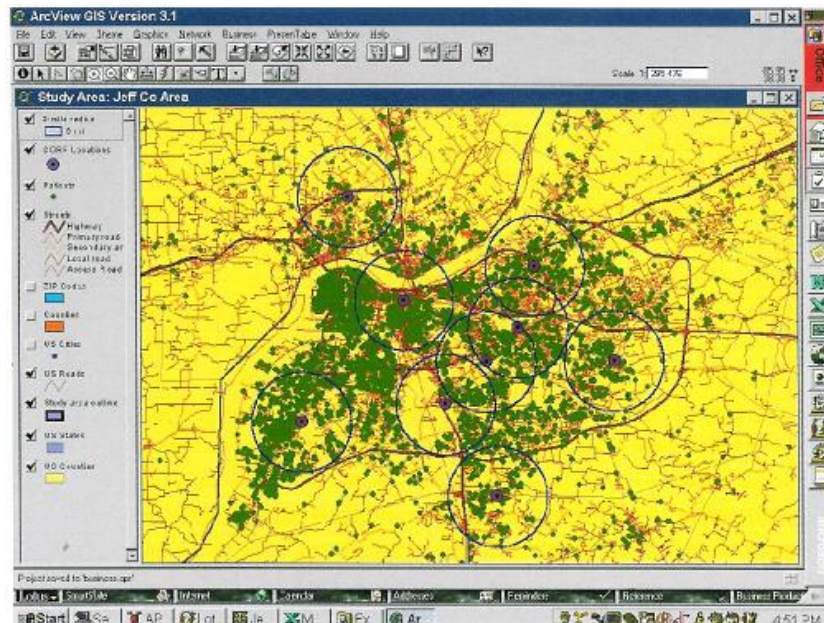
Source: GIS for Health Organizations

When deciding where to build another clinic, the analysts can use this data to help determine which locations have enough potential patients but don´t overlap another center´s service area.

4.3 Nowadays in Spain and Catalonia Region

Referring to the Case Study there are three important things to focus on: First how are the regulations in Spain and specifically in Catalonia; second is good to know how the region is prepared for the wildfire emergencies; third the helipads plan around the whole Region in the present and in the coming future.

Knowing the background can give to the user some idea how important can be the solution of the case study and at the end it gives the opportunity to compare with what is implemented nowadays, letting know if what they are doing is appropriate or not, at least in terms of the location of the bases and the attention time.

4.3.1 Helipads Regulations 2013

According to the document "The Airports and Heliports Availability" [17] published in February of 2013, can be established four different types of heliports (Public Heliports, Heliports of exclusive military use, Private Heliports and Casual Heliports), removing the second one the other three can be used for the wildfire purposes. Once the user gets a possible location of the bases according the gvSIG software will be able to decide in the real life if there is some of these Heliports near the place given by the program so they can be adapted or if it has to be necessary to build new heliports in some areas. Of course the idea would be to adjust the solution to what is already in the field to minimize the costs and possible negative impacts (Is recalled that is an academic problem but at the end can be adjusted to reality).

4.3.2 Catalunya Daily Fire Risk Map [18]

The map of forest fire risk is produced on a daily basis in Catalonia by the Forest Fire Prevention Service (SPIF) of the Department of the Environment and Housing (Generalitat de Catalonia). During recent years the SPIF and CREAF have been working together in order to improve the map. The aim of the project is to create a system to show the risk of forest fire which combines the information and knowledge that have been acquired over the years and that which is currently being produced. This improvement is based on the integration of the different lines of research and work methodologies that are commonly used in the production of the map into a modular computer tool which is open and easy to use and which is principally based on the MiraMon GIS.

Until now, the main tasks carried out are those related to the production or improvement of different layers of Geographic Information which are useful to define the risk. These include, among others, vegetation cover, maps of combustible and flammability models, or the map of forest mass continuity. Finally, the results of the improvement of the fire risk map have been validated obtaining with it, a dependable daily fire risk map as shown in the figure below.

Figure 7. Catalonia Daily Fire Risk Map
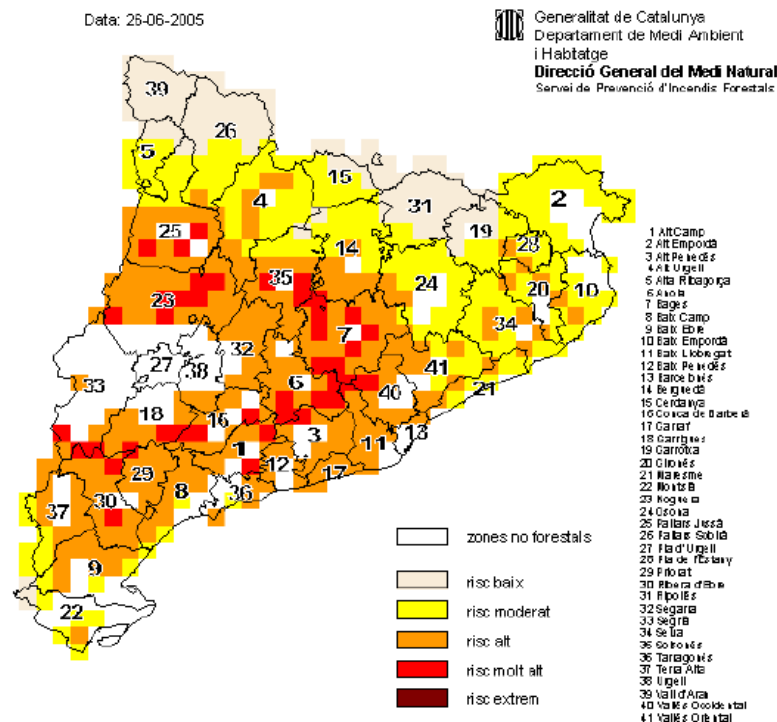
Source: SPIF

4.3.3 Catalonia Helipads Plan 2009 – 2015

Nowadays Catalonia has a fleet of 80 helicopters, distributed in 18 Operators and 82 heliports infrastructures. However the forecast said that at the end of 2015 more than a 100 helicopters will operates in the Region; the 70% will perform social activities such as wildfires, hospital transportation and the 30% will be in charge of tourism. [19]

In this moment the Barcelona Metropolitan Area focuses between the 50 and the 60% of the helicopter activities in Sabadell airport. In the Pirineos area focuses 16 facilities promoted by the Government and they are related to rescues and emergencies. In the other parts of Catalonia the operations are related to the Agriculture (Delta de l´Ebre), Traffic Control or the Oil Rig (Casablanca).

The plan proposes a network helipads structure defined in four levels: General Network Access, Basic Network, Public Services Network, Emergency Network and Private Network.

Figure 8. Proposed Scenario Plan 2009 - 2015
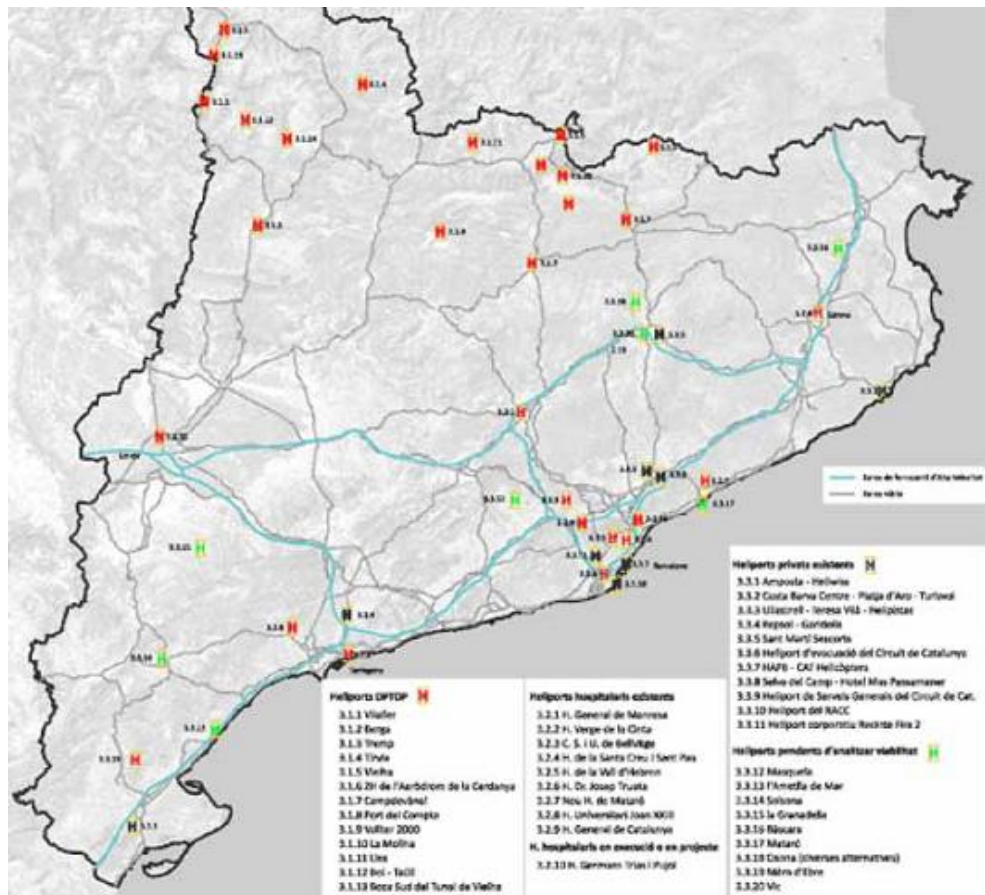
Source: SPIF

5. Methodology

The most important requirement for a good tutorial is the ability to communicate effectively. The idea of the Tutorial 1.12 gvSIG is to share my knowledge about the topic and explain it in a simple way, using plain language, one that any person interested can understand. From here appear the necessity of clarifying the difference between a Tutorial and a User Manual due to the audience targeted. The aim is to spread the basic tools of the software given by the tutorial to persons which are just starting in the GIS world and at the same time give an added value showing how to deal with a real case, that's why the option chosen was the TUTORIAL.

Then, the method used for the Casestudy can be represented with the following figure:

Figure 9. Method used for the Casestudy

Source: Applications of GIS to Logistics and Transportation [20]

The first stage of the process was to establish the problem, defining the constraints and focusing in a topic which can cover the basic elements of the program according to my experience; after a decision process the Catalonia Case Study was decided because allows to explain the main themes deeply taking into account the relevance of this for the area and the second process of the method was not easy but it was known that some information could be found.

As mentioned above, after taking the decision the second stage is perhaps the most important because for any GIS the data is the heart of any project and without it is

impossible to work. So for the current document collecting the data was challenging because although the information is available on-line arriving to it takes time; this probably happen due to Catalonia is protecting this type of information more than other regions within the country.

The whole process for the collection of information is explained in a simple way, following the tutorial dynamic in the "second step" of the next chapter that shows step by step what the user should do for downloading the needed files.

The third stage of the method used was the implementation of the Geographical Information System in this specific case the gvSIG 1.12, where according to the nature of the project the properties of the tool are shown step by step following a coherent order which includes:

1. **The preparation of the initial information:** This section make the previous information downloaded visible and ready to be used for instance: Catalonia municipality base, the roads and what the government called Priority Protection Areas (PPA).

2. **Manage Attribute tables:** The second section gives the concepts of how to search, use and manage the information shown in tables to convert huge amount of information in useful one that indicates what you want to know in a organize way.

3. **Create Shape Files:** The idea was not only to use the information given by a data source, also to create a new .shp File that gives the parameters that helps to place anything over the map view. In this case was useful to create one of those to place the locations of the firefighting bases around Catalonia region.

4. **Create an Area of Influence:** This step permits to use one of the geoprocessig tools, in this specific case the buffer areas in which it can be created a new polygon layers, with polygon buffers of the geometries of an input layer. The influence area represents the coverage radius of each of the bases.

So, after following the method at the end we wish a solution which has to be represented in a simple way as a deliverable; that is why the fifth step was establish:

5. **Create a Map:** The last stage is for showing the whole process in just one output; all the previous steps are required for obtaining a quality map with the result we got after following a path within the gvSIG software.

Finally the intention more than having a final product with a feasible solution about a hypothetical case adjusted to the reality, is to give the user the basic tools about the software, which he have obtained since the first step of the Tutorial.

6. Tutorial

6.1 First Step

The first step you should follow is downloading the free software gvSIG 1.12; for doing this, you have to go to the gvSIG official website: www.gvsig.org

Figure 10. gvSIG Portal
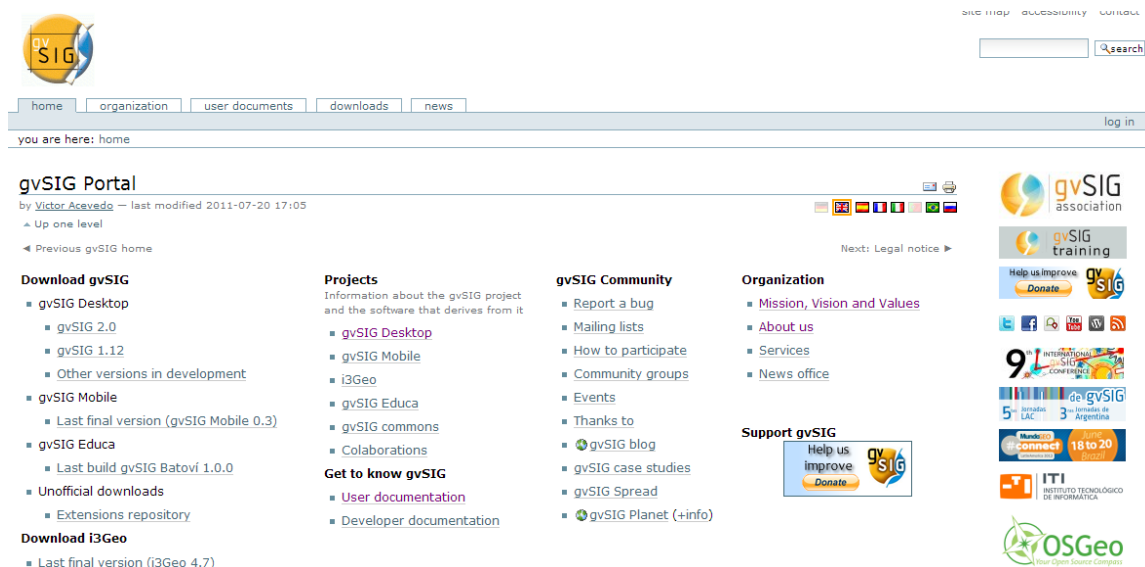
At the right side on the top you can choose your language, and under the title "Download gvSIG" you click on "gvSIG 1.12". The reason why the version chosen is the 1.12 and not the 2.0 which is the latest is because the last one is not exempt from errors, as well as they keep updating continuously to trying to solve some known issues in the source code. The Final version was updated on (25/09/2012). In the column "binaries" you should choose between Linux (BIN) or Windows (EXE) is up to each user.
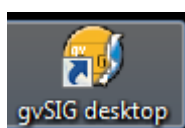
Figure 11. Download gvSIG

Click on the icon (in this case we choose the EXE version) and wait few seconds until the dialog chart appears (It is recommended to open it in a new tab) and executed like any other conventional software.

Figure 12. Execute Software
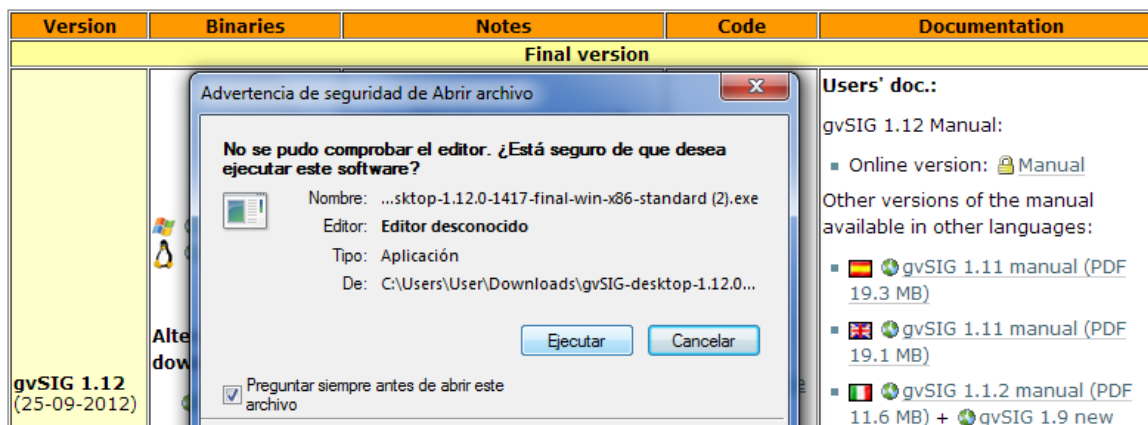
Once installed the gvSIG direct access icon should appear in your desktop.

Figure 13. gvSIG icon desktop

6.2 Second Step

To work in the gvSIG software is required to have some initial GIS data to work with. The more you know about the project and its goals, the better you can ascertain what data is the best. In this case the *hypothetical problem* establishes the following constraints:

- The area of the Municipality in which the bases are going to be located must be higher than 750.00 Km^2. This has been chosen in this way to assure that the biggest areas would be covered, implying that on there the negative impacts are bigger.

- The access to the Municipalities in which the bases are going to be located must be of principal order, such as: Highways, national roads or level 1. This to assure a fast and easy response on earth that complements the air work in case of a wildfire.

- The bases must cover almost all the Priority Protection (95%) Areas assigned by Catalonia government. This assures that the bases are going to be located in the places in which the probabilities of an emergency are higher; it also helps for not distributing the bases in a uniform way.

- The maximum time allowed for the helicopters to arrive to the emergency place since the emergency is detected must be less than 14 mins.

Because of the particular constraints and the nature of the project, it has been chosen the following information, which will be enough to answer the problem while learning the software tools.

- **Municipal Base:** This layer will be the base of the other layers; it gives Catalonia perimeter and permits us to locate the region in a visible way.

- **Priority Protection Areas:** Is the layer that shows inside the Municipal Base which are the protected areas that in case of an emergency like a wildfire must be considered like priority for the society.

o **Roads:** Another important layer because we determine it as a constraint due to the importance in case of a wildfire; the main idea of the case study is to locate the heliports in an optimum place, moreover to make it real is mandatory to consider also the access to the affected place by earth, so the impact can be mitigated.

### 6.2.1 How to obtain the initial information for the Case Study

6.2.1.1 Municipal Base

Institut Cartogràfic de Catalonia (ICC) is an entity of the Generalitat of Catalonia which aims to carry out the technical tasks of developing the mapping information in the field of competence of the Government. Today the ICC hosted the map Library of Catalonia that has extensive background cartography from the sixteenth century to the present. [21]

The route you should follow to get the Municipal Base GIS Data is the following:

o Go to www.icc.cat (on the top right you can chose the language you prefer in this case English).

o Click on Digital Geoinformation

o View and Download (On the ICC website is Visser "Picture Viewer Raster Image Server", open source – based application that allows viewing and download the maps produced in the ICC.)

Figure 14. ICC Municipal Base (1)
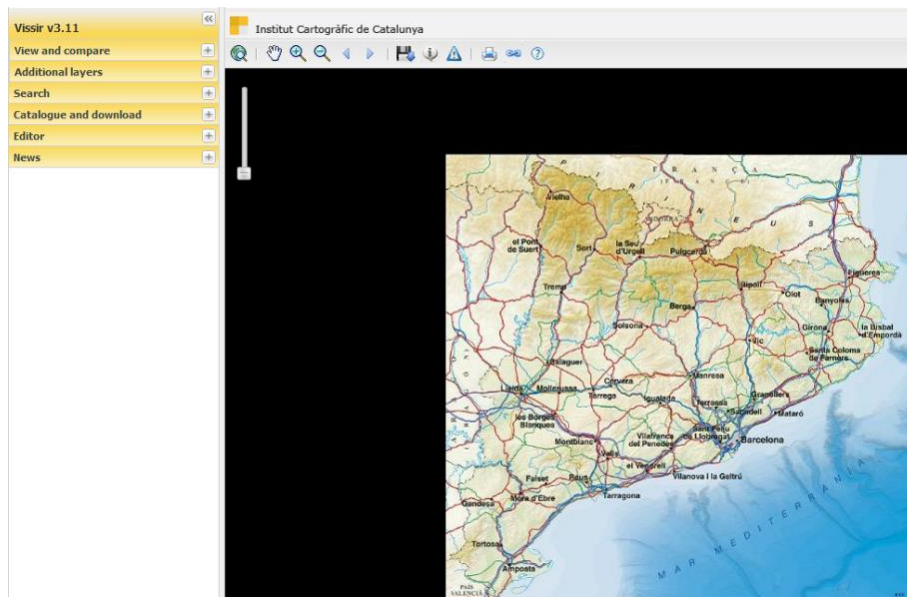
- o Catalogue and Download
- o Others
- o Base Municipal 1:50.000 (Is exactly what we are looking for)

Figure 15. ICC Municipal Base (2)
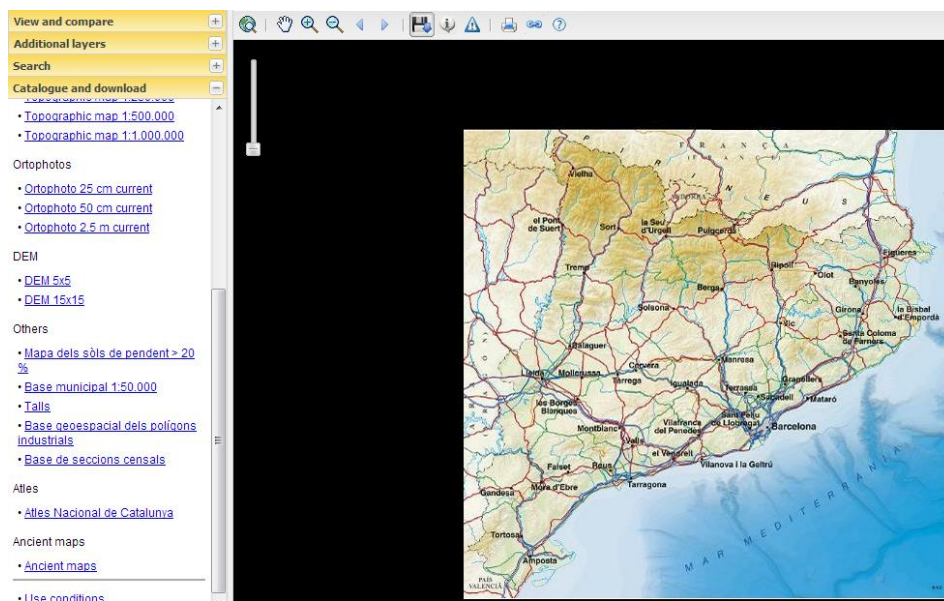
o Download. When you click on Download you can chose the Available formats (DXF, DGN, SHP) and the Reference System (ETRS89, ED50); we decided to select SHP as a format and ETRS89 as a Reference System.

According to the "Institut Cartografic de Catalunya (ICC)": The reference system called ED50 (European Datum 1950) had been used on official ICC maps, but because of the constant movement of the European continental plate, amongst other reasons, the cartography needed to be adapted. To this end, in 2007 a new reference system was agreed for all of Europe called ETRS89 (European Terrestrial Reference System 1989), and this means that all the coordinates must be moved (otherwise they would give the wrong locations).

Figure 16. ICC Municipal Base (3)
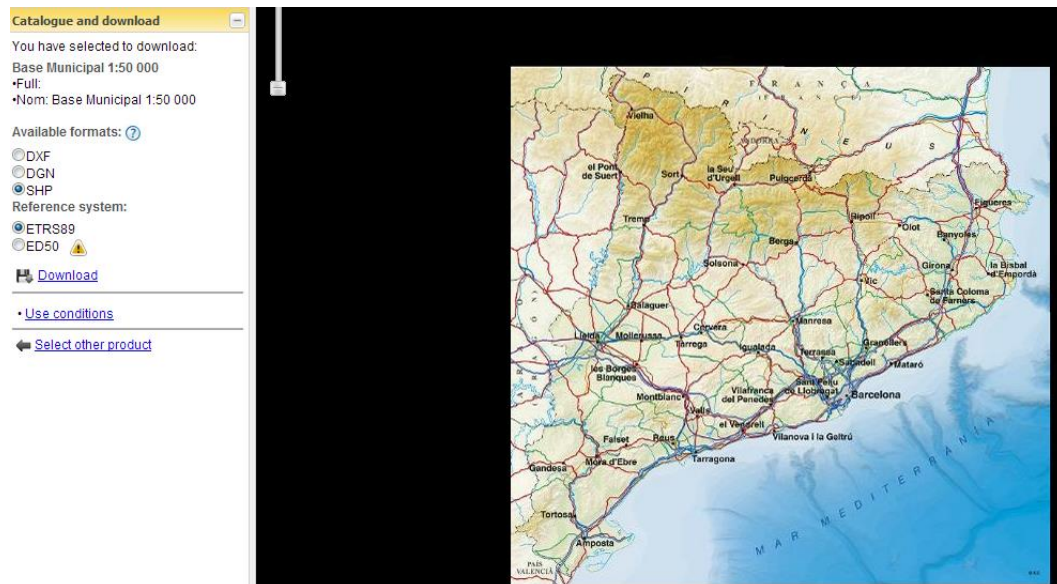
o When you download a dialogue chart appear asking you a Username and a password; the first time you want to log in it is mandatory to Register, then afterwards you just have to access with your User and your Password. The registration allows downloading maps, aerial photos, etc…

Figure 17. ICC registration
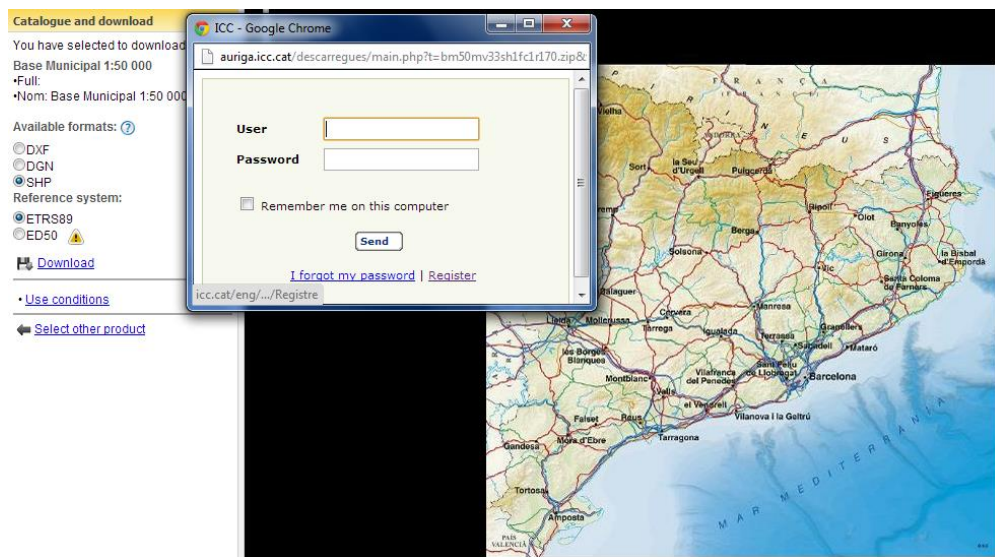
- o Once registered a confirmation email will arrive to the email address you filled in the Registration form and then you will have access to the information.
- o After few minutes a ZIP file will be downloaded to your PC.

6.2.1.2 Roads

The route you should follow to get the Roads GIS Data is the following:

- o Go to www.gencat.cat (on the top right you can chose the language you prefer in this case English).
- o Topics
- o See all Topics
- o Region and Landscape. Urban Planning

Figure 18. Region and Landscape /gencat.cat
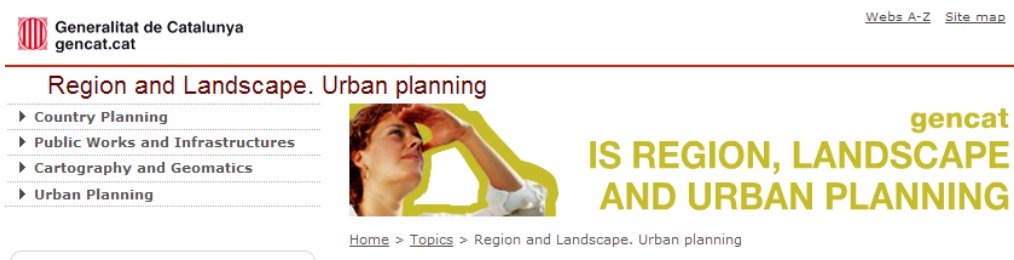
o   Cartography and Geomatics

o   Cartography of Catalonia in Miramon format, DXF and/or Shape

Figure 19. Region and Landscape information

Region and Landscape
Country Planning
❯ Territory (Catalonia section)
❯ General Regional Plan of Catalonia
❯ Regional Plans of Catalonia
❯ Coastline planning
❯ Mountain policy
❯ Landscape policy
❯ Natural protected spaces
❯ Landscape Observatory of Catalonia ↪
❯ Parks of Catalonia
❯ Trustees of Montserrat
❯ Pyrinees ↪
❯ River Ebre area ↪
❯ Toponymy Comission
❯ Institute for Country Studies (Ietcat) ↪
❯ Municat: municipalities and counties of Catalonia

Public Works and Infrastructures
❯ Nacional pact for infrastructures
❯ Catalan Airports
❯ Roads
❯ Tàrrega Public Work Supervisors School
❯ Ports and coasts
❯ Ports of the Catalan Regional Government
❯ Infraestructures.cat
❯ Olympic Channel of Catalonia (Equacat)
❯ Cadí Tunnel, SAC ↪
❯ Tabasa Infraestructures i Serveis de Mobilitat SA ↪

Cartography and Geomatics
❯ Hypermap: e-Atlas of Catalonia
❯ Street Guide
❯ Digital Climatic Atlas of Catalonia ↪
❯ Cartography of Catalonia in Miramon format, DXF and/or Shape
❯ SIGPESCA Marine cartography
❯ Land Cover Map of Catalonia

Be careful from this point due to some problems with the structure of the website you cannot continue in English so pay extremely attention to the next steps.

o   "Cartografía I Toponimia" – Cartography and Toponymy-

o   "Bases cartogràfiques" – Cartographic Databases-

o   "Territori I Mobilitat" – Territory and Mobility-

Figure 20. Cartography/gencat.cat

- o "Carreteres" – Roads
- o "Graf de Carreteres" – Road Graphs- On there you should select the file SHP

Figure 21. SHP roads file

- o After few minutes a ZIP file will be downloaded to your PC.

6.2.1.3 Priority Protection Areas

The Environmental Department of Generalitat of Catalonia offers in *Nexus Geografics* website geoinformation in different types of formats. The information can be used in any kind of projects, as long as the reference appears and the updated date of the data.

The route you should follow to get the Priority Protection Areas GIS Data is the following:

- o Go to www.dmah.nexusgeografics.com
- o "Territori" – Territory-
- o "Perimetres de Protecció Prioritària per a la prevenció d´incendis forestals – Priority Protection Areas to prevent the wildfires-

Figure 22. Priority Protection Areas (perprot)

Patrimoni geològic. Inventari d'Espais d'Interès Geològic de Catalunya	31/12/2006	patrigeo.zip	Metadades
Perímetres de protecció prioritària per a la prevenció d'incendis forestals	15/01/2003	perprot.zip	Metadades
Pla d'espais d'interès natural	17/01/2011	pein.zip	Metadades
Pla de Parcs eòlics de Catalunya	16/06/2002	parceol.zip	Metadades

o   After few seconds a ZIP file will be downloaded to your PC

Once you download the whole needed data you should move all the .ZIPS to a new file which is going to be the working folder for the project and unzip them. After this, now you are ready to begin visualizing and editing your data.

6.3 Case Study gvSIG 1.12

6.3.1 Introduction

The following Tutorial has been made with the purpose of giving the user some basic tools in the usage of gvSIG software; moreover through the entire document an example will be develop. This example cover some of the most important functionalities of Geographic Information Systems (GIS) such as layer editing, geoprocessing and creation of maps, thus, the user will be ready to create its own project and can implement it in cases of the real life.

6.3.2 Main Goal

To present step by step a hypothetical Geographic Information Processing case with the purpose of getting a final product, namely, in this particular example an information map of the location of one or more of the helipads (firefighting bases) at Catalonia region in Spain.

6.3.3 Initial Information

For academicals purposes are been chosen just three shape files out of several other options that must be downloaded before the application started.

- o **Municipal Base:** This layer will be the base of the other layers; it gives the Catalonia perimeter and permits us to locate the region in a visible way.

- o **Priority Protection Areas:** Is the layer that shows inside the Municipal Base which are the protected areas that in case of an emergency like a wildfire must be considered like priority for the society.

- o **Roads:** Another important layer because we determine them also as a constraint due to the importance in case of a wildfire; the main idea of the case study is to locate the heliports in an optimum place moreover to make it real is mandatory to consider also the access to the affected place by earth, so the impact can be mitigated.

** See the complete download process in the second step, explained above.

6.3.4 Case Study Development Plan

- o Step 1: Prepare initial information.
- o Step 2: Manage attribute tables.
- o Step 3: Create a new shape file.
- o Step 4: Create an area of influence.
- o Step 5: Create a map.

6.3.5   STEP 1: PREPARE INITIAL INFORMATION

6.3.5.1 Create and rename a gvSIG view

After starting the application the Project Manager window will appear. The default type of document selected is "view". It is convenient to rename each view that we create. To do this click "New", then select the view that is created in the text box (default "Untitled - 0") and click "Rename"

Figure 23. Create and rename a view
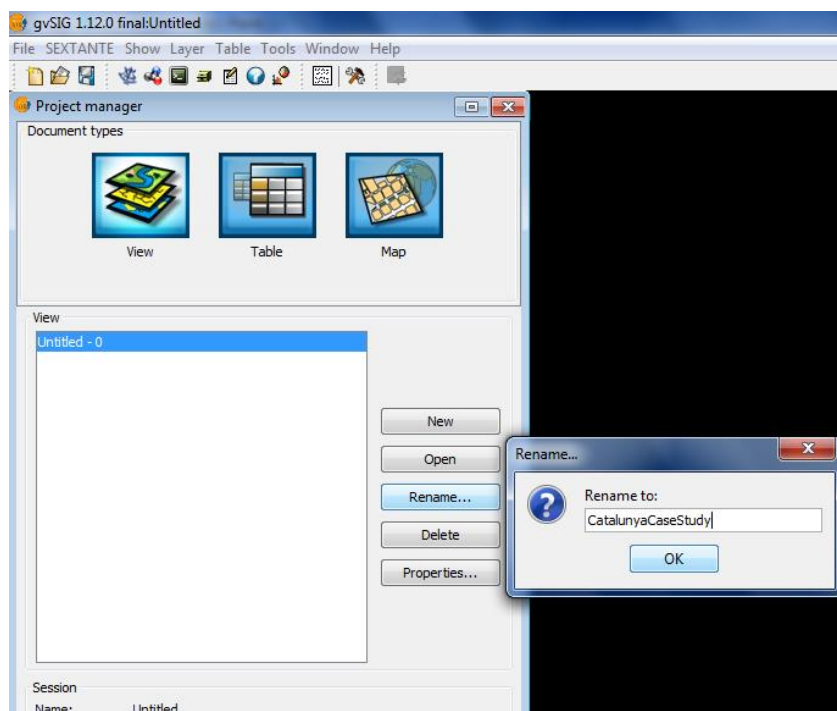
Edit "Rename" and call it "Catalonia Case Study" or in the way you prefer. Click OK and the name will be included in the list of views; select it and click "Open".

6.3.5.2 Add layers to the Created View

We start from a blank view into which we will be adding the different layers we use during the first stages of this case study. In subsequent steps new layers will be added to the project which will be explained in that moment.

To add layers to the actual view, click on the button "Add layer" of the toolbar

Figure 24. Add layer icon

The tab in which "Add layer" start by default is *File,* the one that allows you to search and add the first file we will use.

Click on the "Add" button and a new data search window will appear, surf through it till you find the folder where you have saved your initial data.

In the first place add the layers in SHP format:

NOTE: After following the second step for obtaining Catalonia data you will get several information that you may not use, at least for the current case; for instance: In the folder downloaded for the Municipal Base you will find seven different SHP files and in the Roads folder you will find eight. The other files contain more detail and specific information. For the purpose of the Case Study it has been selected after checking all, the following files:

- o Municipal Base: bm50mv33sh1ftm1r170.shp
- o Roads: CacNivell1.shp
- o Priority Protection Areas: perprot.shp

Figure 25. Selected files
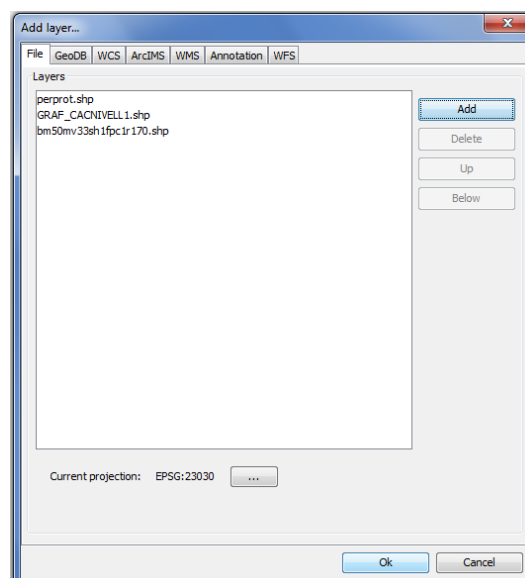
After selecting each file, click on "Open" and the layer will be added to the sequence of layers listed on the "Add Layer" window. Once all the above indicated layers are loaded, press OK and the layers will be added to the view.

Check that the layers have been added to the TOC (or table of contents) of the view in the left side of your screen.

Figure 26. Layers added to the TOC
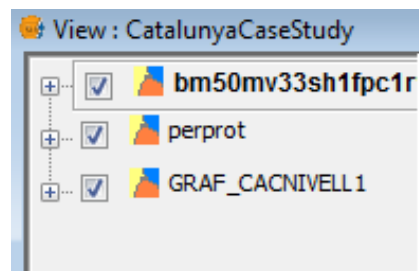
The position of the layers in the TOC is quite important because the order permits visualizing them correctly. In this case we added three layers of polygons and the convenient order for those is shown in the image above (just to see them better). You can change the order of the layers in the TOC selecting the layer you want to move, giving a right click and using the option "Move to top" or just drag the layer to the desired position.

Figure 27. Order of the layers in the TOC
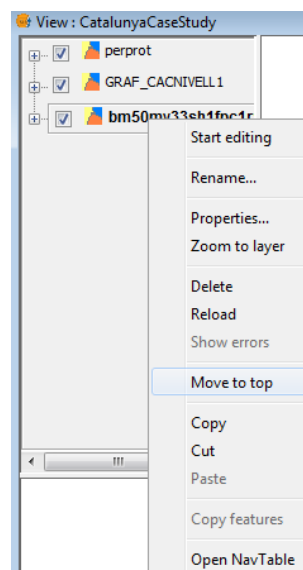
6.3.5.3 Configure Locator

One of the resources used by gvSIG to help to the management and location of the information is the locator.
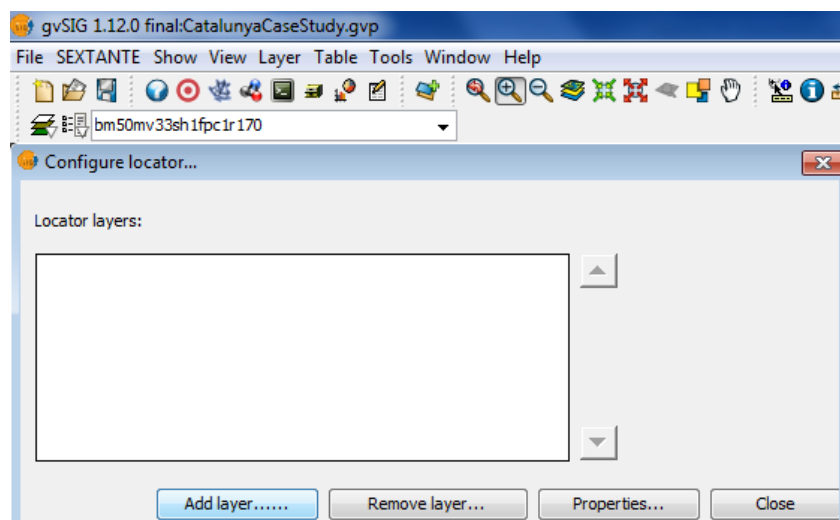
To access this option, go to View/ Configure Locator

Figure 28. Configure Locator
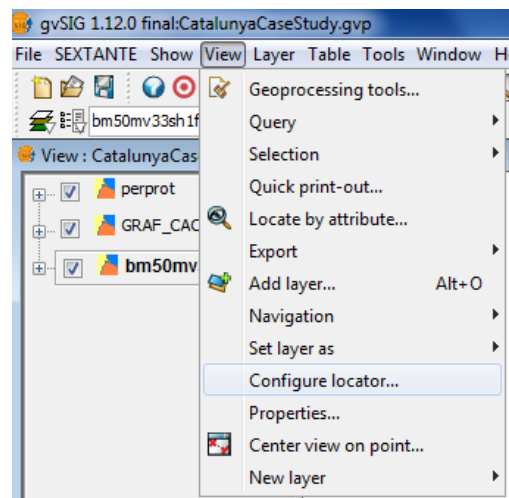
A new window will appear from which you can gradually add layers to the locator, Click on "Add Layer"
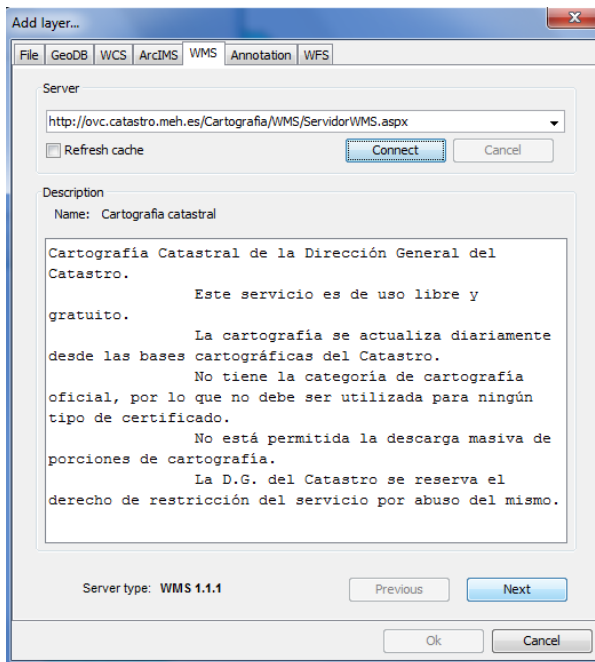
Figure 29. Addition of layers to the Locator

In this case we have decided to add a layer of cadastre locator of Spain. To do this, you should connect to the WMS cadaster server (please note that you must have an internet connection if you want to do this step).

6.3.5.3.1 Connecting to WMS Service

Figure 30. WMS Service

Once you access to the window "Add Layer", place the cursor in the WMS tab (fifth position at the top)

1.- In the dropdown menu from the Server box, you will find a WMS list: Select Cadastre

2.- Click on Connect

3. 4.- When the connection is established a welcome message from the Server will appear, as long as the server has that message configured. Anyway in case that the message does not appear you can check that the connection is successful when Next button allows you to continue.

5.- In the bottom part the WMS version used for the connection is shown

6.3.5.3.2 Service Access

Click "Next" to begin the configuration of the new WMS layer. Once you access to the service, there will be a new set of tabs on the window.

The first tab of the wizard to add a new WMS layer is the Information tab. It shows the summary of the current active settings for this WMS request (service information, formats, coordinate systems, layers composing the query, etc.)

Figure 31. Service information
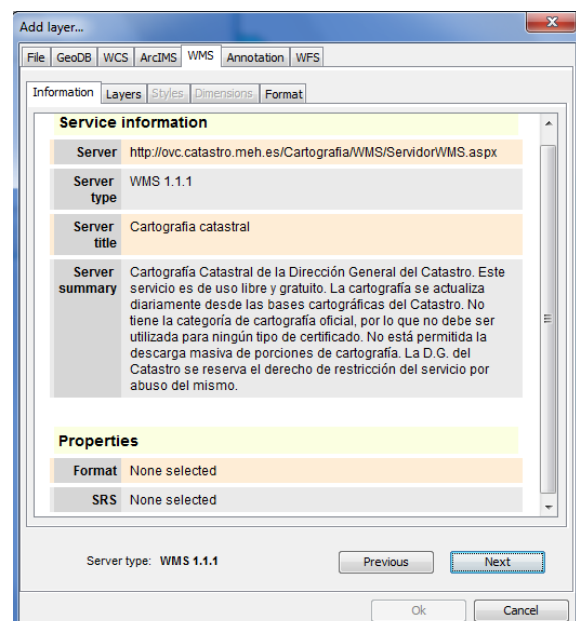
6.3.5.3.3 Layers Selection

Figure 32. WMS Cadastre server
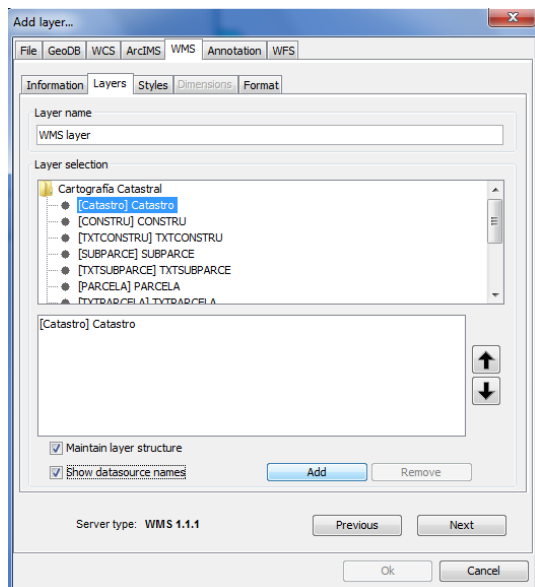
In the "Layers" tab, the wizard shows the layer tree stored on the WMS cadastre server.

Select the document that contains the Cadastre mapping and click on "Add". If you wish, you can give a customized name to your layer in the field "Layer Name".

Note: You will get a description of any layer if you move the cursor and place it in top of it for few seconds. The information stored in the server on these layers is shown.

6.3.5.3.4 Choosing Styles for WMS layers

Figure 33. Styles for WMS layers
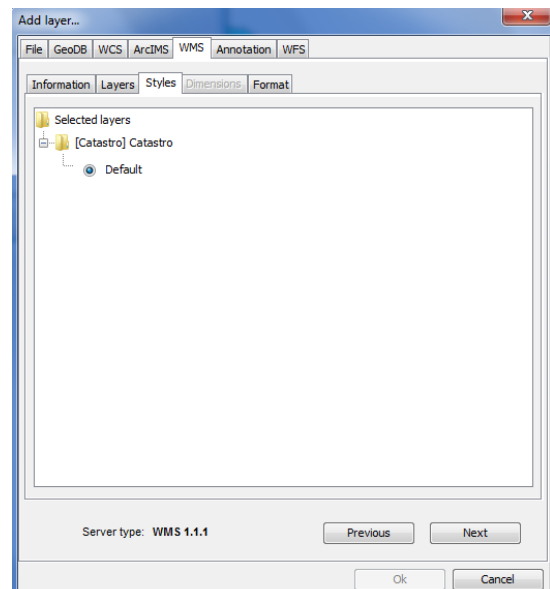
The Styles tab let you choose a display style for the layers selected. In this case, leave the option checked by default.

6.3.5.3.5 Selection of format, coordinate system and / or transparency

Figure 34. WMS Format tab
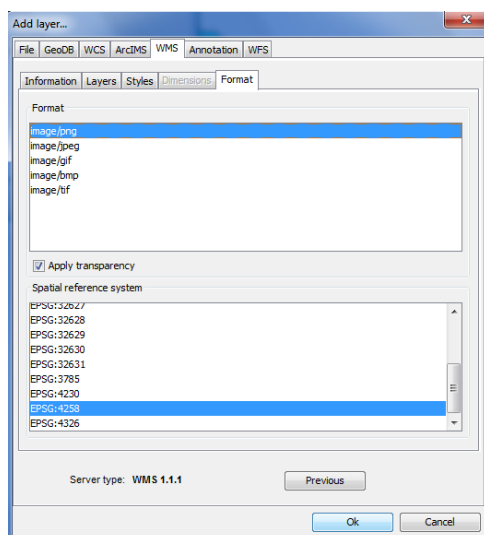
In the tab "Format", you can choose the picture format with which is making the request; specify whether you want to get the image delivered by the server - transparent (to overlap that layer with other layers that the current view of gvSIG already contains by default) and also the system reference coordinates (SRS) which is wanted.
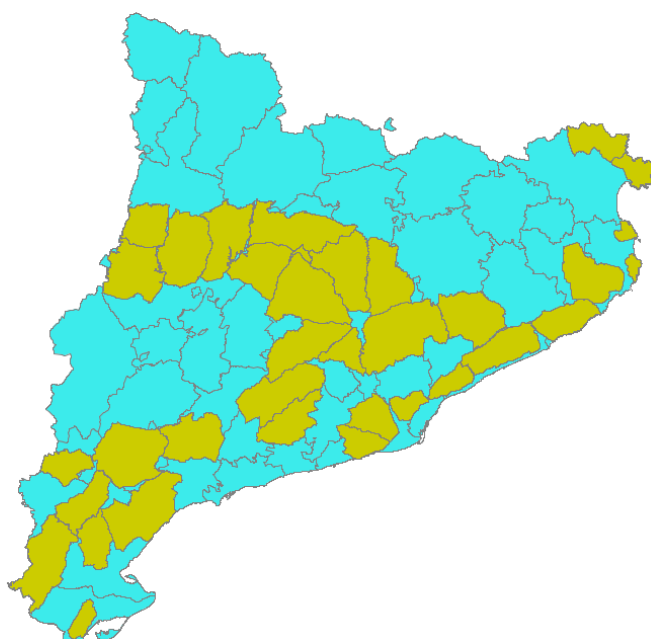
For the Case Study it has been chosen a .png image format and as SRS, it´s has been chosen 4258 which correspond to Datum: ETRS89 [22].

Click OK and the selected layer will be added to the locator.

6.3.5.4 Editing symbology and labeling

After adding the layers, the view will resemble to the picture below. **NOTE:** The colors may vary.

Figure 35. View after adding the layers

One of the main criteria that we have highlighted before to establish the location of the firefighting bases was to cover most of the Priority Protection Areas (PPA) (yellow in the image).

You will proceed to label the layer and change the symbology to have a better view of these protection areas.

To have a clear view of this layer, you will deactivate all the other ones; to do it, you must clear the check box next to each layer name.

Figure 36. Layers in the TOC
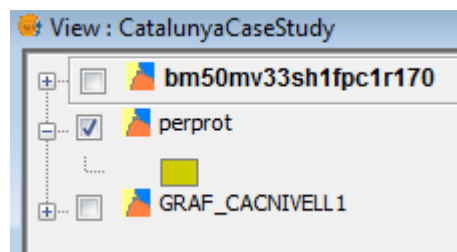
Since we want a layer classification based on the different Priority Protection Areas determined by Catalonia Government; we choose the field that contains the name of each PPA (layer perprot). This information is contained in the attribute table of theme.

To access to the attribute table of the layer, first of all you have to select "perprot" in the TOC and then click on "Show Attribute Table of Active Layer" from the tool bar, which is represented with the following icon.
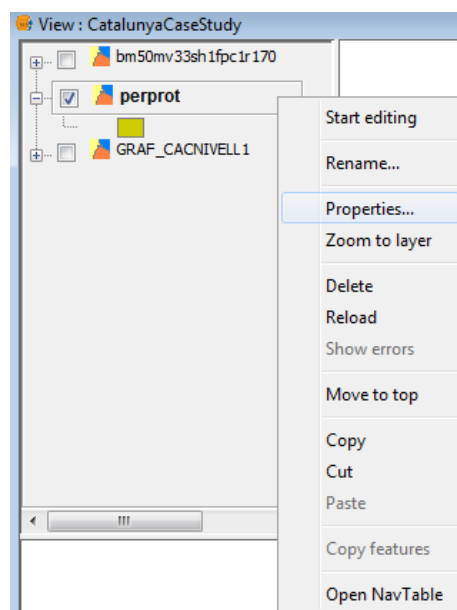
Figure 37. Attribute table icon

The corresponding attribute table will appear on the display showing 43 Total records selected.

Figure 38. Attribute table perprot

Please, note that the NOM column lists all the PPA polygons in the layer.

Figure 39. Perprot properties

If you want to edit the symbolism that came with the layer, you must go to the layer menu (right-click on the selected layer) and chose Properties.

We will classify giving a unique value for each record with a unique symbol corresponding to the value of a particular field in the attribute table. In this case we are interested in listing a function of the different PPA in Catalonia region.

Inside the classification field, activate the drop down menu and choose the field NOM and click on add all.

The field value will be added to the table for each PPA.

Figure 40. Layer properties/symbology
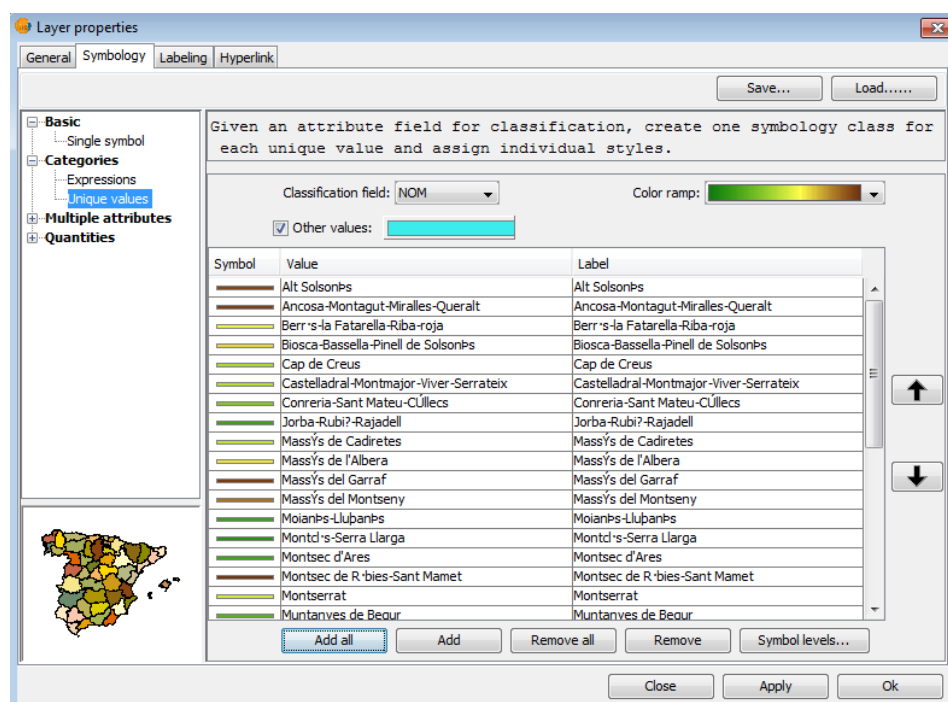
For a better distinction you can edit the symbols color if you double-click over the different colors of the symbol field. Double-clicking brings up a new window from which you should click on "Choose Symbol"; that will send you to the Symbol Library to edit the color, type of fill and line of the record selected.

Figure 41. Polygon symbols
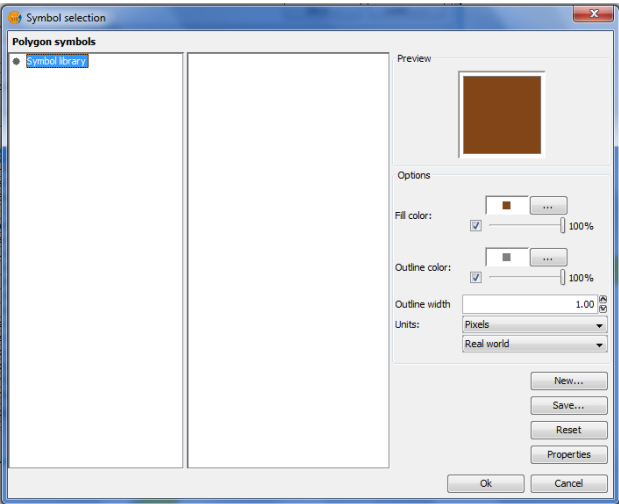
To access the color palette click on the buttons beside the fill and outline options.

Figure 42. Color palette
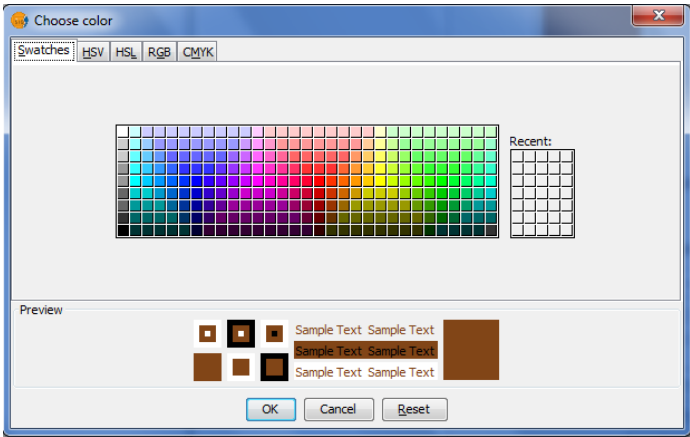
Once the color selection is finished click OK

Figure 43. Layer Properties/symbology
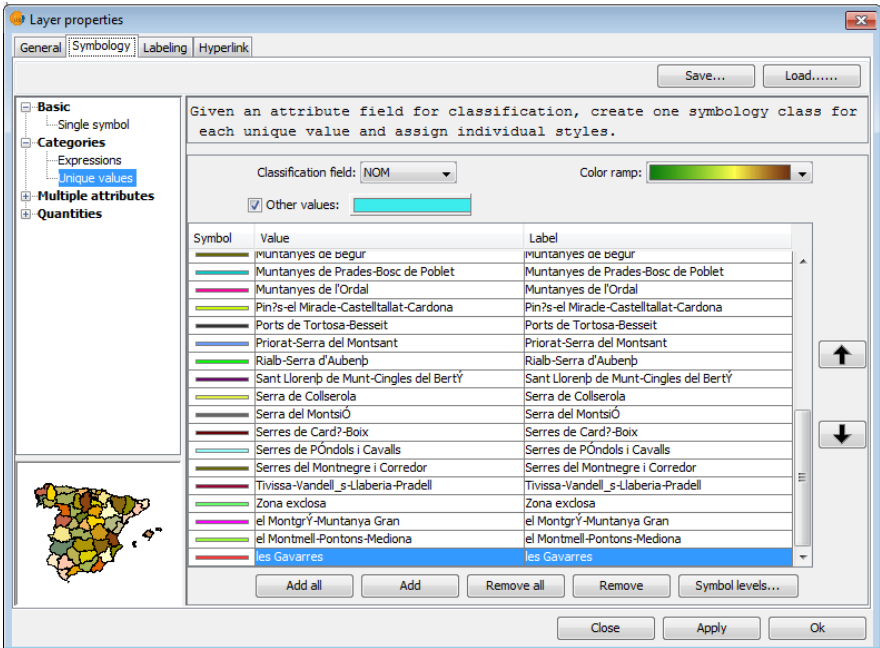
Continue doing the same with the other records. Once you select the color you want for each PPA click on Apply and you can see the changes on the view.

Figure 44. New perprot view with different colors
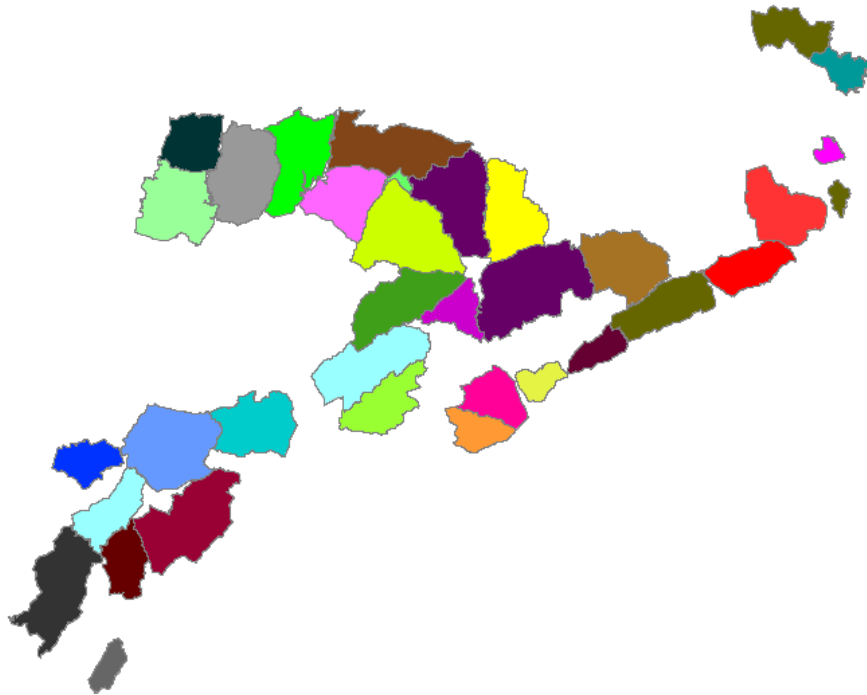
From the same symbology tab you can create the layer labels as well; for this choose the labeling option. The field selected for labeling is the field containing the name (NOM)

Figure 45. Layer properties/labeling

Figure 46. Font Selection

It is possible to edit the font for the labels. Click on the Font button and select the option you prefer: In our case we decided to choose (SansSerif as a font and Bold as a style)

In "text color" we have decided to leave the color as it was: the default option was black. In Fixed Text Height we have selected a value of 7. If you want to try different labels, make some changes to see the final result pressing "Apply" and check the results on the view.

After creating and editing the image with the labels, the final view should be similar to the following:

Figure 47. Perprot image with labels

Now we can activate the other layers to get an overview of the results with each PPA labeled with a different color and to have a global perspective of the whole map.

Figure 48. Catalonia with perprot labeled

6.3.6   STEP 2: Querying

Once you have prepared your data, by editing and creating symbols and labels to improve the visualization (one of the most important parts of Geographical systems), we will proceed to the second step of the case study.

One of the restrictions is that the places in which we have to install the fire bases must be located in municipalities bigger than certain amount of square kms, using the trustuble information given by Generalitat de Catalunya; moreover these places must be accessible by highways, principal roads or local roads of at least level 1.

For those towns that meet all the requirements we apply a filter to the information contained in the attribute tables of the layers so we can make a quick comparison between them.

o First of all we should load the .shp file GRAF_CACNIVELL1.shp on the view, so added to the remaining layers.

o Enable attribute tables of a layer In this case we must activate the tables of attributes that belong to the Layers GRAF_CACNIVELL1 Perprot

To activate the attribute tables as indicated in step 1 of this exercise, it is necessary to select the layer in the TOC and then click on the button "View table attributes"

Figure 49. Attribute table icon

The attribute table of the selected layer appears on the screen.

Figure 50. Roads Attribute table

Table: Attribute table: GRAF_CA...

CARRETERA	DENO...	DESCRIPCIO	DESCRIPCI1
B-433	SANT B...	C-651, Sant...	B-431, Sant .
B-451	ST. FR...	N-141c, San...	BV-4512, Sa.
B-461	ACCÉS...	C-17, Orís (...	Orís (túnel t..
B-500	CARRE...	N-II, PK 627...	N-152a PK 1.
B-502	VILASS...	N-II, Vilassa...	C-1415c PK ..
B-510	ARGEN...	C-1415c/C-...	AP-7, Llinars.
B-511	ARENY...	N-II, Arenys...	C-61, Areny.
B-520	VIC - T...	N-141d Vic (i...	GI-520/BV-5.
B-521	ACCÉS...	N-152a, Vic	Vic (canvi ra..
B-522	VIC - S...	Vic (antiga ...	C-153 Sant .
B-530		B-520 (PK 6....	BV-5305 (PK.
B-603	ACCÉS...	N-II, Sant P...	Rotonda BV-.
B-682	MALGR...	N-II, Malgra...	Límit comarc..
BP-1101		B-111 (PK 0)...	C-37 (PK 89..
BP-1103		BP-1101 (PK...	BP-1121 (PK.
BP-1121		Monistrol de...	BP-1103,Sa..
BP-1241		B-124 (PK 1...	C-59 (PK 20..
BP-1413		Parc tecnolò...	BP-1417 (PK.
BP-1417		Barcelona (r...	BP-1503 (PK.
BP-1432		C-59 (PK 20...	Carrer dels ..
BP-1432z		BP-1432 (PK...	Accés al Ma..
BV-1038		Enllaç A-2 I ...	L'Espelt
BV-1081		Castellfollit	C-37/C-37z

0 / 1232 Total records selected.

Minimize the view from the attribute table and return to the Project Manager Assistant, then select "Tables" and on there you will be able to check if the table you see displayed in the view has been added to the text box.

Figure 51. Project Manager/tables
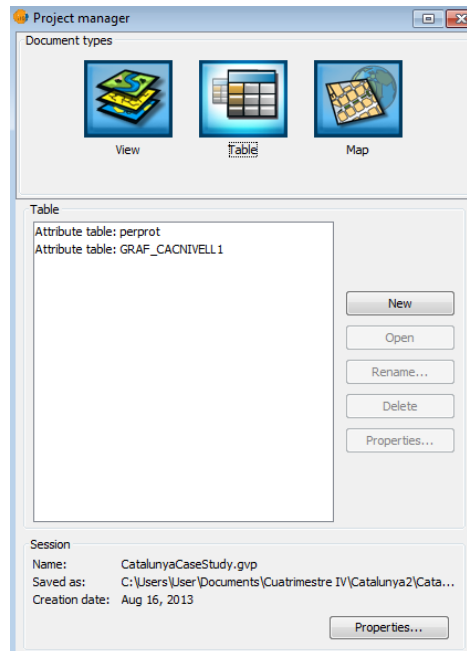
6.3.6.1 Create queries based on applying filters to information contained in a layer attribute table

6.3.6.1.1 First query

To access the tool, you can click the Filter button on the toolbar or from the "Table / Filter" menu.

Figure 52. Filter icon

The selection by filters allows precise definition of what you want to select, including attributes, operators and calculations. Queries are performed using logical operators such as equal to, greater than, not equal to, etc.

Once you press the "Filter" toolbar, a dialog window in which to build your query will appear.

First, we will create a query on the table GRAF_CAC NIVELL1 (remember roads), to do this select the table, and then select the filter tool, the proposed filter has to select all the roads from Catalonia that fulfilling the condition stated at the beginning of the query; In this particular case we need those ways that meet the condition of being a motorway, a road, a highway or a Level 1 regional road.

Figure 53. Filter for road selection
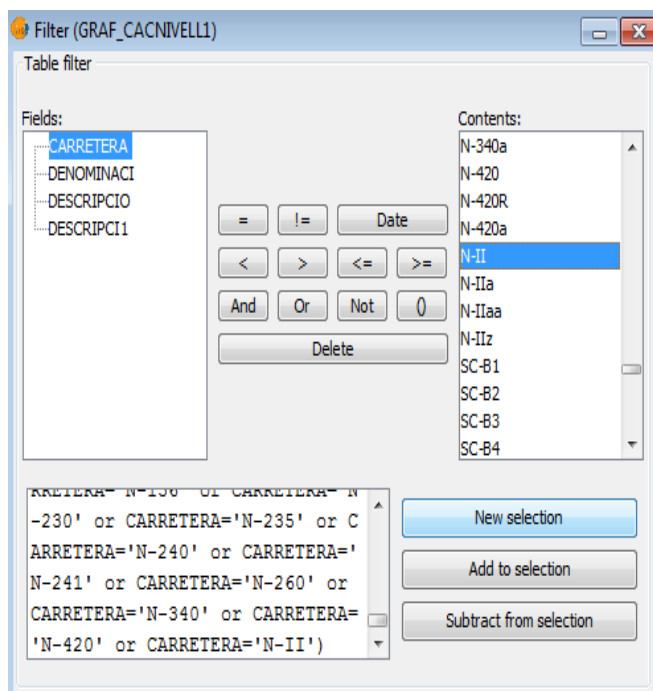
In the list of fields in the layer, double click on the field you want to work with.

Logical operators: You can insert, clicking on them, a logic expression for the consultation. In this case, use logical operators "=" and "or"

Contents: Displays a list of the different values of the selected field.

If you want to add it to the query, then also double click on the value. Values we choose are (A, AP, C-XX, N) that represents all the values that correspond to highways, AUTOV, national roads in Catalonia, Spain.

Consultation: The query you are running will be shown in the text box. You can write directly on this box.

Selection buttons: Execute the query by choosing:

New Selection: Removes any previous selection.
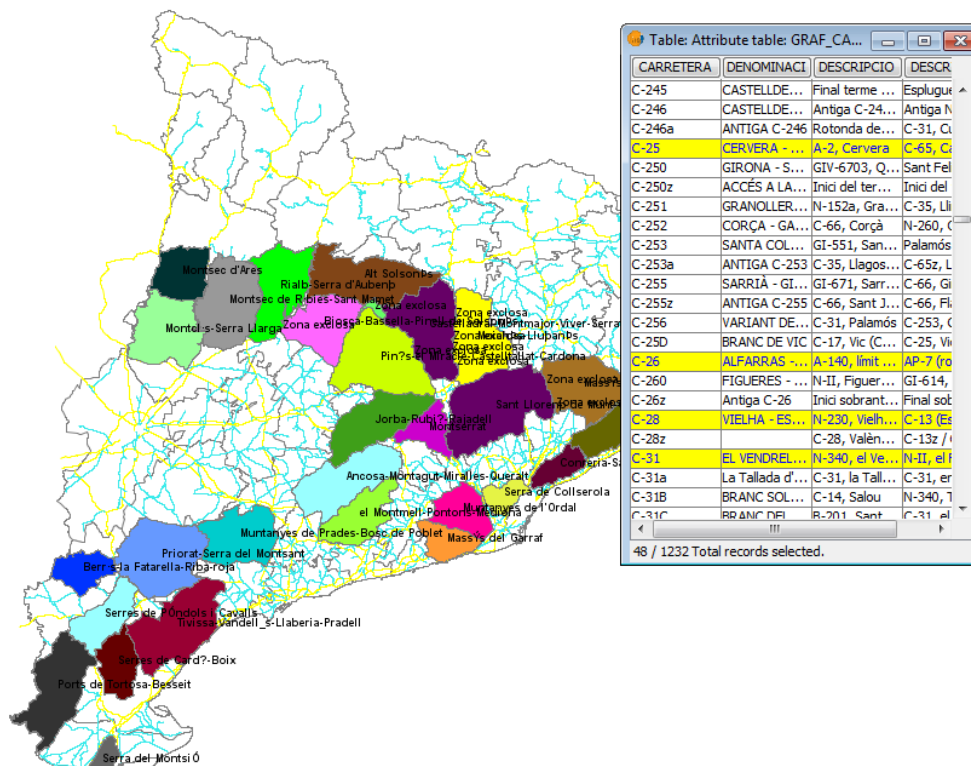Add to Selection: Add the new selected items to those already in the Query.
Select the Set: Perform the query on the elements selected.

In our case we choose the New Selection.

All highways that meet the conditions explained above will be highlighted in yellow color by default in the view and on the table.

Figure 54. Roads that fulfill the constraints

6.3.6.1.2 Second Query

Another constraint we have decided to apply is that the location of the bases must be in a municipality with an area bigger than 750.00 km^2. The decision was taken in that way, because we suppose larger area bigger negative impact as explained before. A change in this parameter can affect immediately with the future location of the bases.

We will learn how to make the selection on the table by another process using tools different than filters.

First, load the population centers table and select the field Municipal Base.shp and select the field on the table on which you want to make the query. To select the field place the mouse on the top of the field, and then click on there. The field will be activated.

For this query we will use the tools to reorder the records according to the selected field. Ascending order permit us to sort the AREA in an ascending order.

We can access the tool that allows ascending order by clicking the following icon on the toolbar or from the menu with the item Table / ascending order.

Figure 55. Ascending order icon

The Ascending order tool will sort the records in the numeric values in the table from lowest to highest. For a text field, records will be sorted alphabetically starting with "A".

Invert selection: It just select the records which were not selected in the previous sort, in other words it change the unselected items into selected ones and visceversa.

To select the record, place the mouse on the first number having the number lower than 750.00 and select to the end using the Ctrl or Shift key of the keyboard. (We select all place that have less than 750.00 of SUP_ COMAR (area).

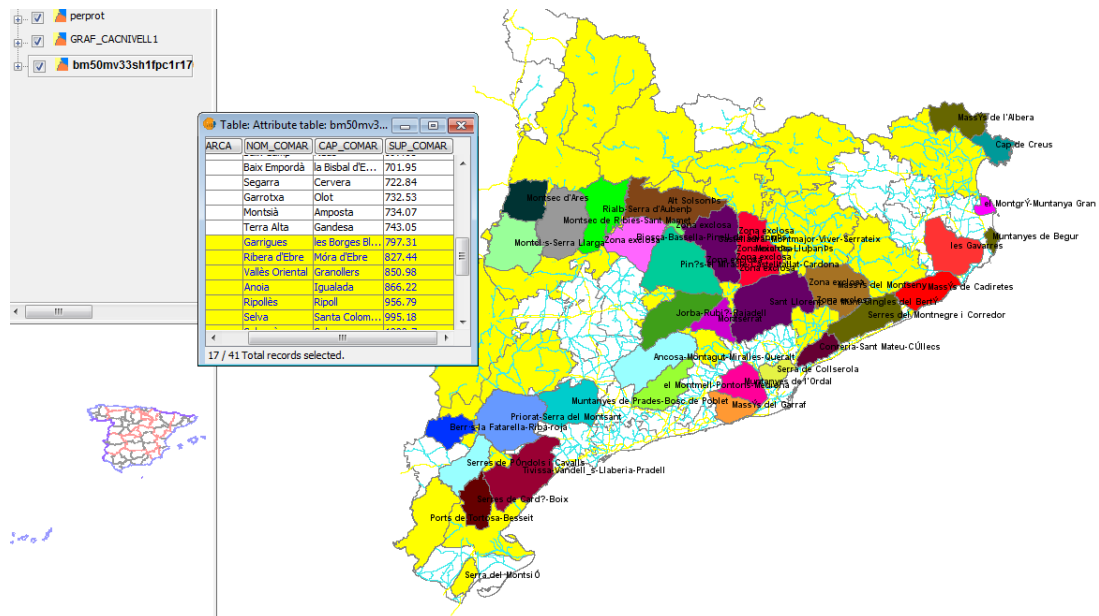Figure 56. Attribute table of municipalities with less than 750 of SUP_COMAR

Now click on the icon of the tool to invert the selection:

Figure 57. Invert selection icon

You will see both in the table and in the view, all municipalities of TYPE bigger than 750.00 are selected.

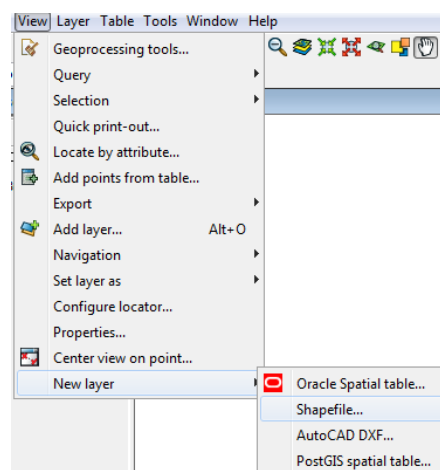Figure 58. Selection of municipalities that fulfill the constraints

6.3.7   STEP 3 Create a new SHP

The next phase will be the creation of a new shape file of dots that help to place the locations of the firefighting bases.
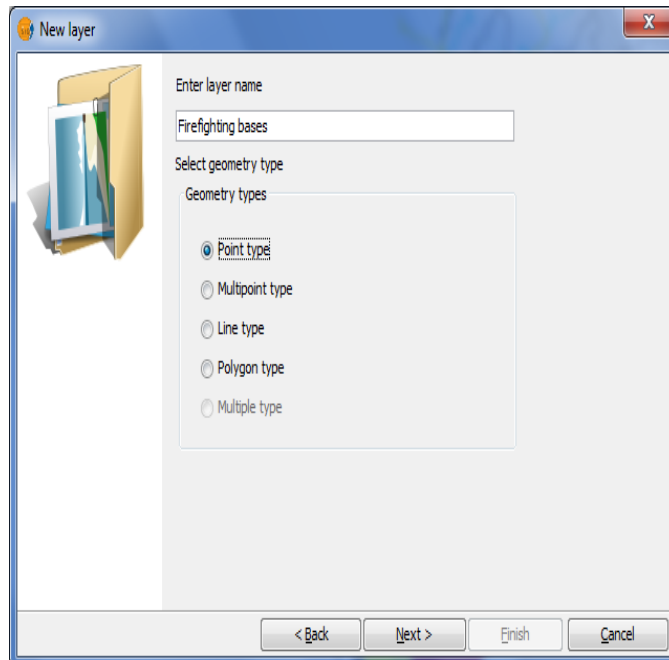
You can access the tool from the "view" in the top part of the tool bar.

Figure 59. View menu

6.3.7.1 Create new SHP

Figure 60. New SHP window

If you select the option New SHP, the new wizard will assist you in the creation of this new layer. The first window of the current wizard asks you to enter the name you want to assign to the .shp file that you want to create, and the type of geometry that will be associated to it.

In this case, the name we gave to the layer is "Firefighting bases" and the geometry will be point type.

Figure 61. Define fields

The second wizard window let you add all the fields you want to add to the attribute table that will be associated to that layer and identify some properties thereof.

To add fields to the table click on the button "Add field" as many times as fields you want to incorporate. In this case, you need a total of 5 fields.
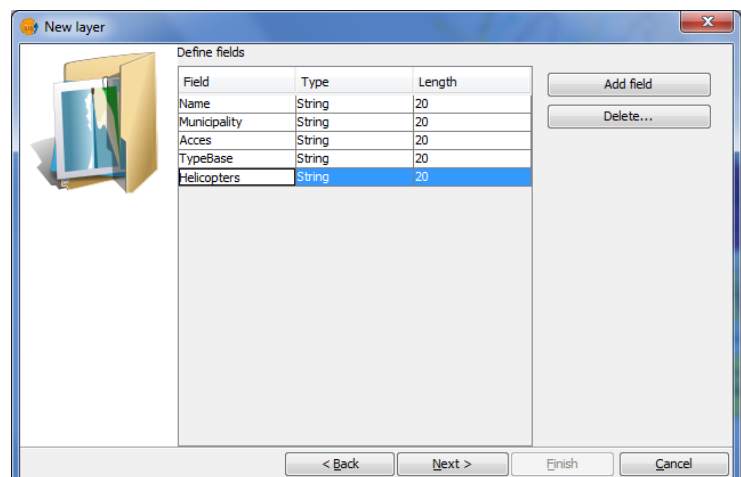
If you want to remove any of the fields created, simply select the field and click on delete. From the table where you define the fields you can edit the other properties.

Edit the field name: For this option, place the cursor over the name displayed (by default and type the new name.)

The new fields you will create are:

- o Name, of the base.
- o Municipality, in which the base will be located.
- o Access, indicates the type of road that passes through the base.
- o Base type: For the case study purpose we defined two categories (BRIF A – BRIF B) with helicopters SOKOL from Poland or Bell 212 determined according to reality): The base A includes 2 helicopters of medium size like SOKOL or Bell 212 and 17 persons between engineers and fighters.
  On the other hand the base B includes just one helicopter of medium size and 9 persons [23].

If you place the cursor on the top part of the "Type", this will activate a drop-down menu from which you can select the type of field you want to create.

BOOLEAN: Create a True / False stetement. This kind of field is useful if you are going to proceed to check other fields within the table.

DATE: Create a field that includes dates.

INTEGER and DOUBLE are two numeric fields. The first is designed to insert integers and the second for numbers with decimal figures.

STRING: A type of alphanumeric field. Field size: Sets a maximum size of characters for the field created.

Given the values that will be included in the table, the field type and size that appear by default are adequate. Once this process is completed click on the next button. From the new Wizard window that appears, you can select a path in which to save your file.

Figure 62. New layer/file path
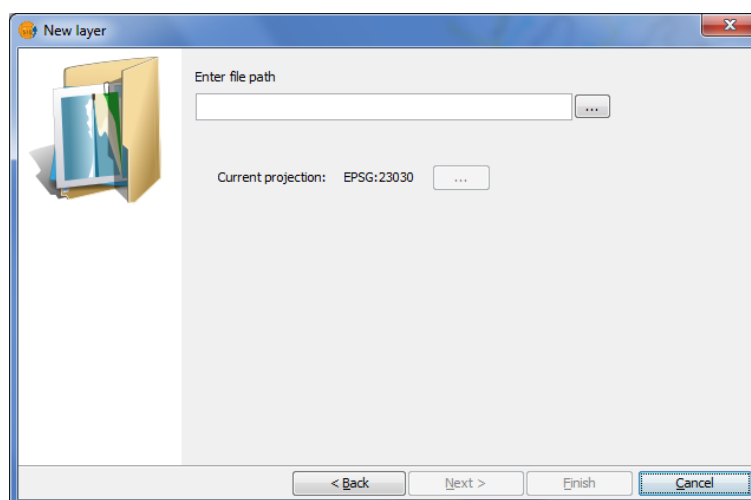
To open the search dialog click the button on the right of the text box. Write the name you want for your new layer (please note that this name will be the name that appears in the shape source file and can be different from the name that appears in the TOC, which name you chose in the first window of the wizard).

But the most convenient choice is for the new shp to have the same name as the name that will appear on the TOC: so our suggestion is to name it as Firefighting Bases.
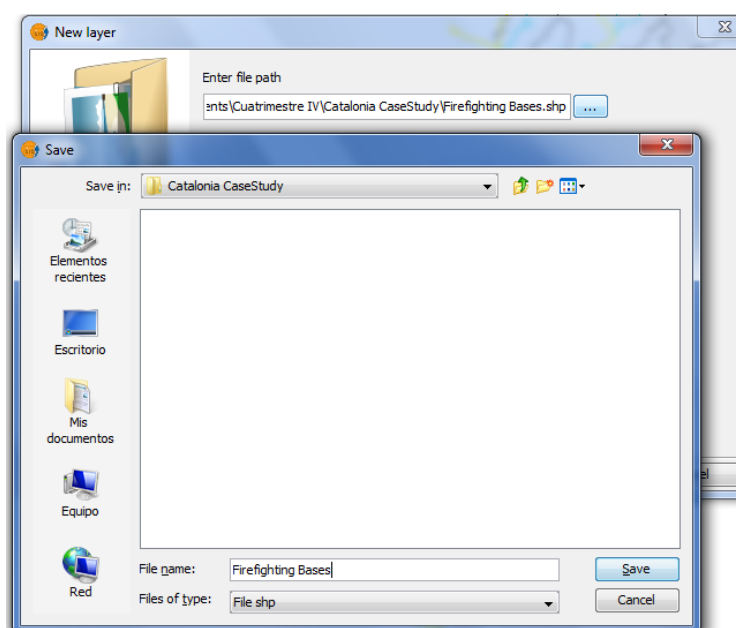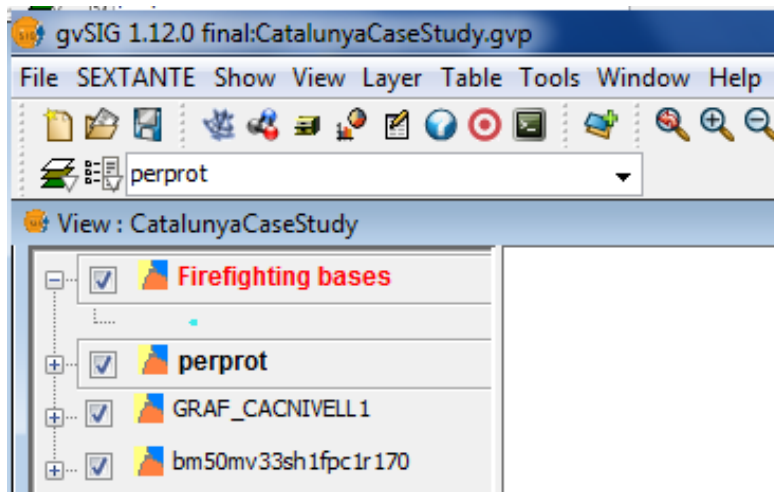
Figure 63. Firefigthing bases file

Figure 64. Firefighting bases added to the TOC

Once the process of creating a new .shp is completed, the file will be added to the TOC. This completion will also activate the editing tools to create elements of the new layer.

A new shape of type point has been created. Each point corresponds to the creation of a new firefighting base. Each firebase has a hypothetical assumed operating radius of action, established as 40 km (BASED ON THE SPEED OF THE HELICOPTERS AND THE REACTION TIME THEY SHOULD ACOMPLISH WITH HAS TO BE LESS THAN 14 mins) [24], it means that the helicopter must cover the entire surface of a circle of 40 km of radius around the firefighting base.

The criteria for the location of bases are based on the constraints mentioned earlier.

Given an overview map and using the measuring tool distances 📏 we are going to establish a total of 8 bases.

We will now locate the first point out of the 8 taken that fit with the requirements.

In the view, we see all municipalities classified from area and roads of category of the categories needed.

These help us in placing the locations. (As the areas allowed are in yellow what we did to distinguish the main roads was to invert the selection, so that is why we will see the main roads in blue color instead of yellow.

Figure 65. Places where the bases can be located
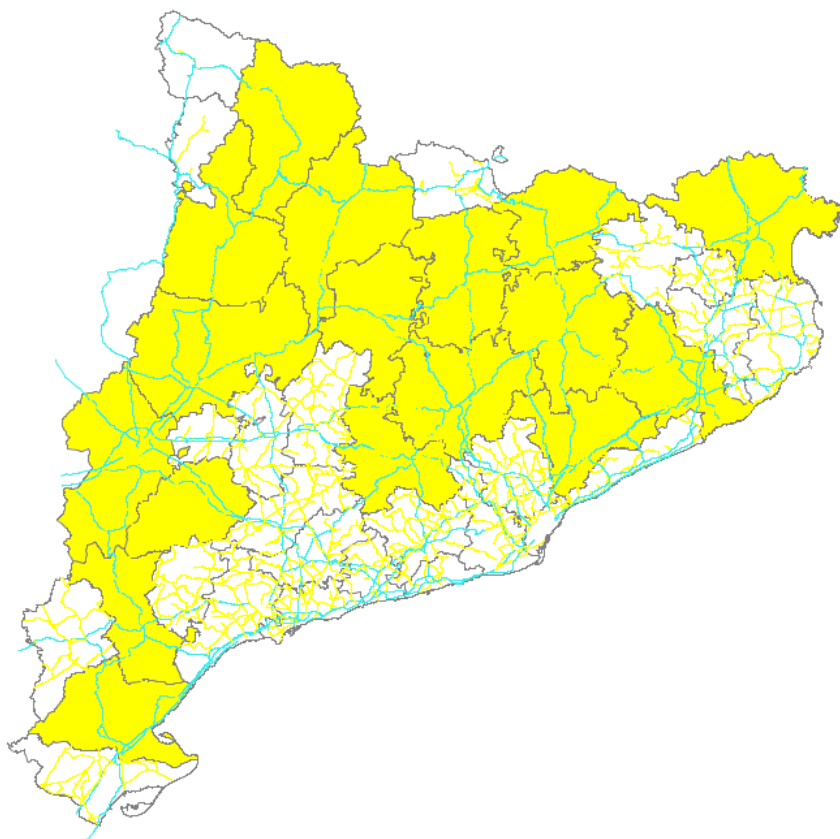
First we will start covering the areas from the bottom part to the top part of the region, but this is completely up to you. We have searched within the area one of the municipalities that meets the constraints outlined above. In this case we find the municipality of *Baix Ebre*.
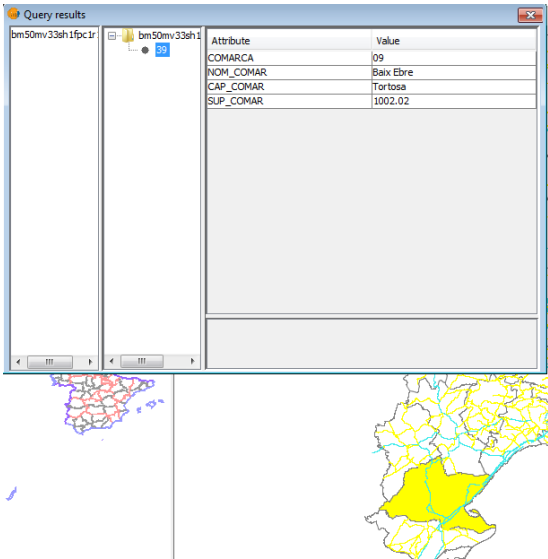
Figure 66. Municipality of Baix Ebre
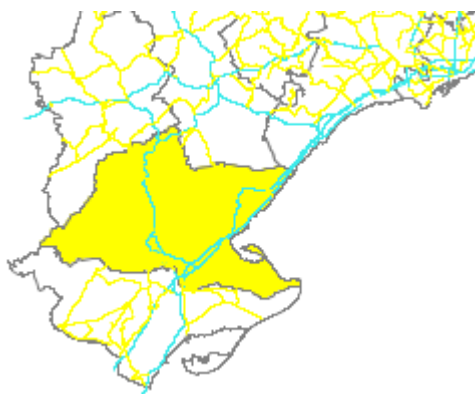
To verify that this municipality meets the requirements, select the layer Municipal Base (bm50mv33sh1ftm1r170.shp) in the TOC and click on the municipality with the information button.

Figure 67. Information icon

Figure 68. Query results/Municipalities

A view appears on the window with the following information: We can observe that the value for the SUP_COMAR is higher than 750.00 so one of the constraints is fulfilled.

Figure 69. Query results/Roads
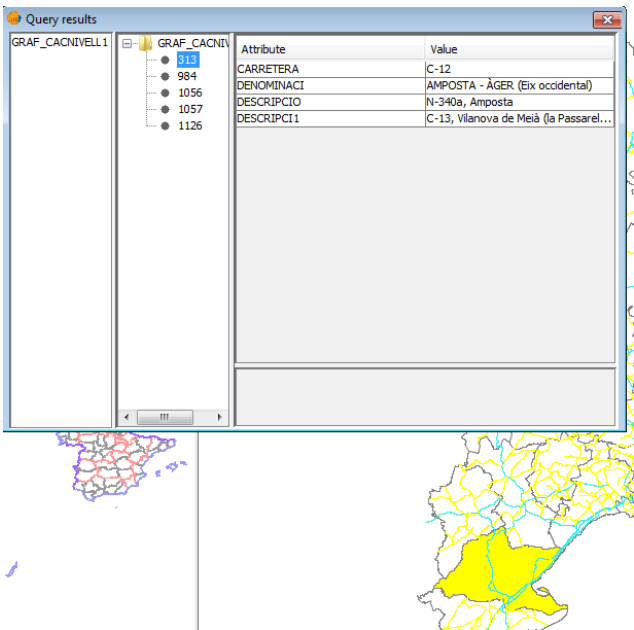
Now we want to check that the road through the town also satisfy the constraints. The process is the same as in the previous situation, but in this case the layer that should be selected in the TOC is Roads (CacNivell1.shp)

Once the municipality is decided, we have to insert one of the points that represent the firefighting base we want to install. So it means that we have to select the "Insert point" from the toolbar, for this we have to go to the layer of firefighting bases and click on edit so this tool will give you more options in which the insertion of the point is available.

Figure 70. Insert point icon

Then, insert a point on the town.

Figure 71. Point insertion in Baix Ebre Municipality
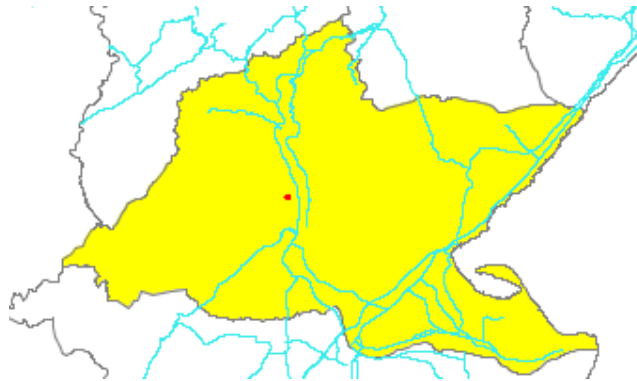
After the creation of the new shape, we will edit the symbology thereof to improve the location on the view.

We have continued with the search for locations that meet the different requirements. To make things simple in the current case tracking, the remaining locations will be made by selection by attribute. To do this, click on the Next button on the toolbar.

Figure 72. Selection by attribute icon

The following window appears from which the query can be stated:

Figure 73. Locate by attribute window
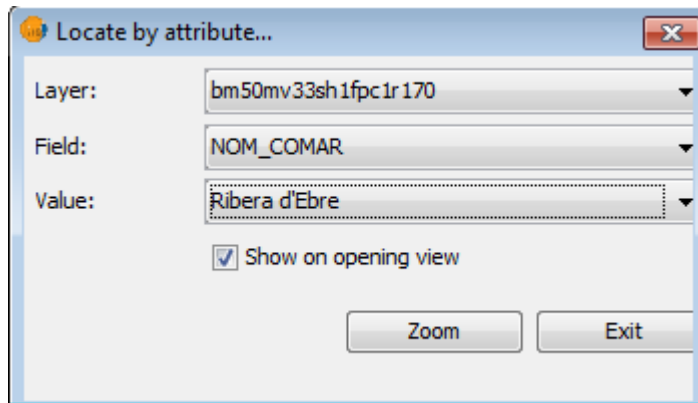
If you switch on the roll down menu "Layer" all the layers of the TOC will appear. The layer containing the names of the urban municipalities is bm50mv33sh1ftm1r170.shp; the field that contains the name is NOM_ COMAR-

Once you locate one of the towns click on the zoom icon and the view will address to the selected Municipality showing it in the map. the place in which we locate the firefighting bases are:

- o Baix Ebre
- o Ribera d´Ebre
- o Anoia
- o Valles Oriental
- o Berguedá
- o Noguera
- o Selva
- o Alt Empordá

(This location is up to the user, this can be used as a reference but they can be located in some in some other places that fulfill the constraints stated in the problem as well).

Figure 74. Locate by attribute/ Ribera d´Ebre
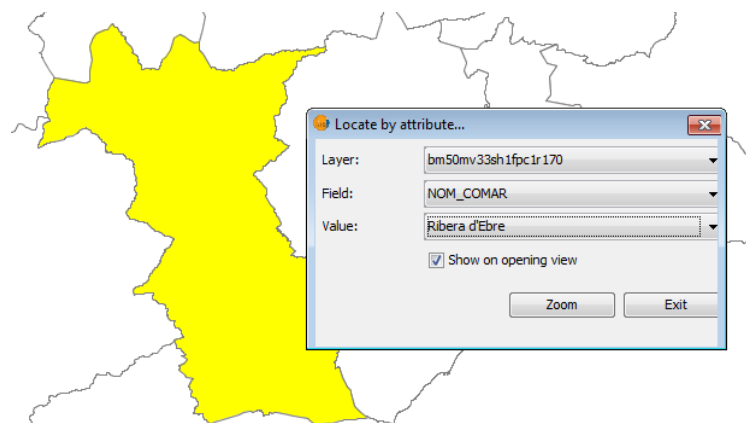
Once the point is entered in the attribute table of the layer firefighting bases.shp, a new record will be added to the data base. Open the attribute table and edit individual records Press Enter to reflect changes.

Figure 75. Location of the eigth firefighting bases
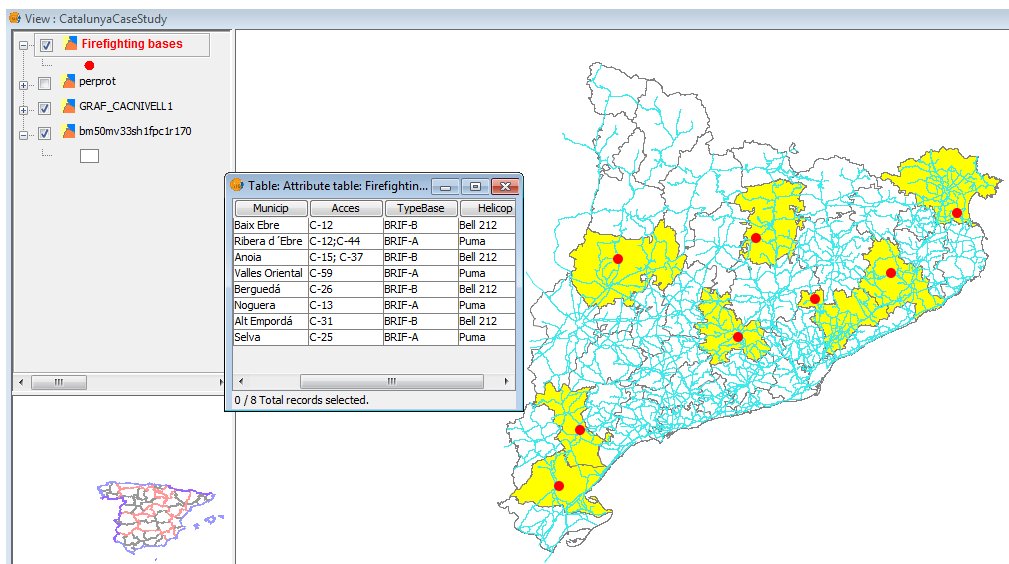
The table that you create must have this appearance:

Figure 76. Attribute table: Firefighting bases

Figure 77. Stop editing the layer
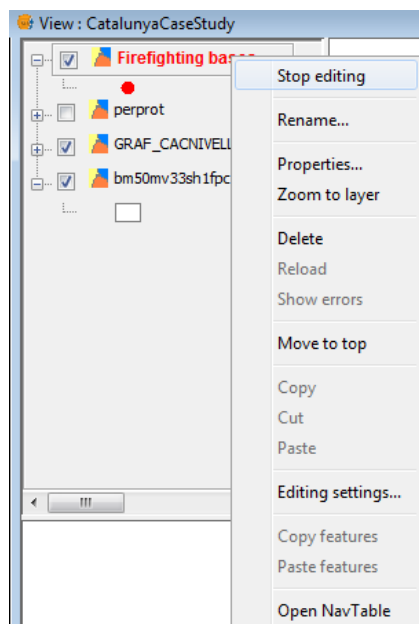

Once all points are inserted and the table is filled with the data, the edition of the layer is done. To save the changes and stop editing, press the right click on the layer and select "Stop editing".

A confirmation window will pop up: Click Yes and the layer will be saved.

Figure 78. Save edits for layer
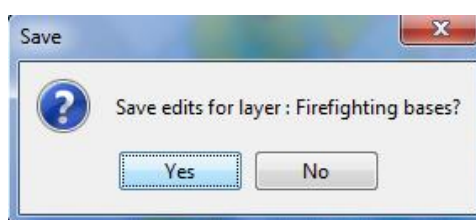
You can edit the symbology of the layer you created for easier viewing of all points. To do this, go back to the Properties menu (right click over the selected layer) and go to the Symbology tab.

Figure 79. Layer properties/ Symbology

6.3.8   STEP 4: Create an influence area

Before proceeding with the fourth step, we will create a layer group in the TOC to facilitate the work with them.

Figure 80. Layer Group

Select with the Control command the following layers:

- o   Municipal Base: bm50mv33sh1ftm1r170.shp
- o   Roads: CacNivell1.shp
- o   Priority Protection Areas: perprot.shp

Once all these layers are selected, place the cursor on any of them and with the right click select the option "Group layers"
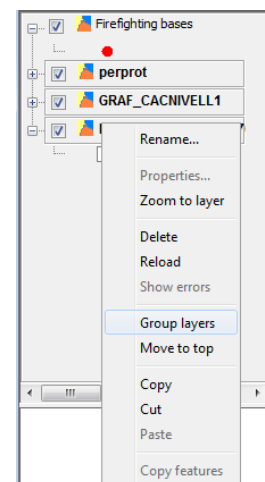
6.3.8.1 Grouping Layers

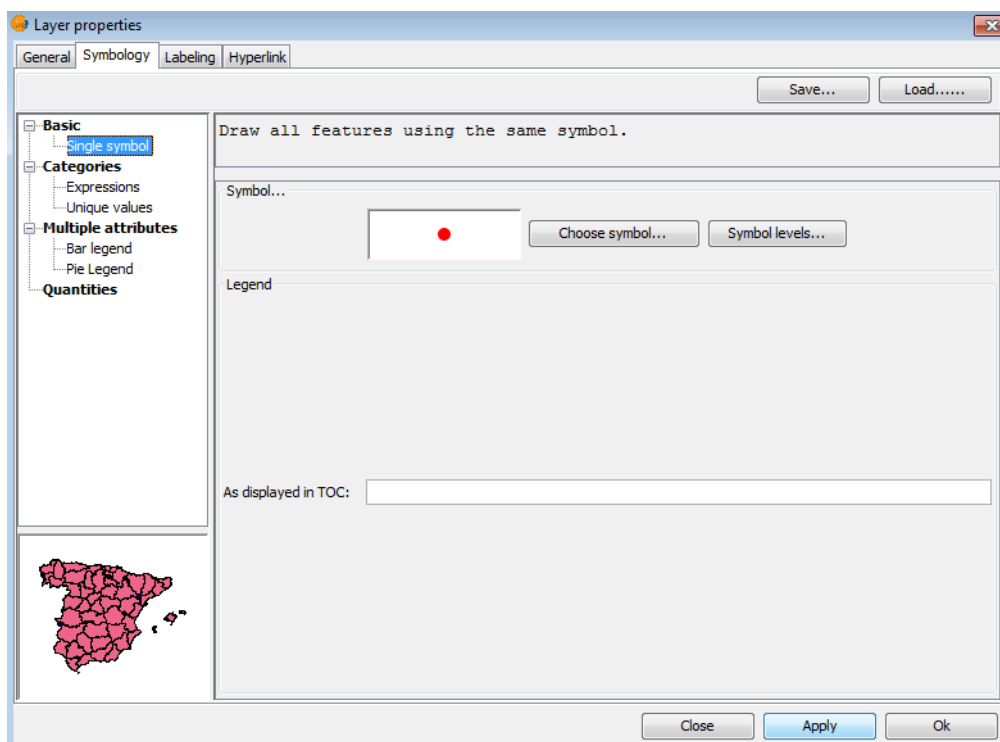A window will appear from which you can rename the group, in this Case we call it Grouping CatCasestudy.

Click OK and the group will be created in the TOC.

Figure 81. Rename Group Layers
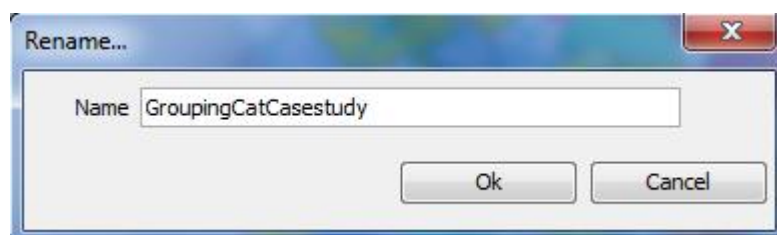
Note: It may happen that the layer firefighting bases.shp appear behind the newly created group and, therefore, not be displayed. In this case, you have to use "Place in front"; another tool from the context menu of the layer.

As indicated above, the urgent covering Area of each firefighting bases was set to 40 km. To set the area covered by each base, we may use geoprocessing tools to create an Area of influence (Buffer).

6.3.8.2 Create Area of influence

We can access to the geoprocesses manager/ Geoprocessing tools by clicking the next button:

Figure 82. Geoprocess icon

Figure 83. Geoprocessing tools
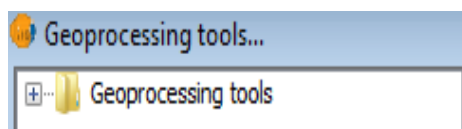
The "geoprocesses Manager" pops up, and, from there, you can choose the geoprocess wanted: in this case, "Area of influence".

Figure 84. Geoprocess/ Buffer zones

To access any of the geoprocess, just expand the tree of each folder so you can see all the options the tool provide.

Once you see the geoprocess you want to use, click on "Open tool".
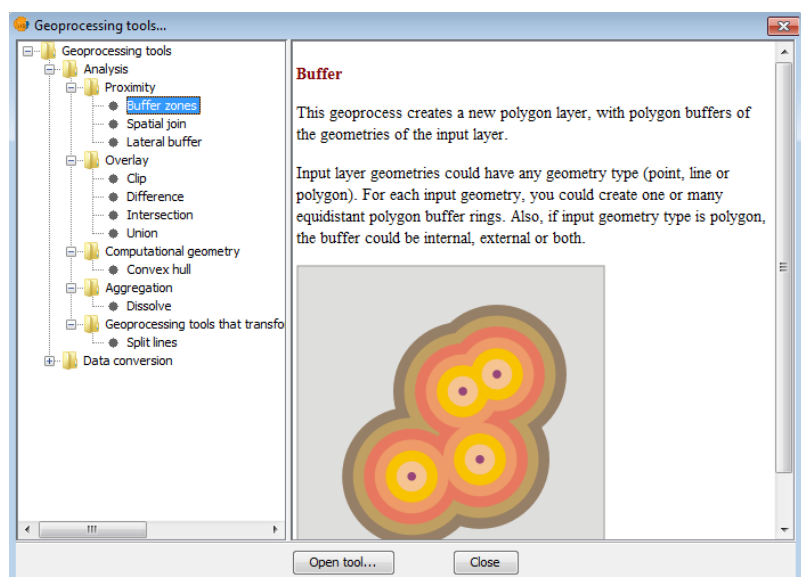
Figure 85. Parameters of the area of influence
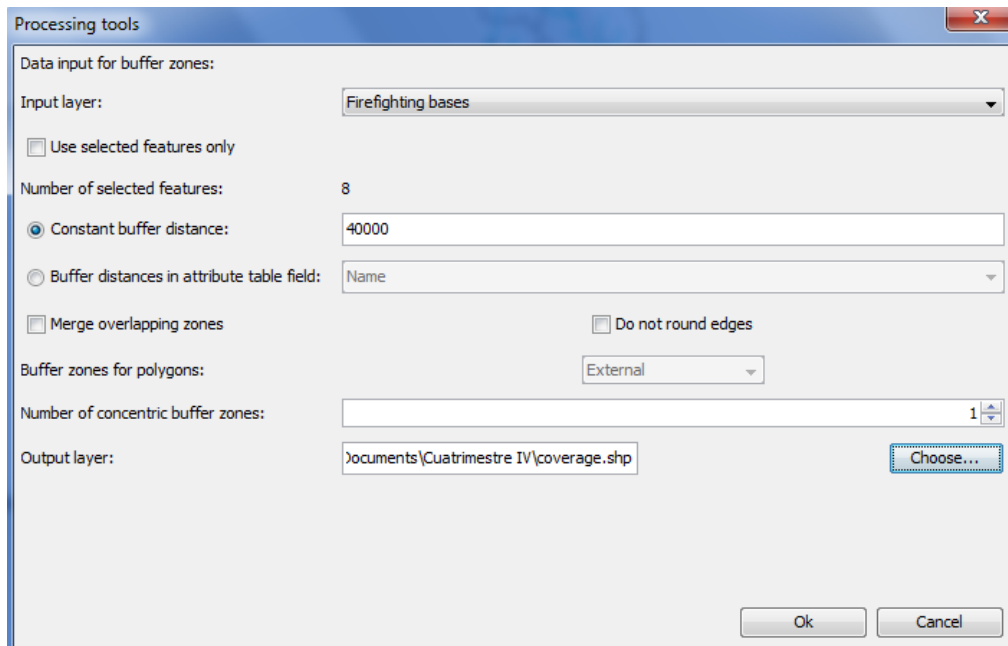
As input layer, choose the layer firefighting bases because it is on this layer that you will create the area of influence of course. Select the option "Constant buffer distance" since we want all the bases cover the same geographical area; on there introduce the value of 40000 meters of radius (= 40 kilometers for the coverage area).

(Typical pitfall: typing 40 instead of 40000. If you make this mistake the operation will apparently yield no results, because 40 meters do not even cover the size of the point symbol of the bases).

Choose an output layer; in our case, the name will be Coverage.Shp (try to save all changes in the same place within your PC to make it easier to find whenever you need it) and click OK

The geoprocess starts and the new layer will be added to the TOC. The newly created influence areas will be drawn on the view. We go to the properties (right click on top of the current layer) (the layer context menu / properties) and edit the symbology of the areas of influence just created, and select a small percentage on the fill color, so the influence area can be visible without any problem.

Figure 86. Layer Properties/symbology

We notice that once the area of influence is applied, the distribution of the bases covers almost all the PPA (this location was obtained after several iterations till we got a satisfactory solution) and most of the whole region.

NOTE: We don't know if this is the optimum location, there are some other options that also work, There is not a good or a wrong answer is up to the user and in real life there are a lot of variables that affect the distribution decision.

Figure 87. Coverage area for each base

Figure 88. Manage fields

We can edit the table that was generated with the creation of the area of influence. To do this, select the layer in the TOC Coverage.shp and activate the edition process, afterwards activate the attribute table.

Go to "Table" in the text menu on the top part and select Manage fields.

A field editor appears that allows you to add new fields, rename or delete them. In our case, what we need are new fields that contain (Id, Distance, name) of urban centers where the bases are located.

Figure 89. Manage fields (schema)

Click on "New Field" and see a new window where you can set some properties of this new field. For example: Edit the "Name of the field" and type "Name". Leave the rest of options with their default values.

Click OK and the new field will be added to the field editor and to the table.

You can add, delete and rename the fields.
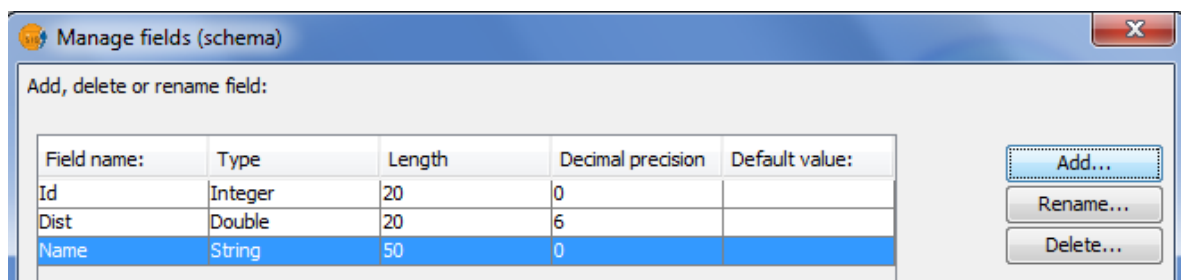
Figure 90. Attribute table/coverage

Edit the records of the field "Name, Id, Dist" with the references of the urban centers where the bases are placed. Once the names are inserted, finish editing and save the changes.
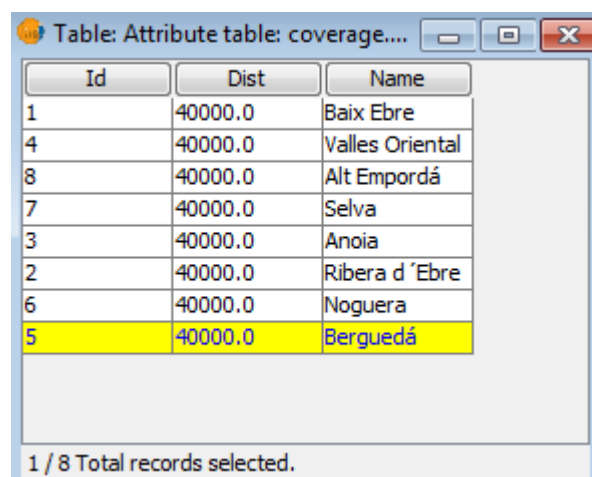
6.3.9   STEP 5: CREATING A MAP

6.3.9.1 Map Access

Figure 91. Project Manager/maps
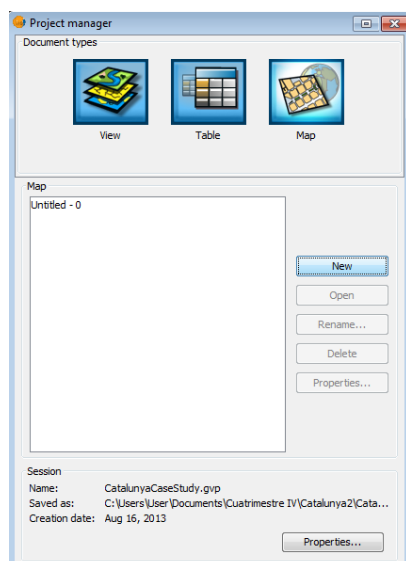
Access to maps document type is made through gvSIG Project Manager.

To create a new map, click on New. After the creation of the document (by default it will appear as "Untitled - 0"), select it and go to the rename option and enter "Wildfire bases", the same process explained at the very beginning of the Tutorial but now for maps instead of views.

Figure 92. Project Manager/open map
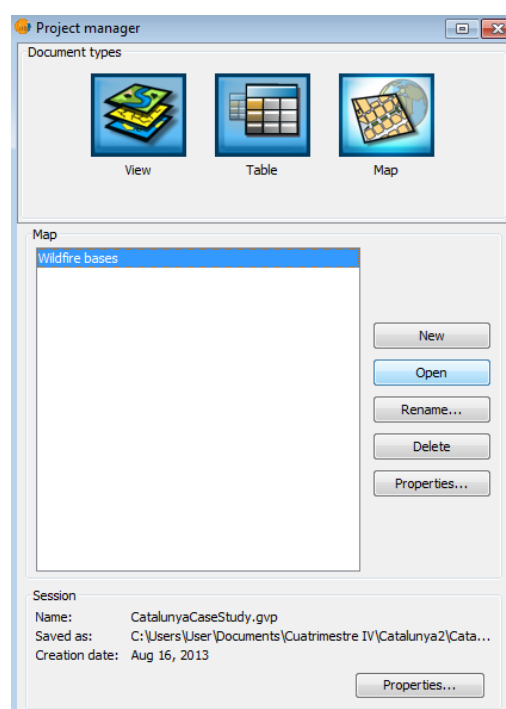
Once you open the map, it will appear the following image.

Figure 93. Map view
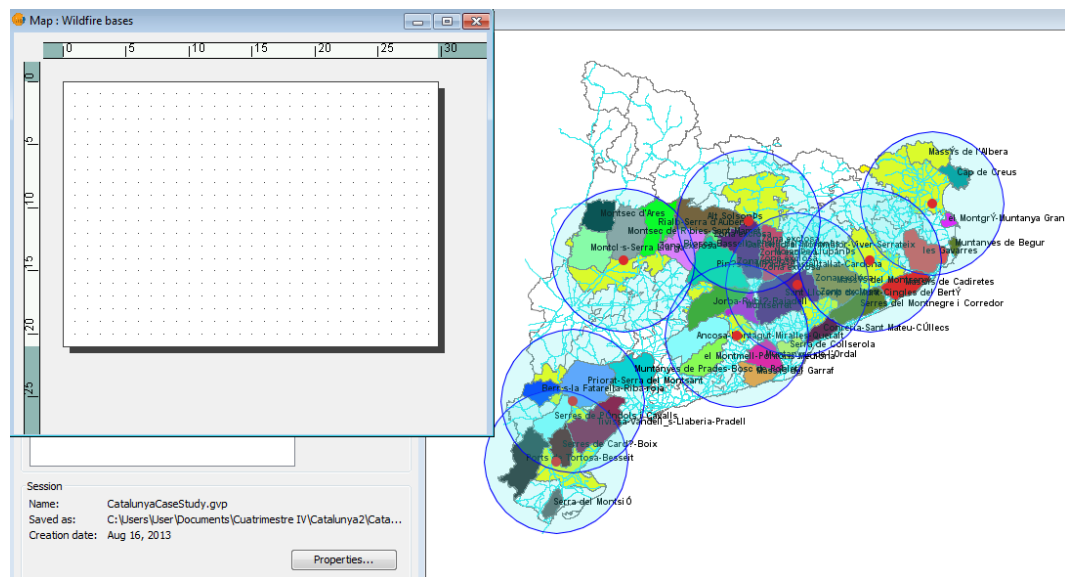
When creating a map, it is important to establish first of all, which is the basic information we want the map to contain.

We wish to create a map that contains information of the location of the base, its coverage area, a picture of the base or at least the type of helicopter that would operate and some other elements that permit to read and understand it such as: Scales, north icon, legends…etc.

An example of that map can be represented by the following picture, but the composition and presentation can be created according to the preferences of each user.

Figure 94. Main Result/information map
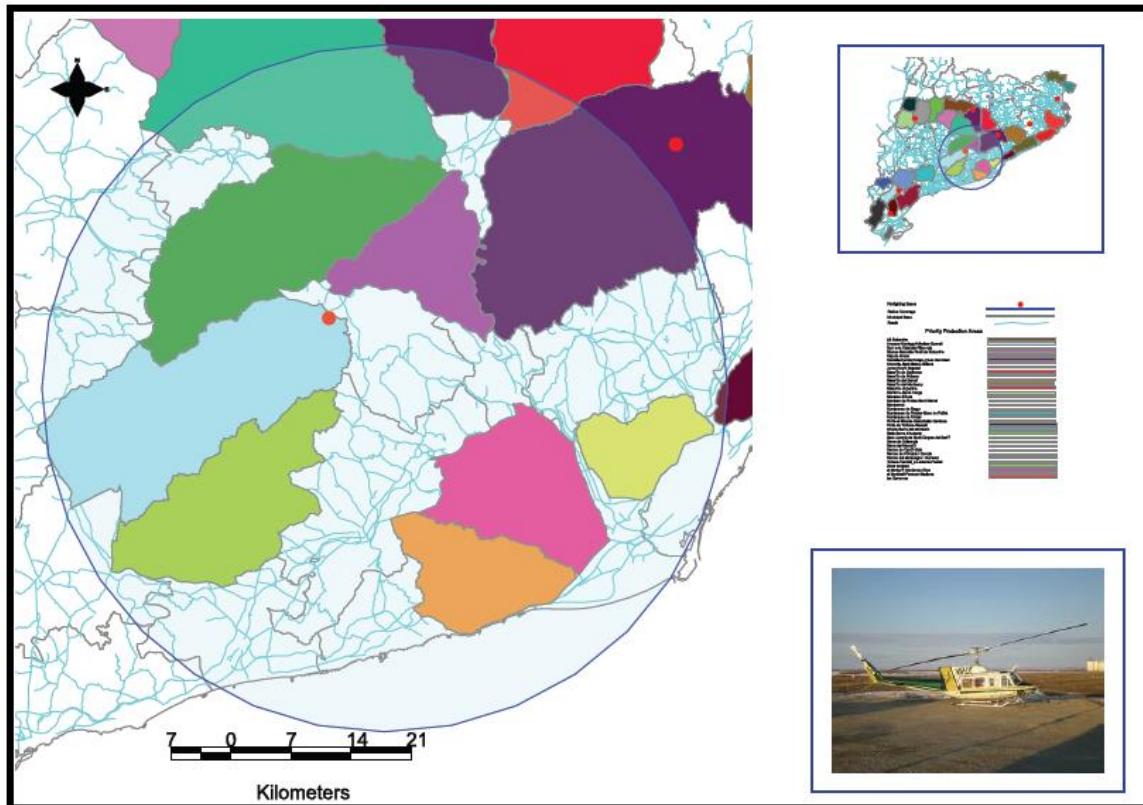
6.3.9.2 Prepare page

The first step is to prepare the page for the future document.

In our case, we will create documents of A4 size, for a future exportation to a PDF file. To select this option, go to the menu Map / Page Setup.

The image below specifies the data to be entered for preparing the page for the desired document.

Figure 95. Page setup
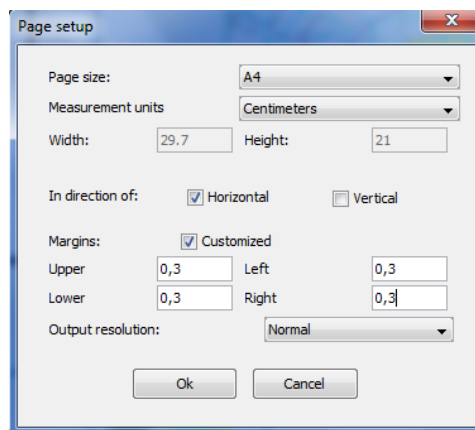
Click OK and the gvSIG map page will show you the characteristics previously selected in the "Page setup" window.

6.3.9.3 Insert Views

At the beginning of the procedure of adding a view on the map, we must modify on the original document view (CatalunyaCaseStudy), some elements for getting the result we are seeking.

Select the view in which we were working on, either minimizing the map or going through the "Window / project manager" menu. We step on one of the bases in this case at Anoia, selecting an image size that displays only the influence area of this base, as shown in the image.

Figure 96. Anoia base view
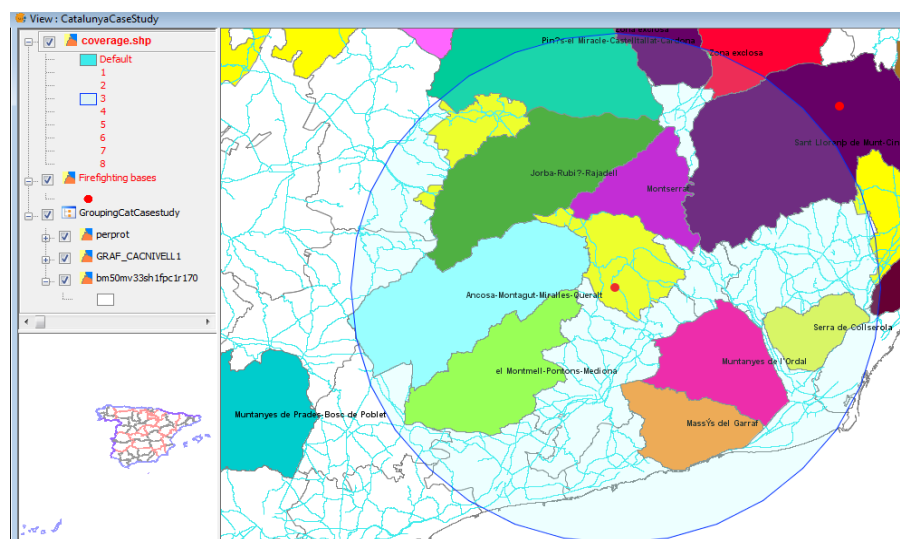
To "switch off" the remaining areas of influence edit the symbolism of the Coverage.shp layer deactivating the line and filling options of each element, except the element Anoia (id number 3), as shown in the picture below.

Figure 97. Switch off the remaining areas
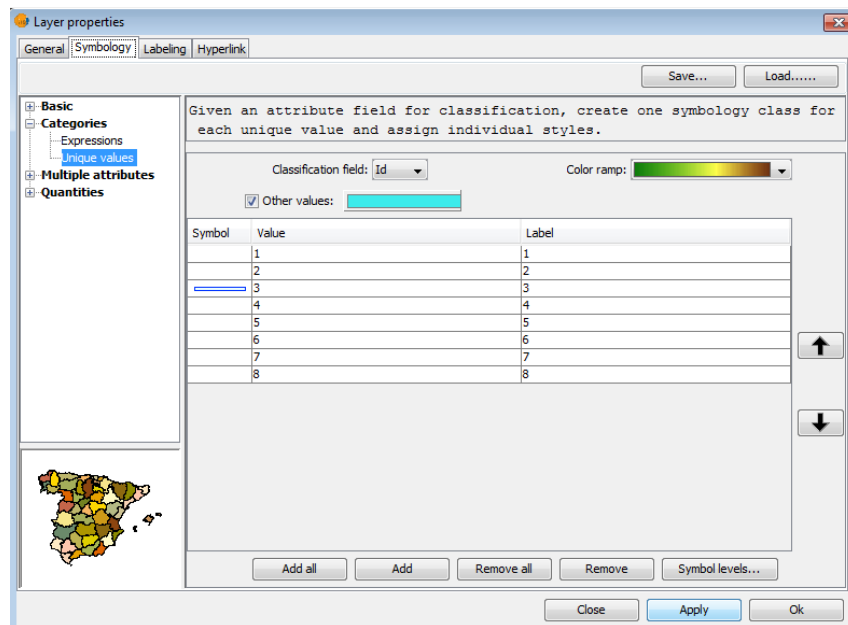
Once we visualize on the view the desired result, we go back to the map (Window / project manager menu). When you are on the map again insert new view with the following icon:

Figure 98. New view icon

Click on the Insert View button on the toolbar. To insert a view place your mouse inside the rectangular box that shows the space to be occupied by the object and drag and drop it at the opposite end. A dialog box appears where you can define the properties of the type view element just inserted.

Figure 99. View frame properties
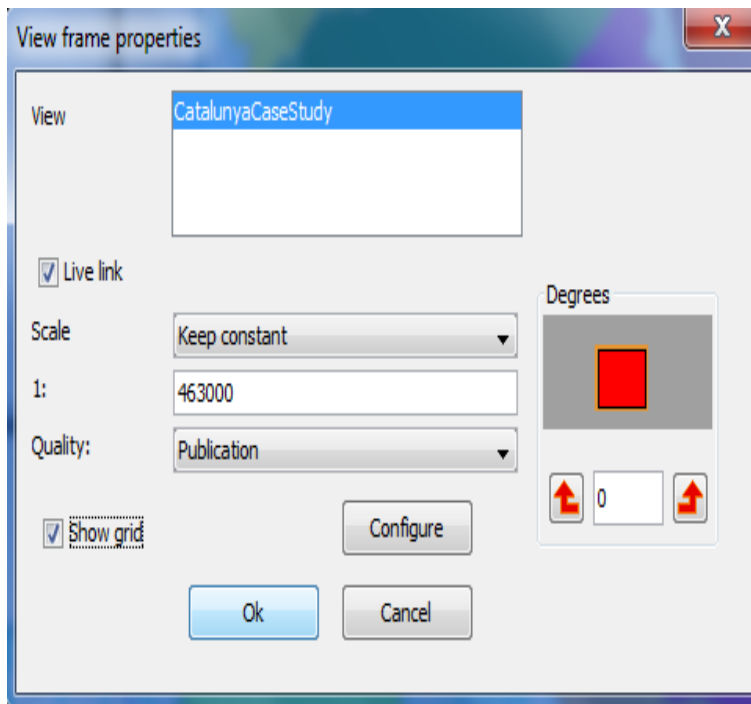
View: Select the view CatalunyaCaseStudy

Live Link: If the check box is enabled, any changes you make on the view (change color, add layer..) will be reflected on the map. You must bear in mind that changes of scale will not be affected by this tick, as these changes are regulated down from the related roll-down menu described further down on the next paragraph.

Scale: Select one of the following three types of scale:

Automatic: In this case, any changes to scale you make on the view will be automatically reflected on the map.

Store display: In this case, even if you change the context of the view on a map, the layer associated to the view will not be resized: It will keep the size it had on the view.

Keep constant: This option allows you to define a customized scale. The scale featured here is the one we have decided to use in this example to create the map. But it depends on the size of the view that we have inserted therein.

Consequently, that size can change, and, therefore, in this example we will not specify any scale: The best option is to try to reach an adequate scale visualization considering the final result we are seeking.

Quality: This has an influence on the display; leave the option "Publication".

Grades: Specifies a rotation to insert the view on the map. This option also appears in the other elements that can be inserted: images, scales, legends and texts. In our example it will be 0 degrees.

6.3.9.4 Insert Scale

To insert a scale on the map, click on the next button of the toolbar:

Figure 100. Scale icon

The procedure to insert a scale is the same as the one used for the view (place your mouse inside the rectangular box that shows the space to be occupied by the object and drag and drop it at the opposite end).

This tool allows you to insert a scale (related to a view) on the map. The dialog of the scale element is as follows:
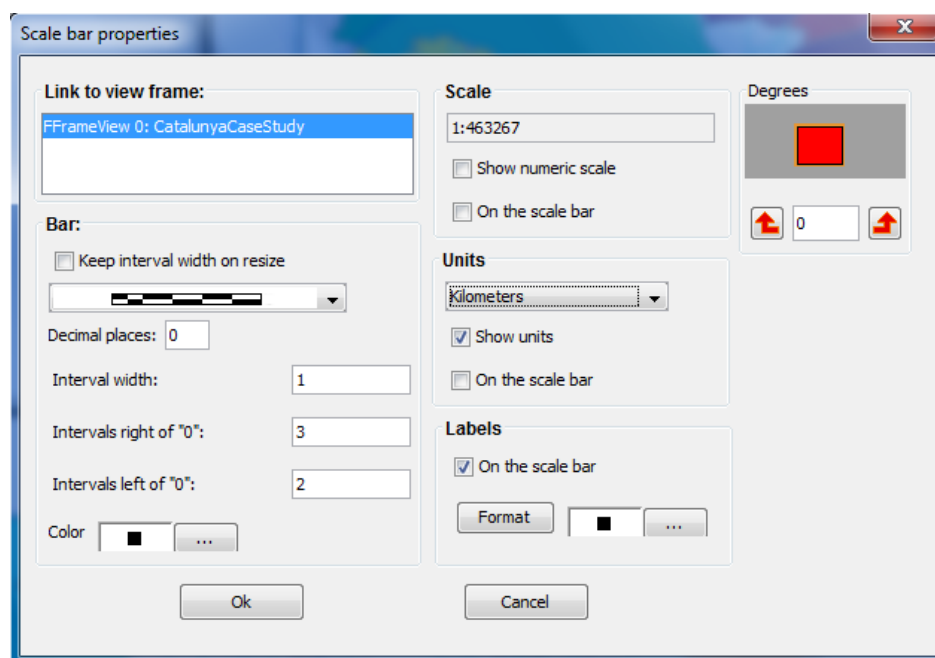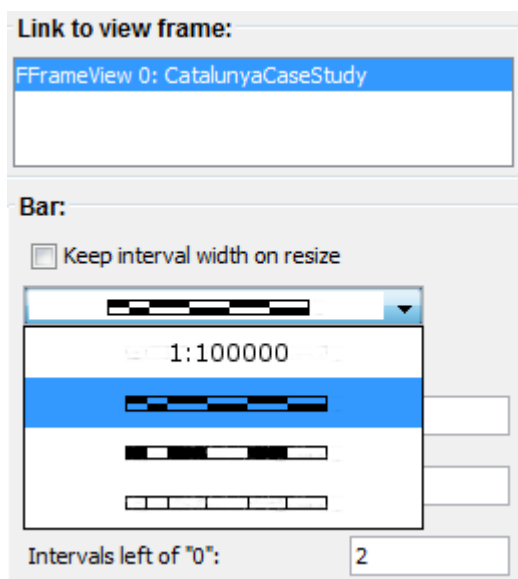
Figure 101. Scale bar properties

Figure 102. Options to display the scale

Select view CatalunyaCaseStudy

Clicking on the dropdown menu, several options to display the scale for inserting in the map will appear.

The other options are disabled but we include a brief explanation of those, just in case you want to insert another type of scale. Select the number of intervals, what each of them is representing is the number of divisions to the left of 0 that you want in the range.

Scale: If you wish, you can bring up the numeric scale on the bar thanks to this option.

Units: Define the graph scale units (meters, kilometers, etc..). Choose the one which you are been working to avoid confusion.

Tags: From this box you can select the color, font, and the status of labels (numeric scale, units ...)

6.3.9.5 North Symbol

Figure 103. North Symbol properties
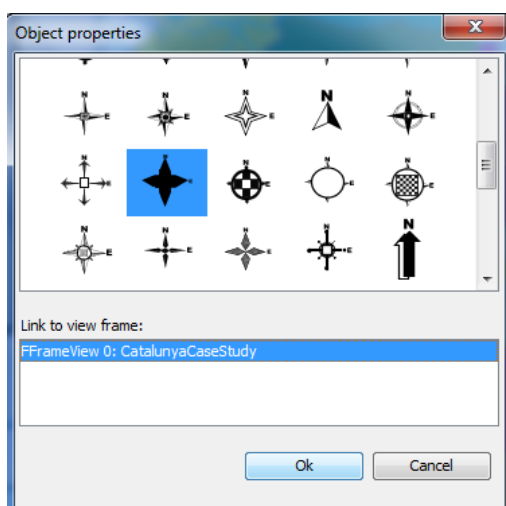
Insert the North Symbol Pressing the "Insert North" button of the toolbar. To get this, place the mouse, click on the rectangle defining the space to be occupied by the symbol and drag and drop in the opposite end, the same way we did with the previous tools. Below is a dialog box where you can choose from several predefined models for the north tag.

The next figure shows how things should be going with the map:

Figure 104. Overview of the map
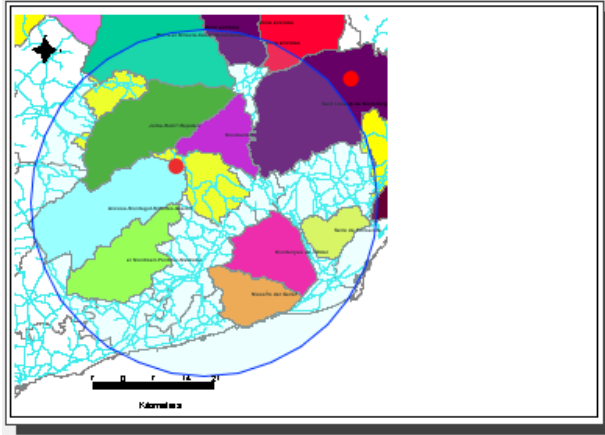
As we have emphasized that it is a location map, we will include a MiniView containing the whole community of Catalonia.

First, deactivate the live link that currently exists with the view so it avoids a possible modification about the view already inserted.

To do this, select the view on the map and with the right click access to the properties menu again and switch off the live link.

Go back to the view and make some changes: disable the labeling (Select the PPA layer and access Properties, the Symbology tab and disable the check to "Enable labeling"). We also decrease the size of the dots (also changing the symbology) that represent the bases and change the display scale of the view to have a complete panorama of the community of Catalonia.

Figure 105. Wildfire bases properties
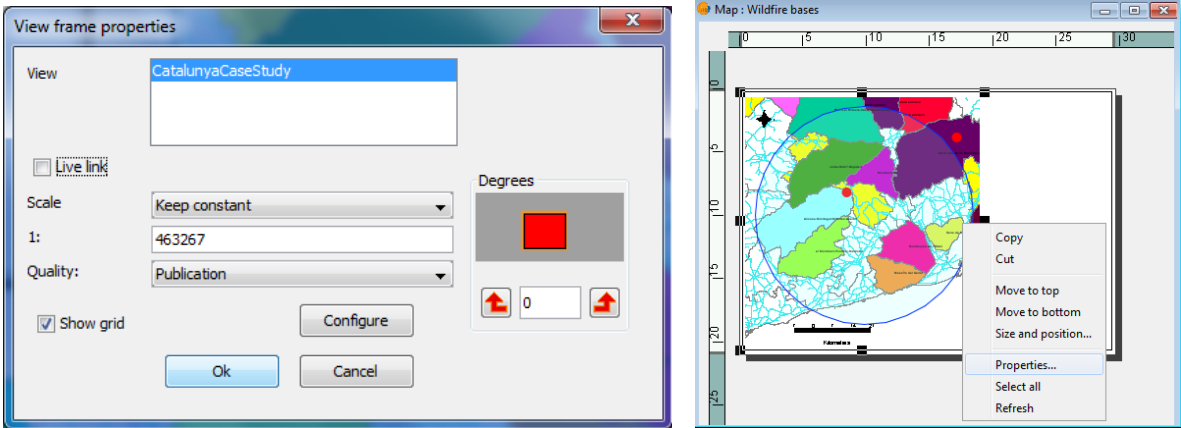
Figure 106. View frame properties

How it looks after making the map in small scale.

Return to the map and insert a new view using the same process described above.

Figure 107. Wildfire bases overview
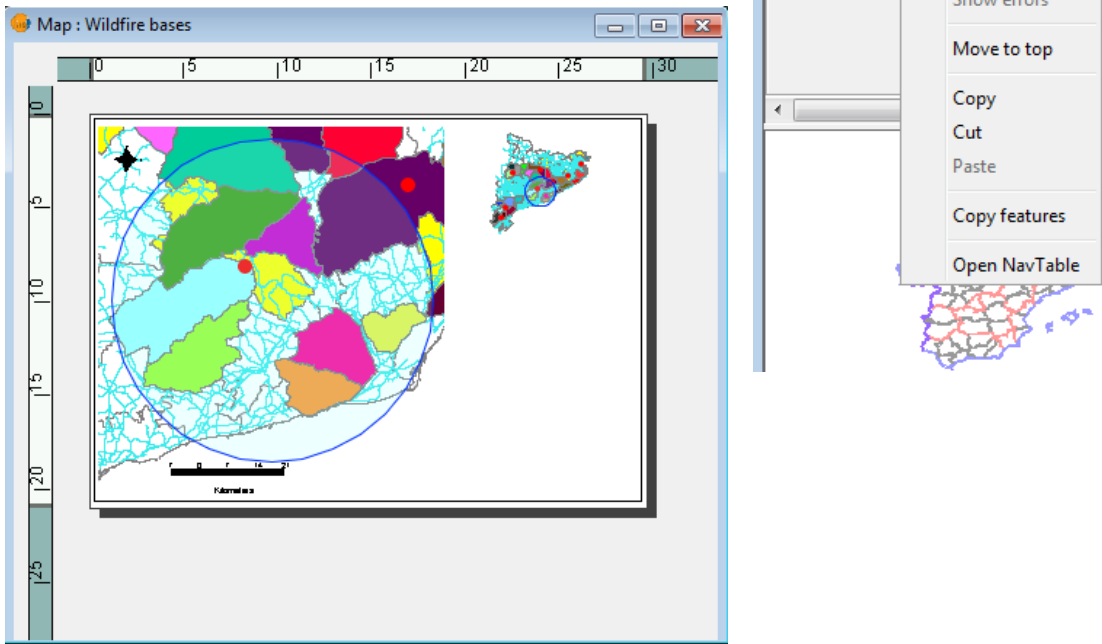
6.3.9.6 Insert a legend

The legend represents the visible layers in the Table of Contents (TOC) view selected. If we insert a legend, the layers are added in the same order as they appear in the TOC. Click on the following button on the toolbar and perform the same steps described in the paragraph "Insert a view".

Figure 108. Leyend icon

The dialog box appears as follows:

Figure 109. Leyend frame properties
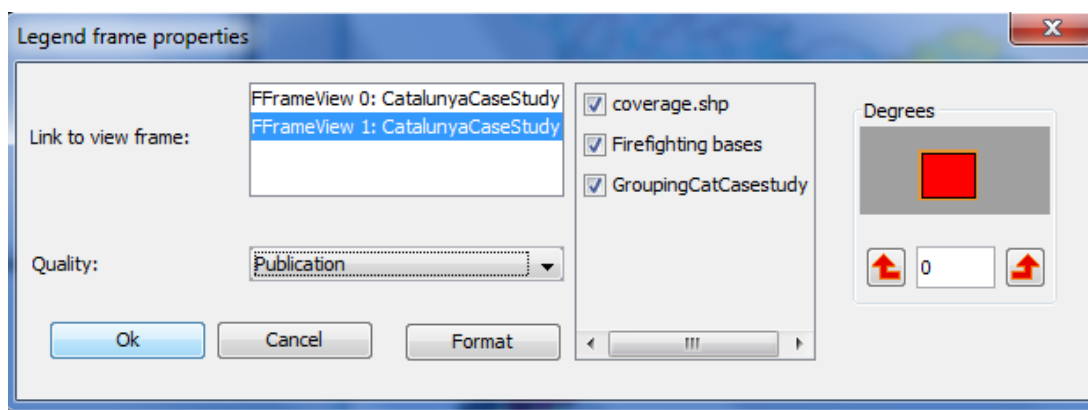
The image of the legend that will appear on the view will be similar to the following:

Figure 110. Leyend image
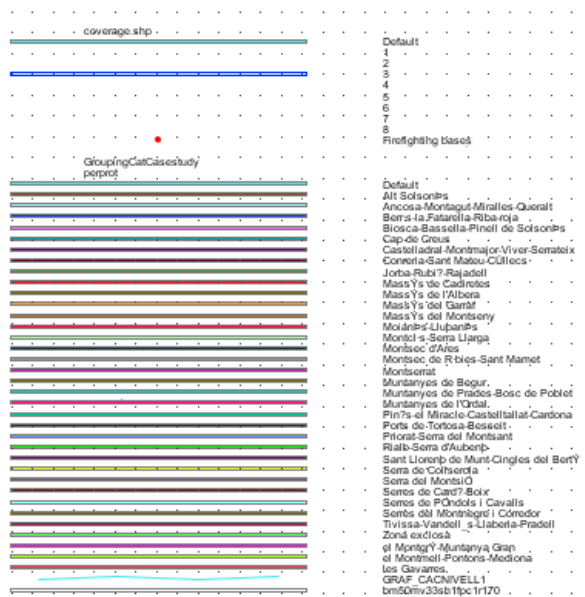
We can improve the appearance of the legend if we split the block of elements and edit some of them or just delete some another ones. For that, right click on the legend and go to the option "Simplify legend". We can perform independent selections of the elements that we do not want to be displayed in the legend: To implement this, click on the delete button.

With the other tools you can move items, change the size of the texts and their content ... Finally, once all the changes are done, it is convenient to regroup the elements.

Figure 111. Group/Ungroup legend
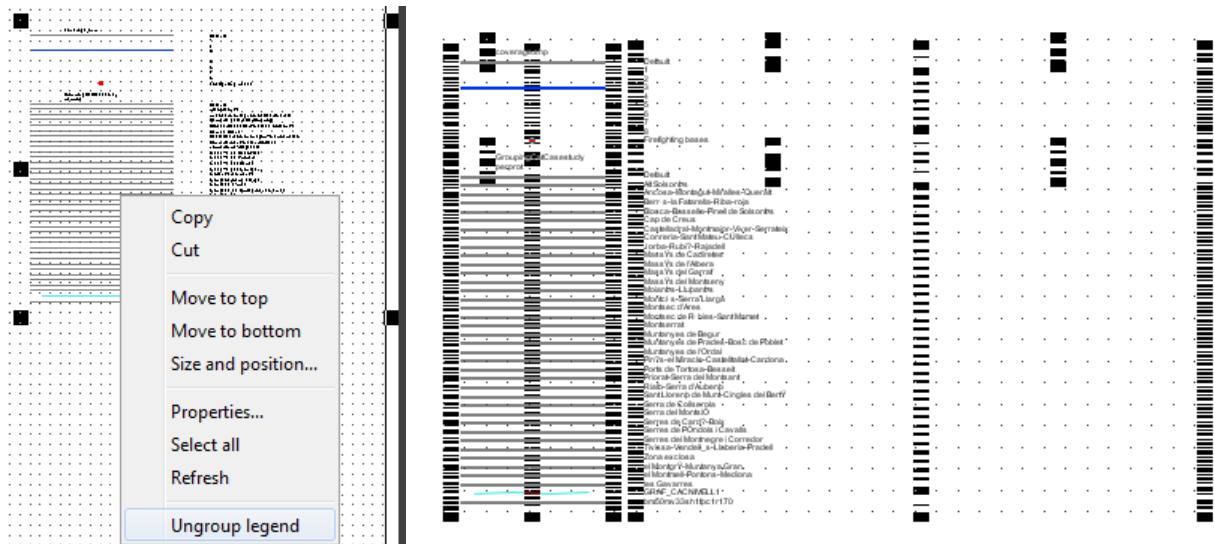
6.3.9.7 Insert an Image

This tool allows you to insert an image on the map.

Figure 112. Insert image icon

If you select the tool and set the frame on the map the following dialog box will appear:

Figure 113. Object Properties
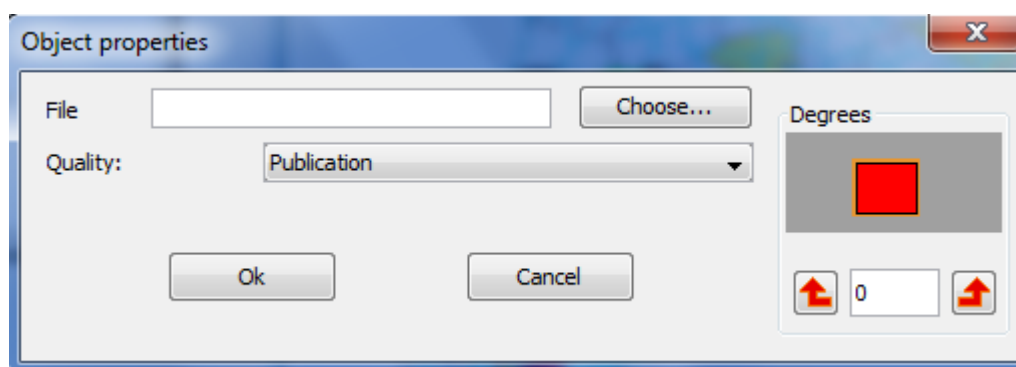
Pressing the Choose button, you can select the path where the image file you want to insert is located within your PC. You can insert an image with the following formats: jpeg, jpg, gif, png and bmp.

In our example we have chosen the following image, but you can insert any image that you want it to be visible in the map.

Figure 114. Chosen image

6.3.9.8 Insert Text

Texts can also be inserted by pressing the following button located in the bartool or selecting it from the menu MapText , as defined in the dialog box that pops up.

Figure 115. Insert text icon

Inside the area of text you can type the text you want to set on the map.

Figure 116. Text Properties
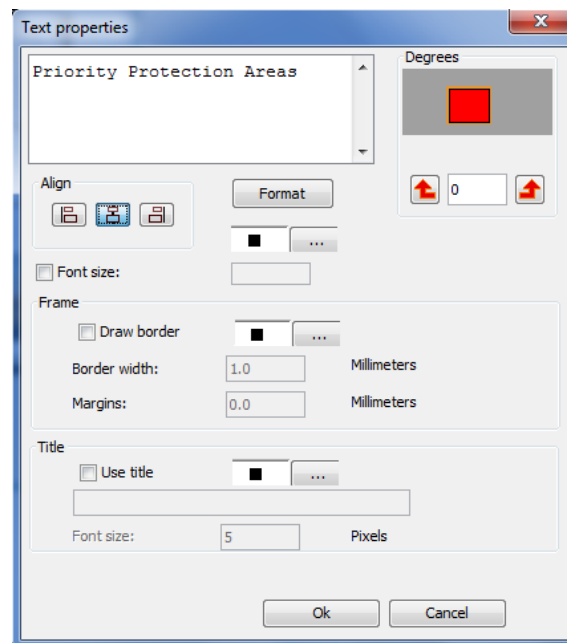
6.3.9.9 Insert Graphs

You can insert the following types of graphics:

- o Points
- o Rectangles
- o Circles
- o Lines
- o Polylines

o   Polygons

All these elements can be inserted from the Insert option of the map menu, or clicking on the appropriate button of the toolbar.

To insert a graph, click on the place where you want to position the element.

Another option we used was the border that helps us to give a shape and a space for each image inside in the map.

Figure 117. Borders icon

Then, inside the rectangle you should go to properties and arrange the border in the way you want considering unclicking the fill color button and leave on the outline color.

Figure 118. Object properties
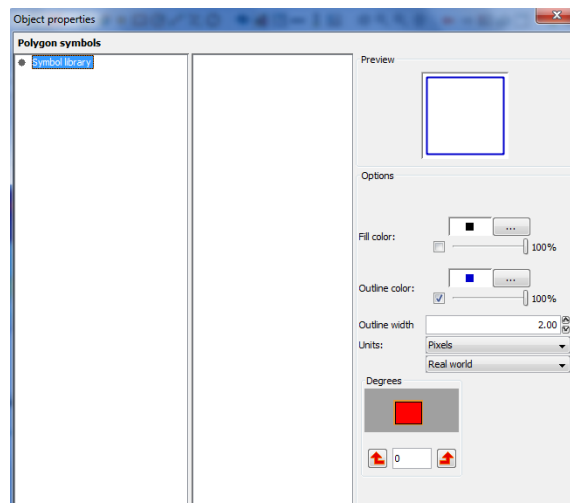
The result will be a frame for each image you choose, like for example this one.

Figure 119. Frame for the image chosen

6.3.9.10 Export PDF

Using this tool you can export the composition to a PDF file:

Select "export to pdf" on the menu or click on the corresponding button of the toolbar.

Figure 120. PDF icon

This opens a dialog box in which a file name is requested: That is the file to save the resulting pdf. Once you select where you want to save the document, press the "Save" button and the PDF file will be in your PC ready to be used.

7. Conclusions

GIS has had a profound influence on geography and will continue to be used in the future as it allows people to efficiently answer questions and solve problems by looking at easily understood and shared data in the form of tables, charts, and maps. Moreover GIS technology, because of its low cost, high reliability, user friendliness and wide usefulness, will be adopted by many users outside the highly developed technological societies.

In Logistics, GIS can be a really useful and determinant tool by aggregating data such as road networks, distribution centers and retail outlets to determine the optimal allocation of routes and distribution points among others; learn how to create and analyze the information into a GIS can be an added value that gives the opportunity of making better decisions.

The gvSIG 1.12 Tutorial is an interactive document created as a learning tool, in which the main aim was accomplished, since the basic concepts were treated step by step and simultaneously the case study has been carried out, giving the user the opportunity to explore the software by himself with a permanent guideline easy to read and interpret.

With the gvSIG 1.12 Tutorial has been possible to show three important elements of a typical Geographic Information System:

- o The cartographic capabilities shown since the creation of the views and addition of layers; it is always possible to see any change made on the gvSIG project allowing the user to be located geographically by maps easy to understand and modify.
- o The data management capabilities shown in the storage of the initial information and how the software associates the information with each layer within the project generating useful data by attribute tables where it was possible to take decisions like which municipalities to choose according to the constraints of area and roads.
- o The analytical capabilities shown during the whole tutorial bringing with it the final output of a map built according to the needs, fulfilling all the constraints and giving a visual drawing from where the data mining becomes easier.

According to the official information taken from Generalitat de Catalonia and considering the constraints of roads (at least from type: A, AP, C, N) and the area of the Municipality (at least 750.00 km2) it's necessary to locate 8 bases to cover almost the 100% of the Priority Protection Areas taking into account an acceptable time of less than 14 mins of arriving from the closest helipad to the problematic area. Although is not possible to guarantee that the locations are the optimum it is guarantee that all of them fulfill all the hypothetical constraints. The case study sets the firefighting bases in the following municipalities from Catalonia region:

- o Baix Ebre
- o Ribera d´Ebre
- o Anoia
- o Valles Oriental
- o Berguedá
- o Noguera
- o Selva
- o Alt Empordá

Figure 121. Eight firefighting bases along Catalonia
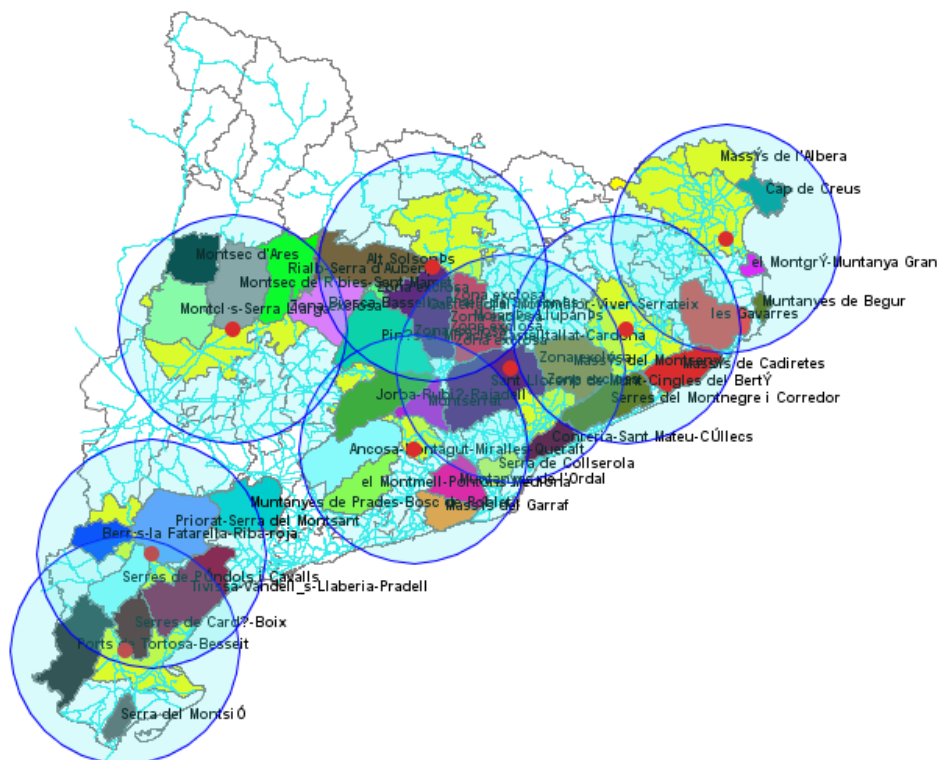
The coverage radius of the bases is constant and it was assumed of 40km, considering the operative speed of the conventional helicopter BELL 212 as 223 Km/hr as dictated by the manual; the furthest place of the zone will be covered in less than 11 mins. Despite some small areas could not be covered by the radius, using the measurement tool of the gvSIG 1.12 software is certain that in no case an helicopter will take more than the 14 mins to arrive to the problematic area.

The gvSIG 1.12 Tutorial follows a coherent order guiding the user through the different stages but letting him/her to try new and different options; of course the current document is just a base for starting in the gvSIG world and there are some another ways of getting the same results in each of the five steps; the important thing was to generate a feasible and trustable document that continues somehow with the free software knowledge policy.

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