Masters Program in Geospatial Technologies

GIS CAPACITY BUILDING FOR RISK MANAGEMENT TO HELP DEVELOPING COUNTRIES.

Case of climate change problem in Amhara rural region (Ethiopia)

Sergio Clark López

Dissertation submitted in partial fulfilment of the requirements
for the Degree of *Master of Science in Geospatial Technologies*

UNIVERSIDADE NOVA
ISEGI

UNIVERSITAT JAUME·I

WESTFÄLISCHE
WILHELMS-UNIVERSITÄT
MÜNSTER

GIS CAPACITY BUILDING FOR RISK MANAGEMENT TO HELP DEVELOPING COUNTRIES

Case of climate change problem in Amhara rural region (Ethiopia)

Dissertation supervised by

Prof. Dr. Joaquin Huerta

Department of Information Systems,
Universitat Jaume I (UJI)

Castellon, Spain.

Co-supervisors

Prof. Dr. Marco Painho

Instituto Superior de Estatística e Gestão de Informação (ISEGI)
Universidade Nova de Lisboa,

Lisbon, Portugal.

&

MSc. Mr. Pau Aragó

Department of Information Systems,
Universitat Jaume I (UJI)

Castellon, Spain.

February 2012

ACKNOWLEDGMENTS

GIS CAPACITY BUILDING FOR RISK MANAGEMENT TO HELP DEVELOPING COUNTRIES

Case of climate change problem in Amhara rural region (Ethiopia)

ABSTRACT

In the Ethiopian rural region of Amhara, variable atmospheric conditions and climate change are affecting the agricultural productivity and the consequences might be irreversible. However, scientific and technological advances nowadays can be more and more helpful to improve the situation. The purpose of the present work is to build the effective strategies that permit the utilization and integration of GIS technologies in the institutional and humanitarian works that are being carried out in the region. Our challenge will be to raise the geographical awareness and optimize the use of resources and tools in the region, involving the farmer communities as key stakeholders in the whole process. The work explains the first steps taken regarding the necessity of building GIS capacity for risk mapping, the data collection related to food security and the use of GIS technologies, being the training of the local staff the key point that leads to further steps such as the implementation of the mechanisms to share spatial information known as Spatial Data Infrastructures. By using SDI, combined with GIS software to access and manage the information, we may improve the understanding and interoperable utilization of geo-spatial data, and therefore contribute to the development of such a needy nation. All that, developed under the umbrella of an Inter-University Cooperation Program.

KEYWORDS

Developing countries

Climate change

Risk management

Food insecurity

Cooperation

Training

Capacity building

Ethiopia

Spatial Data Infrastructures

Open Source technologies

Geographical Information Systems

Interoperability

ACRONYMS

AECID – Agencia Española de Cooperación Internacional para el Desarrollo

BDU – Bahir Dar University

CAD – Computer-Aided Design

CAES – College of Agriculture & Environmental Sciences

CCA – Climate Change Adaptation

CBDRR – Community Based Disaster Risk Reduction

DEM – Digital Elevation Model

DRMSD – Disaster Risk Management and Sustainable Development

DRR – Disaster Risk Reduction

ERCS – Ethiopian Red Cross Society

FAO – Food and Agriculture Organization

FOSS – Free Open Source Software

FSF – Free Software Foundation

GHI – Global Hunger Index

GI – Geographical Information

GIS – Geographical Information Systems

GPL – General Public License

GPS – Global Positioning System

ICT - Information and Communications Technology

IIDL – Institut Interuniversitari de Desenvolupament Local

LC – Land Cover

NGOs – Non-Governmental Organizations

NSDI – National Spatial Data Infrastructures

OGC – Open Geospatial Consortium

OS – Open Source

PCI – Programa de Cooperación Interuniversitaria

RCRC – Red Cross/Red Crescent

SDI – Spatial Data Infrastrutures

UJI – Universitat Jaume I

UN-ISDR – United Nations - International Strategy for Disaster Reduction

VCA – Vulnerability and Capacity Assessment

WCS – Web Coverage Service

WFS – Web Feature Service

WMS – Web Map Service

INDEX OF THE TEXT

INDEX OF TABLES

INDEX OF FIGURES

1 INTRODUCTION

Agriculture has always been the source of subsistence for Ethiopian people and is the backbone of the national economy, employing most of the population. However, due to the poor, traditional and backward agricultural performance, millions of people still face food shortage, famine and malnutrition.

Most parts of Ethiopia suffer also from natural resources degradation that adversely affected food and agricultural productivity. In the Ethiopian rural region of Amhara, where this research is focused, the variable atmospheric conditions and are particularly affecting the local agriculture system and the consequences might be irreversible. To feed a fast growing population, agricultural productivity increase is highly required through the combination of scientific knowledge with traditional know-how. In that sense, technological advances can be nowadays more and more helpful although they highly depend on research and research in turn depends on training and education. Training is the key to the whole process and hence, it takes up a large part of the work presented. (BDU, 2010)

Red Cross Climate Center organization and Bahir Dar University are working in the affected area focusing in a farmer to farmer learning model in order to promote the farmers adaptation to climate change.

The work described in this thesis is just a small part of a major cooperation project where various stakeholders are involved. Red Cross Climate Center organization, Bahir Dar University and Universitat Jaume I are collaborating with the common goal to improve that situation. Our challenge is to analyze how local organizations can use and benefit of GIS technologies for disaster management, food security and related issues.

By training local staff in the use of GIS technologies and tools to gather data and manage the information, we would be able to increase the understanding and interoperable utilization of geo-spatial data, optimizing the existing geographical resources in the region. Therefore, most of the effort will be directed to the capacity building of the local team for the collection of new data, taking into account that the lack of available data in Ethiopia is one of the limitations in that sense.

1.1 PROBLEM DEFINITION

In Ethiopia, chronic food insecurity affects 44% of the population, according to the estimates for 2006 there were 35 million undernourished people (FAO, 2009). With more than 80% of the population living in rural areas (Central Statistical Agency of Ethiopia, 2008), entailing high structural food insecurity, Ethiopia has strong agricultural potential. However, the Plan for Accelerated and Sustained Development to End Poverty of the Ministry of Finance and Economic Development emphasizes that although productivity has increased in recent years, production is still well below the desired level.

Recurrent drought, degradation of natural resources and rapid population growth are among the main causes of declining per capita food production (FAO, 2006). The northern rural region of Amhara is not an exception to the problem, and several international and local organizations are working to improve the situation in that area.

Given the potential of geospatial technologies to monitor analysis and manage spatial data, the question that arises is how those kind of technologies can help on improving such a situation. In order to start an analysis of the needs and integrate GIS technologies on this process spatial data are needed. However, the lack of data related to risks and food security in Ethiopia is one of the greatest handicaps today. Thus, the collection of data is an important task of this project. On that purpose, a technical training needs to be developed with the local team as target, having in mind that they are specialist in risk management, but they are not in the use of GIS technologies and tools. The establishment of a GIS laboratory that involves the participation of people at risk may be the starting point of a big revolution.

1.2 MOTIVATION AND RATIONALE

In the election of the present study several aspects have been taken into account:

- ✓ The practical application of knowledge acquired in the academic phase of the Master, especially in subjects related to GIS Applications, Digital Cartography, Remote Sensing or Computer Science.
- ✓ That the project is real, and not only that, it also serves to help a real problem of humanitarian character that affects many people today.

- ✓ The topic of the research, which belongs to the student's interest field in which he would like to focus his future career.
- ✓ The existing synergy within the Universitat Jaume I (UJI), that permitted the collaboration between different departments.

1.2.1 Relationship with IIDL and BDU

This work is a collaboration between various actors: in one hand, the Institute of New Imaging Technologies and the Local Development Interuniversity Institute (IIDL), both belonging to UJI; on the other hand, the Bahir Dar University (BDU). This partnership has been possible through an Inter-university Cooperation Program (PCI) which is funded by the Agencia Española de Cooperación Internacional para el Desarrollo (AECID) and also assisted by the UJI International Cooperation Program.

Taking advantage of the existing synergies within the UJI, a collaboration with the IIDL was set up. This Institute was already working on a big cooperation project in the same area of action than ours, with the objective of reducing the food insecurity in the north regions of Ethiopia. The project title is: *Strengthening the Centre for Research and Community Service in Disaster Risk Management to improve food security and agricultural productivity in the Amhara Regional State, Ethiopia*. It is composed by four different activities, as it is explained in the next section. One of those activities is the training of local staff in the GIS field. That was the main reason to decide to join efforts and work together, helping them in the GIS activity that should be developed.

1.2.2 Relationship with RC/RC Climate Centre and ERCS

The Red Cross/Red Crescent (RC/RC) Climate Centre, with basis in the Netherlands, was established in 2002 to develop tools and strategies to integrate the new challenges and opportunities presented by climate change into the humanitarian work of the RC/RC. Its aim is to reduce the vulnerability of people to the impacts of climate change and extreme weather events. (Qadir, 2009)

Mr. Pablo Suárez, an Associate Director of programmes at RC/RC Climate Center, contacted the UJI with the aim of getting support and technical advice from the Geospatial Technologies Research Group. He wanted UJI to help RC/RC on the

issue of how to include GIS capabilities in the humanitarian processes in order to improve the decision making and therefore reduce the risks related with climate issues. P. Suarez's work as researcher and consultant focuses on the integration of climate information into decision making for reducing vulnerability in Africa, and he is also in charge of the coordination of audiovisual work and projects in North and East Africa, where Ethiopia is located.

Both UJI and RC/RC began to think of ideas and actions willing to help to improve the situation from a technological point of view. Several videoconference meetings were held and some guidelines regarding the type of actions to take were decided. Taking into account the small amount of economic resources available and the fact that various organizations will participate in the project, the idea of using free open source software came out for the first time.

In this regard, as a link with the UJI team in the study area will act, together with the BDU, the Ethiopian Red Cross Society (ERCS). The ERCS was established by government decree in 1935, after the second Ethio-Italian war, beginning its involvement in humanitarian services. Today, the ERCS has 11 regional offices, 27 zone branches, 50 *woreda* branches and over 1500 *kebeles* all over the country. This network enables the national society to run activities and deliver services at all levels.

The clear understanding of local realities and needs by the ERCS permits to develop relevant programmes that have real impact on the communities. The ERCS manages and implements four core programs; being the *Food Security & Disaster Preparedness/Response* the more related with the present research work. A change in climatic conditions as a result of environmental degradation has proven to have a humanitarian impact on food security, access to clean water, increased vulnerability to diseases and shelter. Hence, the ERCS realizes the necessity and importance of disaster preparedness and response in times of natural catastrophes (ERCS website).

1.2.3 Background and study area

In order to understand the problem that we are facing, a summary of the situation in Ethiopia and particularly in the region of Amhara is given next.
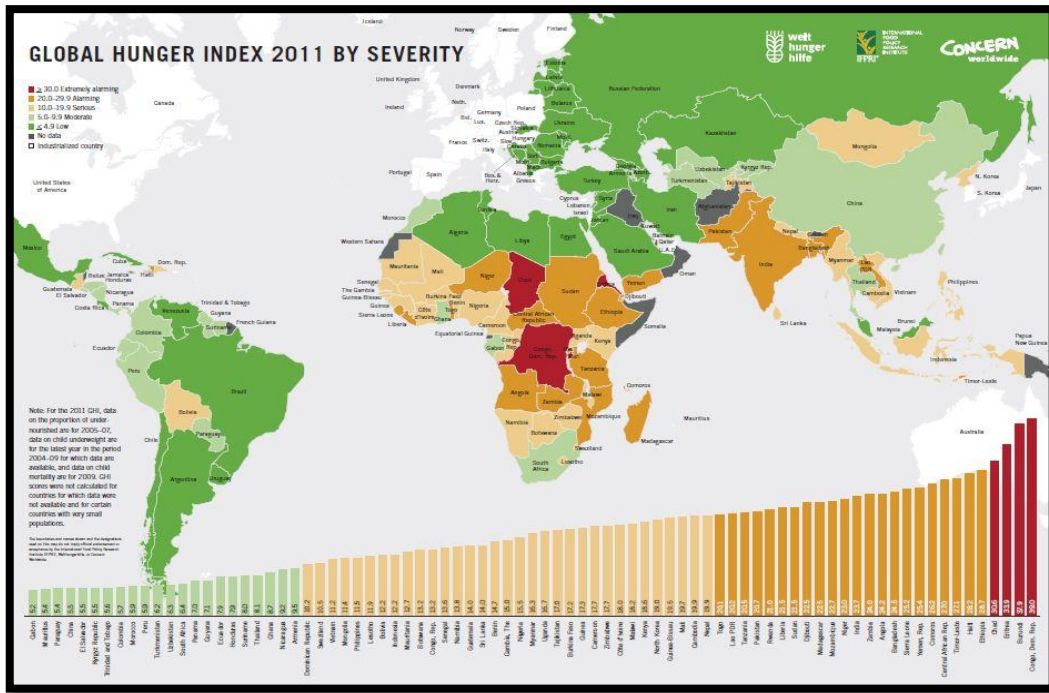
Figure 1. Global Map of Hunger Index of 2011 (IFPRI)

The International Food Policy Research Institute (IFPRI) has recently published the Global Map of Hunger Index of 2011, shown in Figure 4 above. The GHI is based on three indicators: the proportion of undernourished population; the prevalence of underweight in children; the under-five mortality rate. Ethiopia occupies the position 77 out of 81 being in an "alarming" situation and it is, indeed, the world's most food aid dependent country (Clay et al., 1998).

Administrative divisions

Ethiopia is divided into 9 ethnically-based administrative regions (*kililoch*) or Regional States. The *kililoch* are subdivided in 68 zones. These zones are subdivided in around 550 *woredas*. A *woreda* is equivalent to a district, managed by a local government. The *woredas* are composed of a number of *kebele*, the smallest unit of local government (neighbourhoods).

Geography and climate

Ethiopia is located in the Horn of Africa and covers around 1.1 million square kilometres. It has a population of over 85 million, making it the second most populous country in Africa. Within Ethiopia is a massive highland complex of mountains and dissected plateaus divided by the Great Rift Valley, which runs

generally southwest to northeast and is surrounded by lowlands, steppes, or semi-desert. The great diversity of terrain determines wide variations in climate, soils, natural vegetation, and settlement patterns (Qadir , 2009).

Ethiopian climate varies according to the different topographical regions. The central plateau has a moderate climate with minimal seasonal temperature variation. The mean minimum during the coldest season is 6° C, while the mean maximum rarely exceeds 26° C. Temperature variations in the lowlands are much greater, and the heat in the desert and Red Sea coastal areas is extreme. Heavy rainfall occurs in most of the country during June, July, and August. The High Plateau also experiences a second, much milder, rainy season between December and February. Average annual precipitation on the central plateau is roughly 122 cm and it decreases in the northern provinces. Severe droughts affected the country in 1982–84, 1987–88, and 1991. (Encyclopedia of the Nations, 2011). To those, we can add the current drought of 2011, considered the worst in the last sixty years (Reuters, 2011).

Amhara region
The Amhara region is one of the nine ethnically-based administrative regions of Ethiopia and is located in the north western and north central part of the country. It covers an area of about 170,000 square kilometres and has a population of about 17.2 million (according to the 2007 census). The region is very poor with standard of living indicators that are quite low. Only 28% of the population has access to potable water, 17.5% of the inhabitants fall into the lowest wealth quintile and the infant mortality rate is extremely high.

The Amhara Region has very complex terrain with altitude ranges from under 500 to 4620 meters above sea level. About 25% of the region comprises the northwestern lowlands, the vast stretch of lower river valleys and deep gorges with altitude ranges from 500-1500 meters above sea level. More than 50% of the region constitutes the mid highlands areas between 1500-2500 meters above sea level. The remaining 25% are the extensive high plateaus and mountains (2500-4620 meters altitude). Most rivers and streams originate from these highlands and drain most areas of the region.

The region's climate varies corresponding with variation in altitude. Low altitude areas are hot or warm semi-arid areas with mean annual temperature ranges from 20-

30ºC and mean annual rainfall ranges from 400-900 mm. Areas between 1501-2500 meters altitude are cooler sub-temperate areas with mean annual temperature ranging from 16-21ºC and mean annual rainfall ranges from 1000-1600 mm. Areas above 2500, are even cooler with mean annual temperatures ranging from 7-15ºC and have an on average above 1200 mm annually (Qadir, 2009).

Drought and seasonal flood are the main hazards which affect hundreds of thousands of people living in the middle and lower courses of the rivers as well as around Lake Tana in this region.
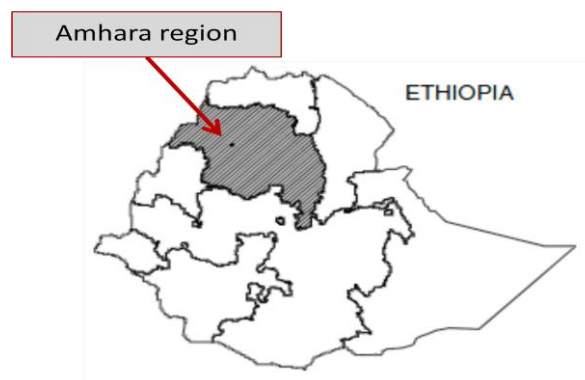
Figure 2. Map of regions in Ethiopia.

Ebinat woreda

Ebinat *woreda* is located in the South Gonder administrative zone with elevations ranging from 1800-2150 meters. It is located 122 kilometres from Bahir Dar, the capital of the Amhara region and 714 kilometres away from Addis Ababa. Of the 249,427 hectares of land in Ebinat, 62,350 hectares are cultivable and 37,846 hectares are designated grazing lands. Ebinat has a total population of 259,053 (census 1996). There are 35 rural *kebeles* and 2 urban *kebeles* included in the *woreda*. 93.8% of the total population resides in rural areas. Livelihoods are predominantly agriculture based, with 97% of the population earning from mixed farming (crop and livestock production), 3.35% from wage labour and 1.25% from petty trading. Crops grown include teff, chickpea, barley, maize, sesame, sorghum, lentils, beans, wheat and potatoes.
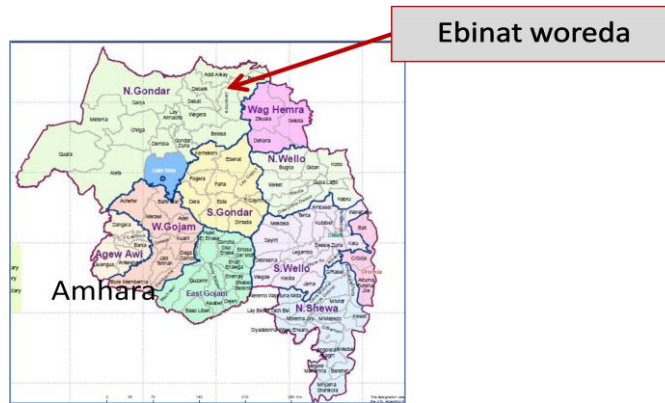
Figure 3. Map of *woredas* (districts) in the region of Amhara.

The figure below shows average precipitation based on station data collected from the National Meteorological Services Agency (NMSA). However, a very short data record was available and therefore this graph is not very representative.
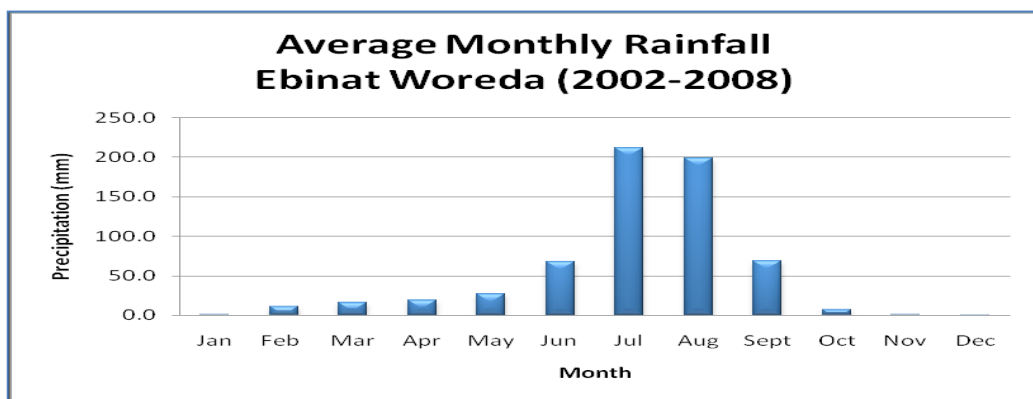
Figure 4. Average monthly rainfall in Ebinat *woreda* (2002-2008).

Fogera woreda

Fogera *woreda* is part of the Debub Gondar Zone. It is located 50 km East from Bahir Dar and Lake Tana. The altitude ranges from 1774 to 2415 meters above sea level and rivers include the Gumara and the Reb, both of which drain into Lake Tana. The land is 44.2% arable or cultivable and another 20% irrigated, 22.9% pasture, 1.8% forest or shrub land, 3.7% covered with water, and the remaining 7.4% is considered degraded or other. Teff, corn, sorghum, cotton and sesame are important cash crops. Fogera is also known for its cattle, which is one of the best milk cows in Ethiopia. Around 490 square kilometres of land adjacent to Lake Tana is subject to regular and severe flooding. Besides, malaria epidemics, crop pests and

animal diseases are other disastrous events. The major causes of floods in the area are overflow of Rib river and increase in the water level of Lake Tana. Fogera was heavily affected by the floods in the past two decades caused by the overflowing of Lake Tana.

Future impacts

It is estimated that the temperature has been increasing annually at the rate of 0.2°C over the past five decades. This has led to a decline in agricultural production and biodiversity, shortage of food and increases in human health problems, rural-urban migration and dependency on external support. Factors compounding the impact of climate change in Ethiopia are rapid population growth, land degradation, widespread poverty, dependency on rained agriculture, lack of awareness by policy and decision-makers about climate change and lack of appropriate policies and legislation. (Qadir, 2009)

1.3 AIM AND OBJECTIVES

To address the above mentioned problem, the overall goal of the thesis is to reduce the risk of climate change-induced disasters and food insecurity by optimizing the awareness and utilization of geospatial data in a proper way by the local community. Therefore contribute to the development of the rural areas in the Ethiopian region of Amhara by promoting the use of GIS technologies in order to help to increase agricultural productivity.

To achieve this goal, the following specific objectives have been formulated. Related to GIS:

- ✓ Analysis the gaps and constraints to effectively utilizing data and information within a GIS to inform decision-making, defining the specific conditions and needs in the region.

- ✓ Collaborate with the University of Bahir Dar (Amhara region capital city) supporting the establishment of a GIS Laboratory in their campus, in terms of equipments, software and training.

- ✓ Contribute to increase the awareness of the available geographical and map information among the local community in the region of Amhara.

- ✓ Lead training courses/workshops of GIS software at BDU so that they can manage the geographical information in a better way, improve their knowledge on this field and spread it to other actors, with the aim that the applications of GIS competencies could be useful for facing food security issue.

- ✓ To promote the creation of a future joint teaching e-learning program on GIS and food security.

- ✓ Help to implement a simple Spatial Data Infrastructure with the existing data in the region in order to improve the access to them, using Open Source technologies as a priority.

- ✓ To support BDU in the introduction of activities for rural community development, such as hazard/vulnerability mapping and data collection to promote food security in the Amhara Region, with the participation of local representatives (small farmers and associations) who will act as multipliers in their communities.

At the same time, other objectives are tangential to GIS:

- ✓ Strengthen BDU's Centre for Research and Community Service in Disaster Risk Management

- ✓ Help in the integration of humanitarian issues into the work of the GIS team at BDU by strenghten the collaboration between them and the ERCS.

- ✓ Contribute to the development of the region of Amhara, making geo-information work for the local development by helping decision making.

- ✓ Share the knowledge within the Geographic Information Community by participating in meetings where we can share our experiences.

1.4 THESIS STRUCTURE

The thesis structure is divided into five main chapters. The present chapter explains the problem faced and the objectives of the research work. The rest of the thesis is arranged as follows:

Chapter 2 is allocated to describe the Inter-universitary Cooperation Project being held and the relationship of the different actors involved on the project. Some background and literature review about Risk Management is described as well.

Chapter 3 starts analysing the current situation regarding GIS in the study area and then illustrates the methodology used to improve the weak points, with focus on the establishment of a GIS laboratory at the Bahir Dar University. The necessary steps followed to achieve this goal are described, starting with the required equipment, the choice of a specific GIS application, briefly reviewing various existing GIS software, and following by the development of the GIS training. Straight after, the spatial data availability and data collection is described, continuing with the explanation of a real use case that has been carried out. Finally, this chapter shows the further step of implementing a SDI to optimize the data access, giving some definitions and principles on that.

Chapter 4 presents a discussion about the whole process and findings, giving recommendations for future work. Chapter 5 concludes the research work by discussing whether the objectives have been accomplished or not.

Additionally, it has been included Appendices from A to G to support the argumentations of this research.

2 HUMANITARIAN COOPERATION AND RISK ASSESSMENT

In order to address the problem properly a literature review process has been carried out and a background description of both humanitarian and technical aspects of big relevance for the present study are given next.

2.1 INTER-UNIVERSITY COOPERATION PROGRAM

As stated, the present Master research is part of a major cooperation project held by the IIDL, attached to UJI. This Institute is working on a Inter-university Cooperation Program (PCI) that includes four main activities, being one of those the GIS training of the local staff at BDU in Ethiopia. In the next paragraph, the PCI is described.

According to *The Food Insecurity in the World* report by FAO there is still a long way to go to achieve the second aim of the first Millennium Development Goal of halving the percentage of people suffering from hunger between 1990 and 2015.

The collectives in situation of structural vulnerability include, among others, small farmers and agricultural workers, a significant fact for an essentially rural country such as Ethiopia. In view of this situation and the experience acquired with a previous PCI in 2009, the College of Agriculture & Environmental Sciences (CAES) at BDU and the IIDL at UJI, organized a participatory workshop at BDU (June 2010) to continue working together, by means of a new PCI.

The general objective established for the PCI is to contribute to improve food security and agricultural productivity in the Amhara Region by strengthening BDU's Centre for Research and Community Service in Disaster Risk Management, promoting its competences in teaching, research and university extension, with the aim to consolidate a joint BDU/UJI academic group on local risk management.

Four main complementary activities have been established to achieve the planned results: inter-university research to increase agricultural productivity, improvement of BDU teaching staff competences in food security and BDU extension at two levels (local and regional/state). For this purpose, an interdisciplinary team has been formed

of various departments from the two universities and with a group of specialists in the different areas.

Regarding schedule, a four year intervention has been planned (2011-2014) starting with teacher training, the introduction of activities and the acquisition of equipment required to achieve the objectives. The PCI work plan is organised around four Work Groups corresponding to each of the activities:

- ✓ Work Group 1. Research to increase agricultural production.
- ✓ Work Group 2. GIS capacity building.
- ✓ Work Group 3. Training and advice to community bodies (local level).
- ✓ Work Group 4. Networking with development actors.
- ✓ Work Group 5. Gender mainstreaming

The Activity 2, GIS capacity building, is actually the bulk of this thesis research. This activity includes the following actions:

- Periodical workshop on GIS at BDU for teachers and students from the CAES, increasing in complexity every year.

- Training visits to UJI: a teacher from BDU's Department of Risk Management and Development visits UJI each year.

- Acquisition of GIS equipment and technologies for the laboratory.

- E-learning seminar on GIS and food security, whose beneficiaries will be the students from BDU's Master's Degree in Disaster Risk Management and Development and possibly UJI students as well.

To monitor the project, online monthly follow-up, videoconferences and production of reports and periodical visits to BDU from the UJI staff are carried out. In that sense, the first steps of the PCI are already having a positive impact, rebounding on CAES students, other BDU units and rural communities which are receiving training and advice. Applying the expertise arising out of the project is expected to contribute to the rural development in the Region. Moreover, the project is contributing to the gradual consolidation of collaboration between the two universities that share a common objective.

As a parallel fact, and in response to the growing need to build disaster-resilient communities, it has been established a postgraduate program in Disaster Risk Science and Sustainable Development (DRSSD) at BDU that includes the institutionalisation of risk management as the key to minimising the vulnerability of people living in low productivity agricultural areas. In addition, there is a plan to promote the use of Information and Communications Technology (ICT) for e-learning, research and knowledge dissemination and exchange, in order to boost the Centre capacity to offer support services to community representatives and risk management specialists.

2.2 DISASTER AND RISK MANAGEMENT

The RC/RC National Societies work with communities to reduce risk, mitigate the effects of, prepare to respond, respond to and recover from disasters.

Disaster Management can be defined as the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to lessen the impact of disasters (IFRC, 2010).

The first people to respond to a disaster are those living in the local community. The RC/RC National Societies therefore focus on community-based disaster preparedness, which assists communities to reduce their vulnerability to disasters and strengthen their capacities to resist them.

In this regard, the BDU team is currently working with community leaders through several activities planned for the present work: data collection, identification of hazards and vulnerabilities and preparation of risk maps.
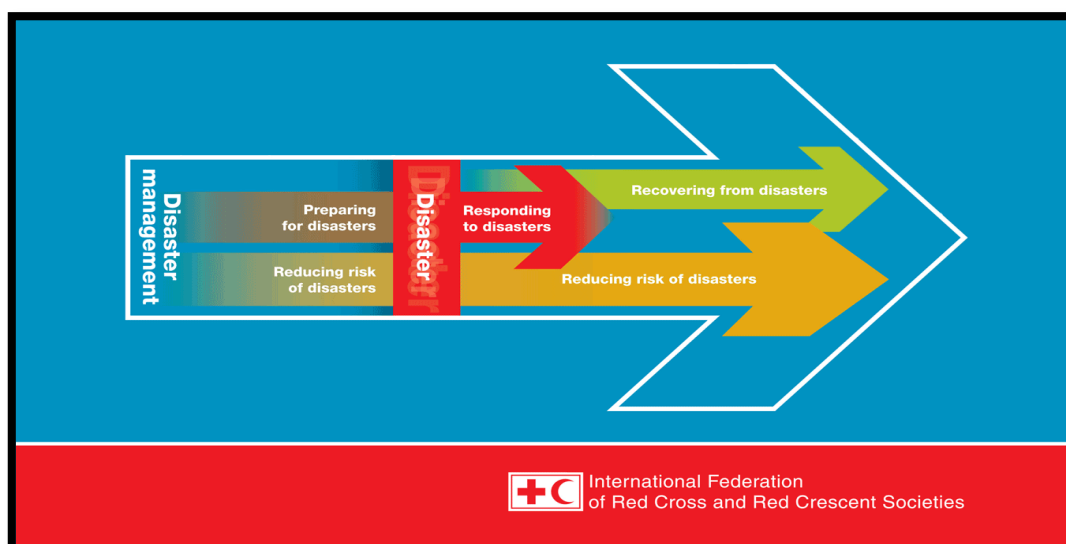
Figure 5. Disaster management diagram (International Federation of Red Cross and Red Crescent Societies)

Assessing Risk, Hazard and Vulnerability

The risk assessment is a methodology to determine the nature and extent of a risk by analysing potential hazards and evaluating existing vulnerabilities that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend (UN/ISDR, 2004). Risk assessments typically include physical, social, economic and environmental factors and consequences.

Hazard and vulnerability assessments utilize formal procedures that include the collection of primary data, monitoring of hazard and vulnerability factors, data processing, mapping and social survey techniques.

Hazard assessments aim to identify the probability of the occurrence of potentially damaging physical events or human activities that may cause loss of life, injury, damage, disruption or environmental degradation (UN/ISDR, 2004).

Vulnerability assessments determine the extent of harm expected under certain conditions of exposure, susceptibility and resilience (UNESCO-IHE, 2011). The UN/ISDR defines vulnerability as "the conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards" (UN/ISDR, 2004).

Risk can be regarded in terms of the likelihood of an event occurring and the impact (or consequence) of the event if it occurs (ISO 31000, 2009). Conventionally, risk is expressed by the notation (UN/ISDR, 2004):

Risk = Hazards x Vulnerability

Related to the risk management, **Vulnerability and Capacity Assessment** (VCA) uses various participatory tools to gauge people's exposure to and capacity to resist natural hazards (IFRC, 2011). It is an integral part of disaster preparedness and contributes to the creation of community-based disaster preparedness programmes at the rural and urban level. VCA enables local priorities to be identified and appropriate action taken to reduce disaster risk and assists in the design and development of programmes that are mutually supportive and responsive to the needs of the people most closely concerned. The aims of VCA are to:

- assess risks and hazards facing communities and the capacities they have for dealing with them;
- involve communities, local authorities and humanitarian and development organizations in the assessment from the outset;
- draw up action plans to prepare for and respond to the identified risks;
- identify risk-reduction activities to prevent or lessen the effects of expected hazards, risks and vulnerabilities.

VCA is complementary to national and sub-national risk, hazard, vulnerability and capacity mapping exercises that identify communities most at risk. A VCA is then undertaken in these communities to diagnose the specific areas of risk and vulnerability and determine what action can be taken to address them.

As VCA is a participatory process, National Societies can develop realistic activities that are better suited to local needs and priorities. As one National Society member stated after undertaking a VCA: *"Before, we used to work for people, but now we work with them."* (IFRC, 2011).

In the case of Amhara region, VCA has been applied in the past and some results can arise. From previous studies we know that farmer community is aware of the existing risks and vulnerabilities in their regions (Qadir, 2008). In that work, rural

communities in Amhara were told to map and rank the risks that affect them through several mapping participatory exercises and the results in order of priority were as follows:

1. Drought
2. Human health problems (malaria and diarrhea)
3. Livestock diseases
4. Reduced productivity of livestock due to climate changes
5. Lack of access to improved crop species
6. Absence of a high school
7. Lack of adequate agricultural implements
8. Shortage of potable water
9. Lack of roads that connect with neighbouring *kebeles*
10. Shortage of cultivatable land

To continue engaging farmers and using VCA participatory tools, BDU team is at present developing training and advice programs for the Fogera and Habru rural communities, as discussed in section 3.3.4.

3 METHODOLOGY AND WORK PLAN

As a GIS specialist, my role in this project will consist on analyse the situation and give the required technical assistance to the BDU and ERCS staff. That is, to find the most efficient ways of using G.I. from the different types and options of geospatial technologies that exist and to build the necessary capacity so they can be applied in the local communities.

The main duties and time has been spent on the analysis of the GIS needs for the GIS lab, the design of the system and process to establish this lab, the preparation and implementation of the training actions, the technical support and the coordination of GIS components.

However, it is a complex issue to work from Spain trying to deal with a problem happening more than 5000 kilometres far away. Even if a frequent contact is held between the different actors, there is always something missing. Therefore, some decisions regarding how to reach out efforts were taken. In one hand, it was decided that the different activities to develop had to reach a consensus within the BDU, which is physically located in the affected region, placed in fact at the capital city of Amhara, thus nobody better than BDU team to be the focus of those activities. The second issue was about a possible visit of the UJI team to the affected region. It was thought as a necessary action to actually work with efficiency. Finally, the visit was planned and the dates were fixed. A multidisciplinary team from UJI was planned to travel to Bahir Dar and rural areas of Amhara in order to check directly in the field what the situation was. It was expected to be a good opportunity to meet the BDU project coordinators and responsible. This team was composed by the PCI coordinator, Rosana Peris, the technical coordinator Isabel Gimenez, and myself as a GIS specialist.

Previous to the visit to Bahir Dar, an analysis of the situation at BDU was carried out in order to study the gaps and necessities they had. From that study, a GIS planning was designed adapting it to the reality of BDU and willing to achieve the objectives of the project. Of course, once UJI team has arrived to BDU, the plan has been

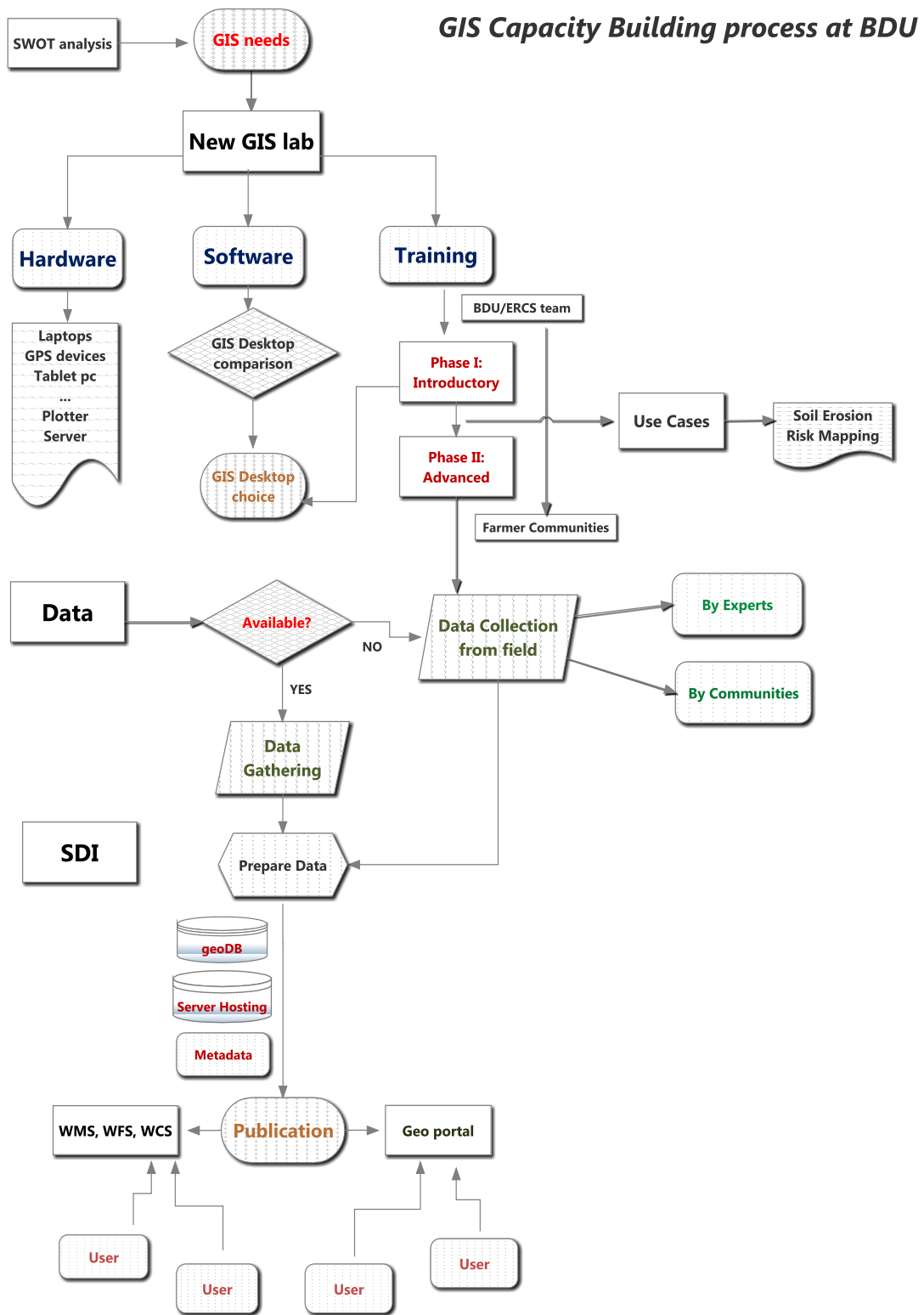adequated to the actual situation. A flowchart diagram with the process can we found next:

Figure 6. Flowchart diagram. GIS plan process.

3.1 ANALYSIS OF GIS SITUATION

In order to describe the situation regarding GIS capacity at BDU and in Amhara region in general a SWOT matrix has been built.

SWOT analysis is a strategic planning method used to evaluate the **S**trengths, **W**eaknesses/Limitations, **O**pportunities, and **T**hreats involved in a project. It involves specifying the objective of the project and identifying the internal and external factors that are favourable and unfavourable to achieve that objective.

- **S**trengths: characteristics of the project team that give it an advantage over others
- **W**eaknesses (Limitations): characteristics that place the team at a disadvantage relative to others
- **O**pportunities: *external* chances to improve performance in the environment
- **T**hreats: *external* elements in the environment that could cause trouble for the project

Identification of SWOTs is essential because subsequent steps in the process of planning for achievement of the selected objective may be derived from the SWOTs. The SWOT analysis is often used in academia to highlight and identify strengths, weaknesses, opportunities and threats. It is particularly helpful in identifying areas for development (Wikipedia, 2011).

Strengths	Weakness
- Local team is keen to collaborate and it is willing to improve - English is well spoken in the country - New GIS lab already built - It already exist a Training program for rural communities	- Lack of proper internet connection - Uncoordinated departments - Slow communication - Very old facilities - Lack of awareness on GIS - Lack of spatial data - Communication channels between Rural Communities and BDU are not well established
Opportunities	Threats
- New technologies market growth trend despite of global crisis - Open Source technologies not	- Reduction of funds for cooperation projects in the future - Worsening of climate situation - Spread of terrorism from neighbour

	yet established there • There is a need to analysis the climate and agricultural data from a geospatial perspective • Spatial information is under-used	territories

<div align="center">Table 1. SWOT matrix for GIS capacity building project.</div>

One of the main strengths of the project is that the team at BDU is keen and open to collaboration and they are quite open to new ideas and actions by UJI part. We can see that they really are willing to improve their situation, not only at the level of University but also with regard to the rural areas that they work with.

Also, a positive point is the language spoken. English is well spoken by most of them and in general in the whole country, except in some specific rural areas where only Amharic or local languages are spoken.

While Risk Reduction and Disaster Management is a discipline well known at BDU and they count on wide expertise, regarding GIS there is a lack of training and their knowledge on this field is very limited.

Regarding the GIS facilities, the new GIS lab is already built at the moment of our visit to BDU. Nevertheless, it is not still ready to use. In terms of hardware and software the work is almost done but there is still much work to do regarding data collection and capacity building. Indeed, one of the biggest gaps of the project is the lack of spatial data available. Therefore, the training to the BDU team for the collection of data in the field by using the new GIS equipment has been started.

From an institutional point of view, a training program to help rural communities has already been set up at BDU. However, the communication channels between those communities and the BDU team is not yet properly established and it lacks of the effectiveness that is expected to achieve.

As weakness of the project, we can consider the fact that different departments within the BDU and, above all, different regional or national institutions are completely uncoordinated among them, and that results on a lack of interoperability and sometimes a duplication of efforts. The communication is often slow, due to

several factors: lack of facilities, more relaxed way of life, etc. In that point it is worth to remark the very old facilities existing at BDU and specially the lack of proper internet connection, reduced to a couple of cable connexions inside the instructors offices. That makes communication and access to online resources almost impossible for the main public.

Opportunities of the project could be the fact that the technological market is nowadays in a growth trend despite of the world global crisis. In that sense, it is expected an explosion of the internet and the new technologies in Ethiopia (and Africa in general) in a few years as it happened in Europe or US in the past two decades (James, 2007).

Regarding OS technologies, they are not strongly established in the region for the moment, but we believe those technologies can be very helpful in such a context so our intention is to promote them when possible.

Moreover, the need to monitor, visualize and analyse the climate and agricultural data from a geospatial perspective is a fact. To geo-locate the real attributes existing in the field and make analysis and decisions based on them has become a must from a humanitarian and institutional point of view. However, the spatial information is currently under-used.

Three serious threats are present in the project. In one hand, the global crisis in the first world is causing a important reduction of funds for cooperation projects in the future. In fact, in our own country, Spain, those funds have been reduced and almost disappeared in many cases, (Intered, 2011). That is actually an important break to the development and continuity of the project.

A second threat might be the worsening of the climate situation. The current drought in the Horn of Africa is considered as the most severe of the last fifty years and if it continues in the next months, it would aggravate the already damaged rural areas of Amhara region (Reuters, 2011).

The third important problem is related to terrorism actions within the borders and neighbour territories, such as Somalia and Eritrea conflicts, where some recent actions such as the kidnapping of NGO international aid workers are making difficult

the establishment of new actions and consolidation of the existing ones (UN News Centre, 2011).

Current use of GIS

During our stay in Ethiopia (November 2011), and particularly in the city of Bahir Dar, we had the opportunity to be in direct contact with the BDU staff, who explained to us firsthand what was at that time the situation and use of GIS at their Departments. Regarding GIS knowledge and training, the situation so far is that an introductory course in GIS is offered to undergraduate students at BDU. We were told that fifty to sixty students complete the course each year. Also several university staff members are trained in GIS. In fact, a GIS training seminar was already carried out at BDU in June 2011 by the University of Dacca (Bangladesh). This fact might serve as a basis for the GIS training we were continuing. The other main stakeholder involved - ERCS team – was not yet trained on the use of GIS technologies in any way.

Staff at the BDU Department of Risk Reduction (DRR) is currently focused on two geographic areas in the Amhara Region, where Bahir Dar is the city capital. These areas correspond to two different *woredas*, Fogera and Habru, and the action plan is to train the rural communities living there on the production of hazard and risk maps. Both *woredas* are currently drought and conflicts have been taking place recently. The DRR program has partnered with the Amhara Food Security Bureau and Disaster Prevention Office in carrying out this research.

By his part, the ERCS is more focused on the Ebinat *woreda*. One of our objectives is to approach both institutions, BDU and ERCS so they can share their experiences and knowledge and join efforts with the common goal to help and give advice to the rural communities, in special on those three areas selected at this moment.

3.2 GIS ACTION PLAN

In order to improve the current situation with regard to GIS and technology in general and dealing with the existing gaps and weakness detected, a methodology with the steps to be taken has been performed. This is a very important task of the present work, since it will serve as a basis to develop the needed actions to achieve

the established objectives of this research. Some of those actions, described in the following paragraphs, have already taken place while some other are still in the first stages of implementation at the moment when this thesis is written.

3.3   GIS LABORATORY AT BDU

At the moment of our visit, a new and more modern GIS laboratory was being built. It was placed in a different Campus and the BDU team plan was to move there during the coming months, when it will be ready in regard to installations, hardware and other issues. The currently existing GIS-lab, where we hold our GIS seminar, was composed by eight computers and a projector was given to us to help during the seminar.

Figure 7. Facilities in the GIS current lab at BDU. (personal pictures)

A second visit to BDU by members of UJI GIS experts is planned for the current year 2012, once the new GIS-lab building will be totally finished. Again, software and data installations will be done and new GIS workshops will be held as a continuation of the one held during November 2011.

Development organisations are also expected to benefit through availability of improved information for decision making and preparedness. Local NGOs currently send requests for specific research to be carried out by students of the DRR program. The GIS lab will also be used by student researchers.

Geographic Information Systems are generally made up of four components: software, hardware, staff, and data (NYS GIS Plan, 2008). In order to set up the new GIS lab at BDU, those necessary components need to be covered. GIS hardware, software and data sets will provide capacity-enhancing tools for the communities to use in decision-making and project development. A description of these components and the process is given next.

3.3.1 Hardware

The acquisition and provision of new equipment to BDU is one of the tasks to accomplish in order to achieve the objective of the new GIS lab establishment. It has been done in different phases. In September 2011, a laptop with GIS tools installed on it was already delivered to the representative from BDU during his visit to UJI. On the other hand, during our visit to Bahir Dar, a second laptop and a tablet pc was delivered to BDU representatives.

In December 2011, after our return to Spain, seven more tablets have been sent to BDU, ten notebooks and two more laptops. It is also scheduled to send a plotter and two projectors. The tablet pc counts on GPS reception for improved collection of data from the field. Moreover, they are being used as text processor to read and edit documents in the field. GIS software *gvSIG mini* has also been installed in order to allow them to visualize maps and connect to online resources while being in the field. They have camera as well, so pictures could be taken in the field while rural community training is being held. In fact, this has been their first use so far, according to the feedback that we receive from the BDU GIS coordinator.

One of the main problems found at BDU during our stay has been the lack of proper internet connection. So far, they are using cable connexion for that, and only a few of them are available in the offices. Thus, with the aim to improve that situation, ten Wi-Fi antennas have been sent in December 2012 and have arrived one month later.

In total, the equipment provided so far is listed as follows:

- 8 Tablets (with GPS and 3G reception)
- 2 GPS receptors
- 10 Notebooks
- 2 laptops
- 10 Wi-Fi routers
- 1 Plotter (with 2 ink chargers)
- 2 projectors
- Several books and eBooks

Figure 8. Delivery of technical equipment from UJI to BDU team, Bahir Dar. (personal pictures)

3.3.2 Software

Before our visit, the knowledge about GIS at the BDU was quite poor. As discussed, in very few of their disciplines, such as the Master of Disaster Risk Management and Sustainability program, the students had a limited awareness of what GIS was used for, due to the introductory course mentioned.

Therefore, this was the moment to choose a GIS software that could perform and meet the requirements and existing needs into the GIS lab and the BDU in general. That is, summarizing, to cover functionalities such as the visualization of spatial data of different formats, the analysis and processing of those data, the creation of maps to be printed and other specific task that are explained in the training course document found in the Appendix 1.

Some literature was reviewed to compare among several GIS software regarding license, platforms and other variables. A summarizing table can be found in the Appendix E of the present document.

Talking to The reality is that proprietary software has been dominating the software landscape to the point that it is today considered as the only possible model by many people. Only recently has the software industry considered free software as an option again.

In that sense, Weeler (2007) remarks the importance of considering the option of using Open Source Software / Free Software (FOSS) when looking for software for a project and so was done in this case. In his words, "the total cost of ownership for FOSS is often far less than proprietary software, especially as the number of platforms increases".

Open source software (OSS) is software whose source code is published and made available to the public, enabling anyone to copy, modify and redistribute the source code without paying fees (Open Source Initiative). On the other hand, the Free Software Foundation (FSF) defines 'free software' the one that fulfil the "Free Software Definition", which grants four freedoms:

1. The freedom to run the program, for any purpose.
2. The freedom to study how the program works, and adapt it to your needs.
3. The freedom to redistribute copies so you can help your neighbour.
4. The freedom to improve the program, and to release your improvements to the public, so that the whole community benefits.

The opposite domain to 'free software' is not 'commercial software', where 'commercial' indicates that the software is sold or used to make a benefit, but 'proprietary software', where 'proprietary' indicates ownership.

OSS is linked with licenses. The license under which a program is distributed defines the rights which its users have over it and this is of great importance. Usually, the conditions specified in licences of open source software are the result of a compromise between several goals: guarantee some basic freedoms (redistribution, modification, use) to the users, ensure some conditions imposed by the authors (citation of the author in derived works, for instance) and guarantee that derived works are also open source software. The licenses can offer different degrees of protection of the four freedoms seen before. The fact is that almost all open source software uses one of the common licences (GPL, LGPL, Artistic, BSD-like, MPL), being the General Public License (GPL) the most protective in a positive sense, since it guaranties all four freedoms.

As stated, the main advantages of using OSS are the absence of licensing fees, vendor independence, flexibility, access to source code and better interoperability through standards-based technology. In our case, we could say that the most important reasons to choose OSS are its low cost but especially the technological independency that will permit the different organizations involved in this project work in a more comfortable way.

	Proprietary software	Free & Open source Software
Advantages	Warranty[1] of developing company on product (holds for every company)	no licence fees
	components should work together	unrestricted use (e.g. no limits for the number of installations)
	usually well documented software	no update enforcement
		support of open standards
		support usually available from several providers[2]
		customisation at API level
Disadvantages	software price and maintenance fees	installation know-how necessary[3]
	training costs	training costs[4]
	maintenance tied to specific licensed companies	
	customised development can be difficult due to available resources of vendors support only as long as software company exists	

Table 2. Differences between proprietary and FOS software (Weis 2006)

Therefore, after joint reflection between the main actors involved in the PCI where this research is based on, - UJI, BDU and ERCS - a conclusion was reached. The

preferred type of technologies to be used in this case were the free open source. A summary of the benefits that using that kind of software brings is shown next:

- Low cost. Don't have to pay license fee to use them. Unlimited number of installations.
- Source code is managed and customized to the user own specific needs.
- Never have to pay when upgrading.
- More security and privacy in the sense that you own the source code which you can use as you want. This keeps you safe from proprietary restrictions.
- Complete independency of any company formats and technologies.
- Adaptability, modifications and bug fixing faster due to continuous evolution. Users' feedback.
- Use of standards to agree the level of interoperability needed.
- Online support is easily available. Mailing active lists for users and developers are often efficient.
- OS development increases user community participation.

Providing a desktop tool to access the G. I.

There are two options when dealing with spatial data. Either we access them through online web services as we will explain in section 3.6 about SDI, either we load the layers or access remotely to them by using a desktop GIS tool which has previously been installed in our computer.

At this stage of the project and taking into account that the advanced training about SDI and web server technologies has not been delivered yet to the BDU staff, we think that the most efficient option will be to use, for the moment, a desktop GIS. This software should cover the technical necessities for the BDU activities.

ESRI defines a Desktop GIS as a mapping software that is installed onto and runs on a personal computer and allows users to display, query, update, and analyze data about geographic locations and the information linked to those locations.

Every desktop GIS project can be evaluated in terms of its foundation, application focus, as well as its user and developer community, type of license or developing

language used. As discussed, the priority in this project is to use free open source software (FOSS) when establishing the GIS lab at BDU, based on the benefits explained in the previous paragraphs. Hence, a review of the main OS Desktop GIS projects available and its advantages has been carried out.

The main projects that can be considered nowadays are: GRASS (Geographic Resources Analysis Support System), QGIS (Quantum GIS), uDig (user-friendly Desktop GIS), gvSIG (Generalitat Valenciana, Sistema d'Informació Geogràfica), SAGA (System for Automated Geo-Scientific Analysis), ILWIS (Integrated Land and Water Information System), MapWindow GIS, JUMP/OpenJUMP, KOSMO and OrbisGIS. Each of them has its own characteristics (see Appendix F for details).

The maturity of the gvSIG project and the fact that it covers the majority of functionalities required for the BDU regarding spatial analysis for both raster and vector formats were decisive factors that made us to choose this software as the tool to be used in this work. In addition, it was also taken into account the expertise that we already had on the use of this specific software.

gvSIG Project

gvSIG started in 2002 within the open source software migration process that took place in the Regional Government of Valencia. Nowadays, it is a European Commission project, a long term R+D+I project. Its main characteristics are (Anguix and Díaz, 2008):

- Platform independent (it runs in most of the existing Operative System).
- Modular. Developed using independent modules adding scalability value.
- License GNU/GPL.
- It follows the standards defined by the OGC. This guarantees the interoperability with all the GIS applications.
- Simple use: it can be used by many users (even non-GIS experts).
- Internationalization: big effort on translation of interfaces, tutorials, etc.

The first prototype of gvSIG was released in 2004. During the development process new stable versions have been released constantly, until the current 1.9 and 1.10 versions (2011).

gvSIG is able to work with most known data formats, raster and vector and most of the geospatial databases, like PostGIS or MySQL. It provides most common GIS tools such as data visualization, map navigation, query map information, distance measurement, thematic cartography, legend edition, labelling, feature selection, table management, layout manager, raster processing, etc. Its SDI client condition permits the connection through standards to OGC services like WMS, WFS and WCS, accessing data and being able to overlap it and combine it in map views. Discovery service client is also provided which can be use to locate data resources, through Catalogue and Gazetteer search services, following different protocols. In addition, it includes a CAD editing environment, geo processing functionalities and the SEXTANTE raster analysis tools, which include a wide range of tools related to agricultural and remote sensing applications. This means that in its current release gvSIG covers most of the BDU needs regarding functionalities, and with a free license.

Many other plug-in can be been added to the gvSIG functionalities (3D extension, mobile devices access, publishing and metadata) and others are being developed at the moment.

In 2008 a gvSIG evaluation was achieved by the EC project Cascados, regarding three different criteria: Marketing, Economical and Technical potential. The final results were considerably satisfactory to gvSIG. It was compared with a much more mature OS GIS, GRASS, and the evaluation for both projects is shown in the following Table 4.

Evaluated software	Marketing potential						Technical potential							Economical potential					Overall score
	project Maturity of the	Community Strength of	Market Share	Legal/Licence issues	Collaboration with other projects	Total	Functionality	Reliability	Usability	Efficiency	Maintainability	Portability	Total	Cost of installation	Cost of migration	Cost of operation	Total		
Maximum score	15	15	12	9	9	60	15	9	9	9	9	9	60	24	18	18	60	180
GRASS	13.8	13.9	10.0	9.0	9.0	55.7	12.6	4.2	8.2	6.9	7.4	8.4	47.8	24.0	7.1	10.8	47.9	151.4
gvSIG	8.5	12.0	8.0	9.0	9.0	46.5	10.9	6.0	6.4	7.5	5.4	7.5	43.7	24.0	10.0	10.8	44.8	135.1

Table 3. Evaluation of gvSIG project and comparison with GRASS (Cascados 2008, EU).

Nevertheless, SEXTANTE module included within gvSIG installations already allows the integration of GRASS algorithms into gvSIG.

Another important point for the choice of such software was the community around it and the sustainability of the project. OS code evolves through community cooperation, where individual programmers as well as large companies participate. OS software has been maturing over the last years into well-supported tools whose code grows exponentially and OS GIS is not an exception to this trend.

In the case of gvSIG, the project has suffered a really fast evolution from a local level to an international level in only a few years of existence. It counts on active user and developer community participation, the software has been downloaded in more than 70 countries all over the world and the interface has been translated into more than 20 languages. User documentation is also available at several languages and, as well as other tutorials, workshops and seminars have been prepared for many events in the recent years.

The project is supported by many government agencies and private companies at national and international level. Many official events are organized through the year all over the world. The International gvSIG Conference takes place in Valencia every year and presentations about the Master of Science in Geospatial Technologies and its relationship with gvSIG project usually take place. In fact, part of this research work and our experience in Ethiopia was presented in the last edition of this Conference in December 2011.

Regarding community support, in the last years it has been set up a new infrastructure for the gvSIG project management, a meeting point for users and developers where support is given and the common place to publish extensions and contributions by external developers, under the philosophy of putting the project in the hands of the community.
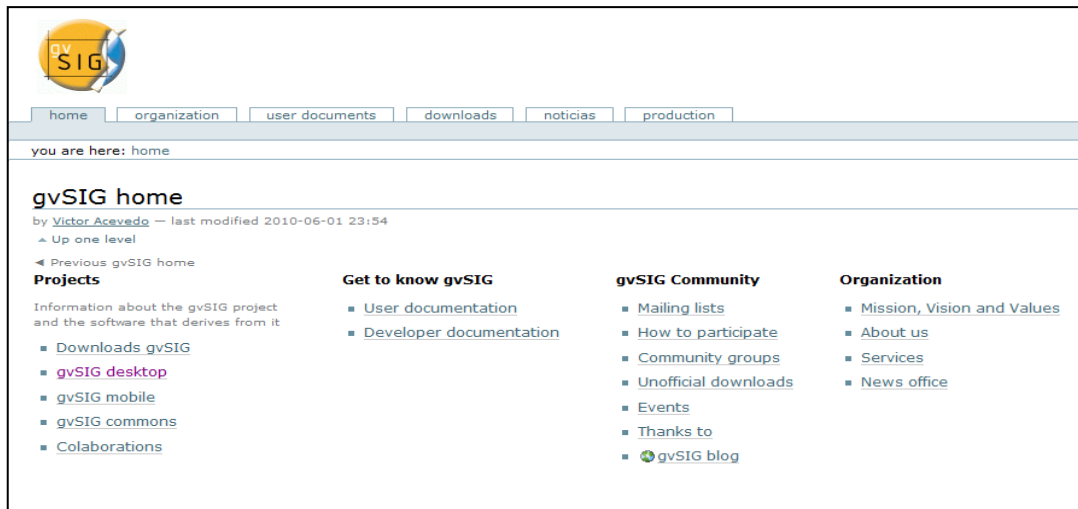
Figure 9. gvSIG official website for the Community (www.gvsig.org).

Moreover, a professional structure has been created in order to grant the sustainability of the project, materialized in the *gvSIG Association* that was born in 2009 to promote FOSS4G and gvSIG development based on collaboration values, shared knowledge as a model of development and no monopoly practices.

Apart from providing the required GIS Desktop tool, other software are being used and trained on such as *gvSIG mini* for the tablets and *Google Earth* to visualize maps and ortophotos of the country.

3.3.3 Capacity building

The third component for the establishment of the GIS lab corresponds to the capacity building of the local team involved in the project. Proper training is important for all staff using GIS. In this regard, a large effort has been made for the training on both software and hardware having as targets the team at BDU and ERCS.

The "GIS capacity building", as one of the four activities that integrate the PCI, has been planned in two phases. The common goal is that the attendees get the ability to apply the knowledge learnt when dealing with climate-change induced problems and, in turn, be able train other people as well. That is a key point that permits to spread the knowledge and awareness of G.I. and tools, potentially helpful against climate change problems, and may improve the food security in the area, a crucial objective of this Master Thesis and also of the whole PCI.

Phase I. Introductory training

The Phase 1 was planned for the year 2011 and it is here where this work has been developed. Some tasks have already been done, such as the visit to UJI of Tesfahun Asmamaw, coordinator of the GIS activity at BDU that took place in October 2011, where he had the opportunity to participate in a GIS training as well. Such a visit was profitable also to meet him personally, through several interviews and meetings that allowed us to know better how things were going at BDU and what were exactly their expectations regarding the future GIS seminar, planned for November 2011.

We were informed that a short GIS training to BDU staff was already held by University of Dacca some months ago. In that sense, the training to be done at BDU for us as GIS experts will enforce that one.

As planned, the GIS training seminar took place during our visit to BDU. The details are explained in the next section. It is expected that this training enables the staff at BDU DRR program to produce improved risk hazards maps by providing the exact location (increased precision) of hazards and resources, and thus improve their research capacity.

Currently there is an insufficient number of computers with GIS tools for the number of students enrolled in the GIS introductory course, but it is expected that the new equipment provided by UJI will allow greater access to GIS tools, as well as a greater quality of GIS education overall.

The main focus of the training has been on the lecturers and instructors from the CAES at BDU, but the final beneficiaries will be the agricultural communities that depend to some extent on the decisions that authorities and specialists take every day. As we are collaborating with ERCS as well, a representative of this NGO was scheduled to attend the seminar but finally it was not possible due to professional compromises. Nevertheless, new material is expected to be purchase for RCRC staff as real GIS users, as long as it will be required.

Students from the Master of Disaster Risk Management and Sustainable Development (DRMSD) were also invited to the seminar. An announcement was posted at the BDU website and also through posters in the Campus, as we can see in

the Appendix B of this thesis. As stated, the training seminar took place at the current facilities of the BDU, considering that the new GIS-lab was still not ready to be used.

Preparation of the GIS seminar

Once the date and schedule for the seminar was fixed according to the preferences of the BDU coordinators, a workshop of 20 hours duration has been prepared. The first step was to prepare the material to use in the workshop, the data. Due to the lack of data provided from the BDU or other institutions in Ethiopia, an internet research was carried out and various cartographic layers corresponding to Ethiopia features has been gathered. Vector layers corresponding to the administrative boundaries at the different levels (national, regional, zones,...) and raster layers corresponding to satellite images of northern Ethiopia have been found out. Source links can be found on Appendix A of this thesis. Layers from the city of Valencia that were already collected previously were also used during the seminar exercises.

The next step was to design the agenda. The seminar content was mainly practical, composed by several exercises organised by topics. During the seminar the attendees could get in touch with the main functionalities of the gvSIG application. gvSIG version 1.9, that we considered one of the most stable, was used on that purpose. A practical look at both basic commonplace GIS tools as well as more innovative tools that gvSIG provides was taken. Several exercises were prepared following the next schedule:

Session 1 (Tuesday)
- General presentation of the project and the GIS training activity
- Installation of software and data
- Exercise 1: Data visualization
- Exercise 2: Visual analysis

Session 2 (Wednesday)
- Exercise 3: Using Remote Services
- Exercise 4: Editing
- Exercise 5: Geoprocessing

Session 3 (Thursday)

- Exercise 7: Map authoring

- Tablet pc and GPS navigation practise

The exercises were prepared focusing on the topic of climatic issues such as risk of flooding or drought. Classification and symbol legend functionalities occupied also much of the time of the seminar as we can see in Figure 13, as well as geo-processing and editing, to end with the map production.

In addition, an explanation of the *Google Earth* application was given to the attendees, as a useful tool for visualizing images and maps of a desired place rapidly, as we can see in Figure 14. Finally, training on the use of the tablet pc and its applications (GPS, Map viewer, gvSIG Mini, documents reader, camera) was given. *gvSIG Mini* is the *gvSIG* version for smart phones. It is a viewer of free access maps based on tiles (OpenStreetMap, YahooMaps, Microsoft Bing, etc.) with a WMS client, address search, routes, location and many more things. It runs with both on/off-line modes and it was installed on the tablet pc for the BDU team geo location in the field.

Certificates of completion were prepared and sent to the attendees once we came back to Spain. A copy of one of those can be found in the Appendix section of the present work, as well as the complete seminar document (Appendices A and B).
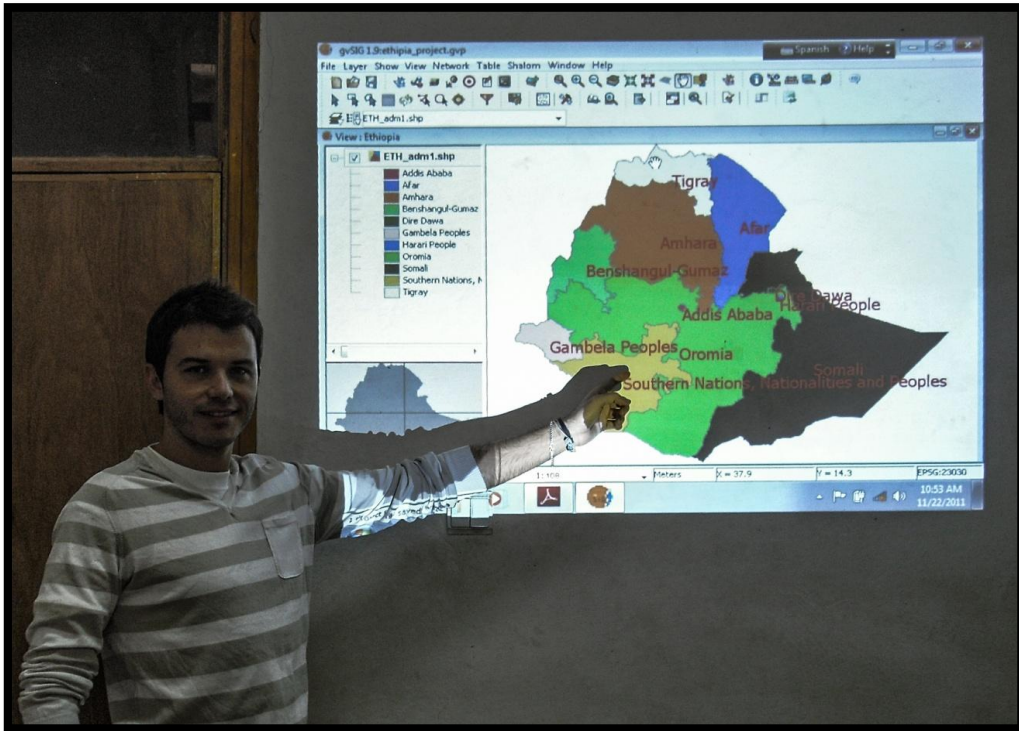
Figure 10. Visual analysis with gvSIG during GIS workshop. (BDU, November 2011).
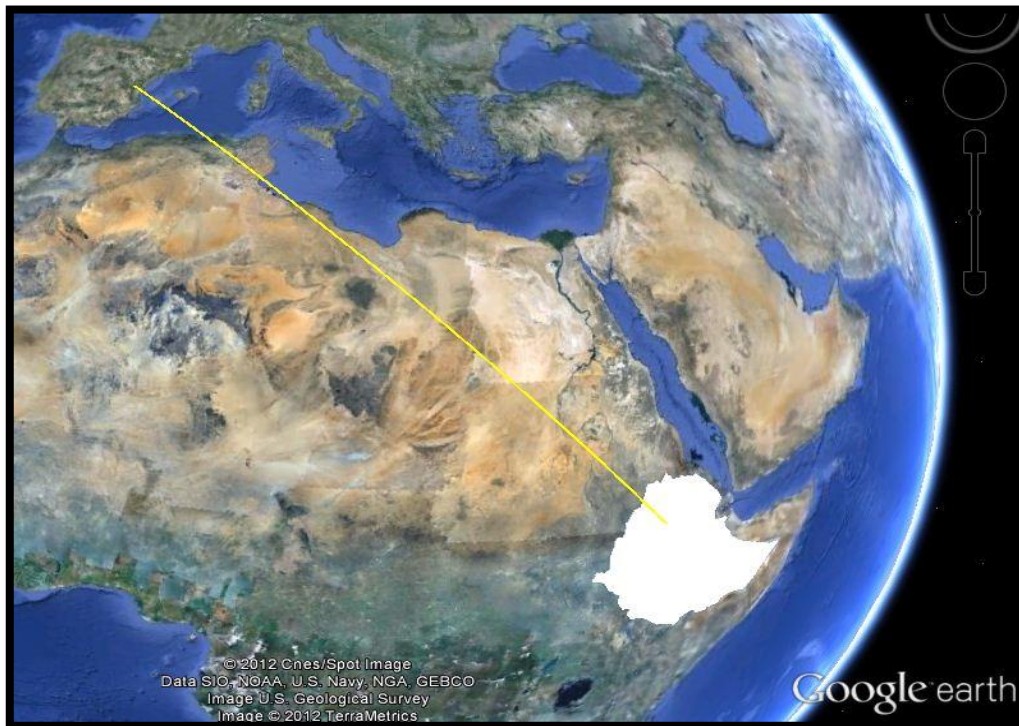
Figure 11. Google Earth screenshot during GIS capacity building action.

Figure 12. Equipment provision and training to BDU team (BDU, November 2011).

Some recommendations for improvement after the GIS training given during Phase I can be mentioned: more climate and food security related exercises in the coming seminars (they now have a general overview), to gather more quantity of data from the area of study (in order to prepare more specific activities with data from Amhara region), to give more importance to the field work (prepare more exercise where they have to use the mobile devices, GPS, etc.) and to engage more attendees in the courses.

Phase II. Advanced training

The GIS seminar in the phase I was just the first step of the capacity building activity. The second phase has started after we left Ethiopia. Advanced seminars and GIS training workshops are planned to take place during the 2012 at BDU, starting on March. Those will continue the seminar held in November 2011 and hopefully more and more students, lecturers and staff from BDU and local NGOs will be involved. These seminars will again be provided by specialist staff from UJI in order to assure their quality, always having in mind the actual necessities and feedback

from BDU team. Nobody better than them know the problems that rural communities are facing in Amhara region.

However, a seminar is not as useful as it could be if a feedback is not established once it was finished. That is why the idea of creating a support mailing group composed by the attendees (and whoever likes to be included) and GIS specialist was set up in order to solve future questions and suggestions regarding the data, the hardware or the software in use. Also, they now have access to the different tutorials, real use cases, official user mailing list and all the tools available in the gvSIG project. A regular e-mail contact is held between the BDU technical coordinator and the UJI team to follow up the activities regarding GIS.

During this Phase II the GIS capacity building will be focused on hardware devices, advanced functionalities of the software and the SDI technologies and components.
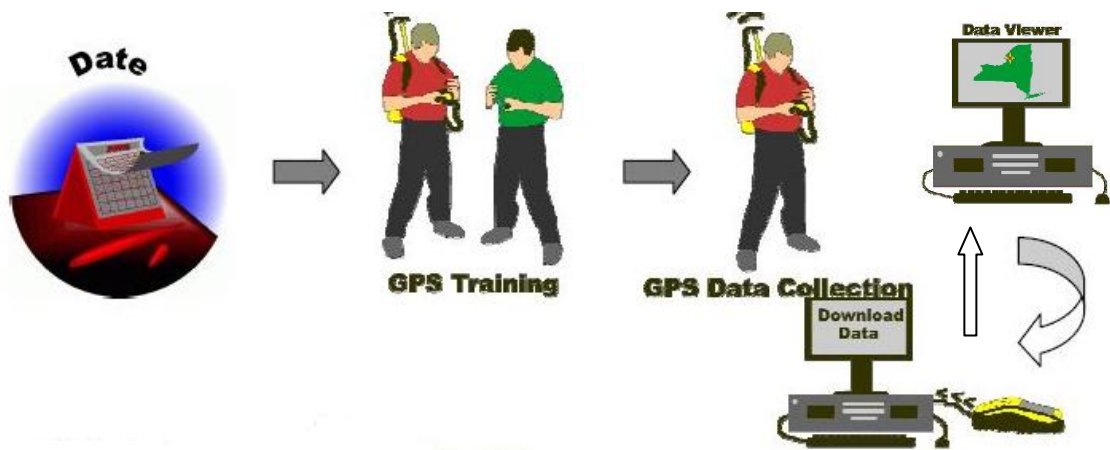
Figure 13. GPS data collection training schema. (NYS GIS Strategic Plan 2008)

e-learning GIS seminar

Included in the Phase II of the GIS activity, an e-learning GIS program is being prepared at this moment by UJI in collaboration with BDU. It is planned to be ready by September 2012 so that students from Ethiopia can register and follow it. At the moment this Thesis is being written the design and preparation of materials is being carried out and the materials given in the seminar at BDU have been reused as a starting point for that future online seminar.

Another visit of BDU coordinator to UJI is planned for March 2012, followed by a visit of the UJI GIS team to BDU.

3.4 DATA

An effective Geographic Information System requires accurate and precise GIS data. The idyllic situation would be that the geographical data to be used for BDU and ERCS staff were available and provided by the official producers of it, such as government agencies and public institutions. As Harvey and Tulloch (2007) state when describing the SDI pyramidal model, data integration rests on local-government data sharing, following the National Spatial Data Infrastructure. Availability of local-government data is fundamental for all SDI-related data sharing in this model. However, in our case – and in many other – those official data were not provided officially. Thus, we believe that a bigger effort is needed in that sense. Either on creating the mechanism that makes the Government to share the data they owe, either on producing new data, with the desired accuracy, when needed.

3.4.1 Data availability

We currently have access to large amounts of data through several GIS Clearinghouses, but data collection is still needed in the region to build a solid geospatial database.

From surveys carried out through interviews to other students and volunteers working in the study area, some facts were noticed: knowledge of hazards exists but their geographical location has not been verified by the use of GPS; not much GIS information is available online. In public agencies, such as the The Bureau of Finance and Economic Development (BoFED), some vector data are available, but no raster data. BoFED provides data for one zone or district for free but if more is required they will charge a fee; the data is out-dated but due to the high cost to update it those data are still used; very few meteorological data exist. ; little sharing of data occurs and institutions are unaware of what kind of data (if any) others hold.; at academic level, the use of cartographic data by BDU is very limited, while ERCS rarely uses that kind of information so far.

Therefore, one of the main problems we faced is the lack of data available and the lack of interoperability and capacity of sharing among different institutions and actors. In general, the situation about availability of data is that, in one hand, more accurate data is needed for certain areas and, on the other hand, an effort on the publishing and sharing of those data is needed and desirable.

3.4.2 Data collection

As explained, one of the biggest limitations of this work has been the lack of spatial data available. This fact has led us to a first phase of data search and gathering through the internet, where several geographical data of Ethiopia and Amhara region in particular have been downloaded. Those data have been used during the GIS training seminar at BDU, to perform the different exercises. However, more accurate and specific data are still needed to achieve the goals of the BDU activities. On that purpose, a data collection campaign has been launched, with the participation not only of the technician staff and experts involved in the project, but also where rural communities should take active part. We will differentiate from these two types of data collectors.

By Experts

From February 2012 a GIS application research related to vulnerability and food security has been launched by the BDU team, within the Phase II of the PCI. The equipment sent from UJI has arrived and it is already being used for the rural communities training.

Regarding data collection, BDU technicians are in charge of the gathering of different type of data in the field. In one hand, land use/land cover data when such information is missing. Besides, those experts are also in charge of geo referencing all the data collected from farmers and rural communities. On that purpose, both GPS navigators and tablets are used. Therefore, the previous training on the use of those devices and software is a key task for the continuity of the process.

By Rural Communities

The farmers themselves play an important role when talking about data collection. They have first to be trained by the BDU and ERCS experts, which previously have been trained –and still they are- by the UJI team.

In January 2012 a research on hazards and vulnerabilities has been launched by BDU with the help of UJI. The new equipment is already being used for the rural communities training. As a first activity, BDU staff is currently providing a Disaster Risk Reduction and Climate Change Adaptation (DRR/CCA) training in the selected *woredas* of Habru and Fogera. The main objective is to train *woreda* and *kebele* officials in the development of community-based DRR and CCA planning process using pre-existing disaster risk related information. This training is primarily intended for those personnel involved in the implementation of community-based DDR and development projects. Therefore, the target population includes the local officials of different sectors related to DRR and CCA in these *woredas* such as Food Security, Water resources, Agriculture and rural development, Woreda administration, Health, Kebele community representatives, NGOs working in the woreda, etc.

A five day workshop to develop the attendees' skills about Community-based Disaster Risk Reduction & Climate Change Adaptation (CBDRR/CCA) in order to reduce the risk associated with flooding and other hazards has been carried out. CBDRR/CCA is an approach that aims to reduce local climate and disaster risks through the application of participatory assessment and planning methods. It is a practical strategy to integrate local development efforts on one hand with strategies that reduce the impact of disaster and climate risks on the other. It aims to reduce vulnerabilities and strengthen people's capacities to manage specific disaster and climate risks. It is therefore a process of developmental disaster risk management in which the communities at risk actively engage in identifying, analysing, managing, monitoring and evaluating disaster and risks to reduce their vulnerabilities and enhance their capacities (Asmamaw T., 2012).

Pictures are taken with the tablets while communities are doing hazard mapping exercises. Texts and documents are read as well by the facilitators during the training while moving around class.

Figure 14. Strategy selection exercise at Fogera rural community. (DDR/CCA training, January 2012).

The fair use of the equipment will hopefully continue during all the spatial data collection phase for mapping vulnerable and food insecure *woredas* in Amhara, allowing the communities to collect their GIS data with GPS technology. Definitely, the use of GPS devices and the power of GIS tools will help decision makers in the identification and prioritization of the most vulnerable zones in pastoral areas, as stated in the case of use explained in the following section.

3.5   RISK MAPPING: SOIL EROSION USE CASE

A use case related with risk mapping has been done to illustrate the type of analysis to be carried out during further activities to be performed at BDU. In this regard, the given training has enabled BDU technicians to understand the analysis. This is an important point to remark, since they are the target of the training and the   and processes and .

Soil erosion occurs when water that cannot infiltrate into the soil becomes surface runoff and moves soil down slope. A soil becomes unable to absorb water either when the rainfall intensity exceeds surface infiltration capacity (Hortonian runoff) or when the rain falls onto a saturated surface because of antecedent wet conditions or an underlying water table (saturation runoff). These two types of runoff generally occur in different environments: bare crusting soils for the first one and humid areas for the second one, though they may also be combined in some cases (Cros-Cayot, 1996).

Modelling is difficult because of the complexity of the numerous interacting factors in the erosion process. Four main factors are generally considered: soil, topography, land cover and climate (Wischmeier and Smith, 1978; King and Le Bissonnais, 1992).

In the use case presented, a very simple approach is used, where only two variables are taken into account: slopes and land cover. In order to determine the most threatened areas by soil erosion, some mapping has to be completed.

First steps

The approach used in this case of use is very simple but will serve as rural communities' first contact with the GIS field. It consists on making erosion surveys based on observations and bibliography. The goal is to identify the most likely affected areas due to soil erosion, based on land cover maps and slope calculations.

This approach has, obviously, some limitations. Rain is usually the main factor for water erosion and its erosive effect is related to its amount and intensity. However, we don't count on rainfall data of the areas surveyed, so the results will be only approximated, being our objective in this case rather to promote the participatory processes of rural communities than reaching high accuracy results.

We can only count on two types of data. In one hand, a general Land Cover (LC) map of Ethiopia and, on the other hand, a raster DEM of the northern part of the country. These data have been downloaded from the FAO and the USGS websites respectively.

The GIS software used is gvSIG 1.9 and its raster tool SEXTANTE. The following steps have been carried out:

1- **Identify in the general map of Ethiopia our areas of interest.**
   The areas of interest for our work have been identified and clipped from the Ethiopia general shapefile, in order that gvSIG software manages them easily. These are the *woredas* of Ebenat and Fogera, currently being the study focus of the BDU and the ERCS.

2- **Find a Land Cover map and identify the cultivated areas within the two *woredas*.** On that purpose, a quick online research has been done and a LC general map of Ethiopia has been downloaded, with shapefile format (source: http://www.fao.org/geonetwork/srv/en/main.home) Then, this general LC map has been cropped with the boundaries of the two *woredas*, in order to keep only the polygons within our areas of interest.
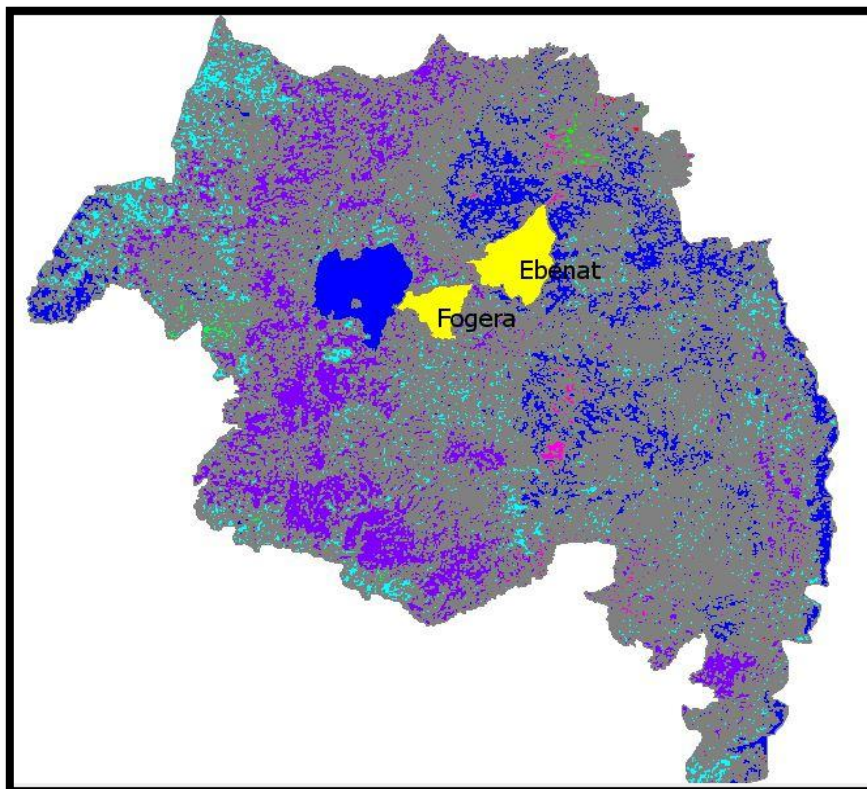
Figure 15: Selected woredas over the LC map of Amhara region.

3- **Categorize the LC raw codes into classes**. The several categories of LC which are categorized by a numerical code, have been categorized as descriptive classes based on the annexed information found with the shapefile layer.
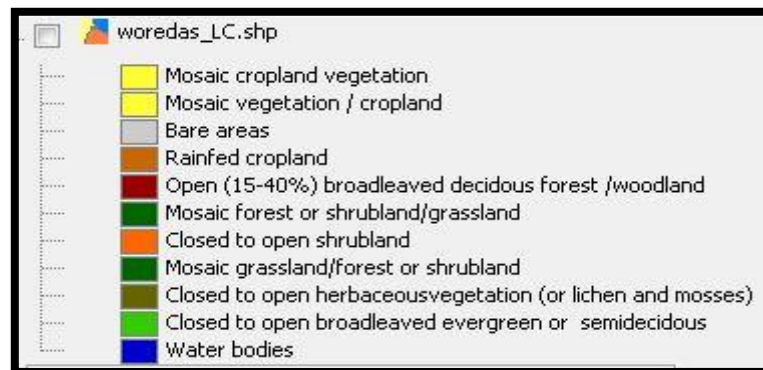
Figure 16: Classification of Land Cover.

4- **Reclassify LC classes into the minimum possible classes.** LC types have been reclassified into nine classes, each one corresponding to a specific behaviour towards soil erosion. Moreover, an appropriate colour legend has been applied to them.
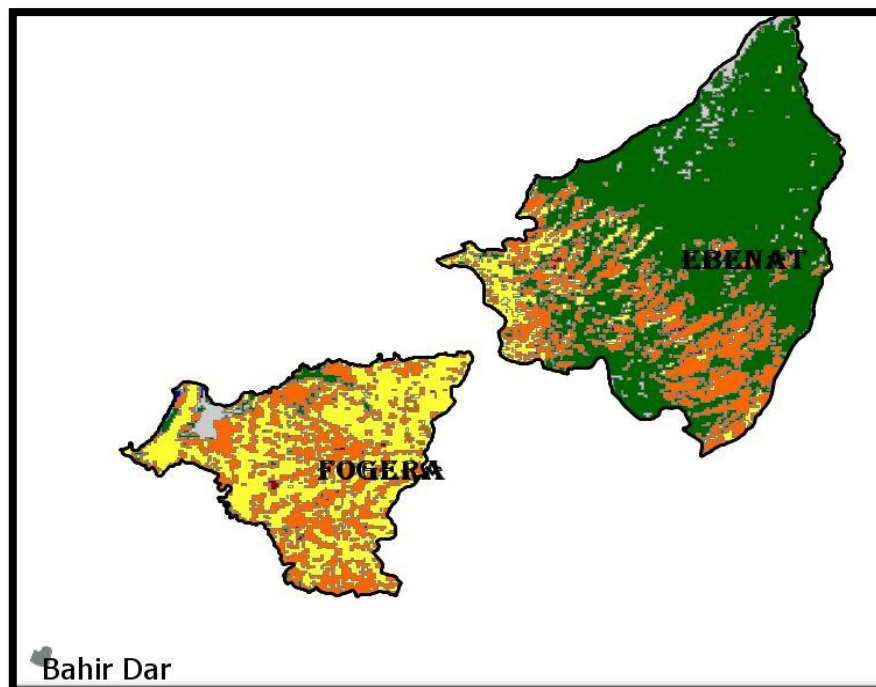
Figure 17: LC map clipped with the selected woredas.

5- **Identify only the cultivated areas within the** *woredas*. Since we are only interested in agricultural areas, the polygons that represent this type of use have been selected from the LC map.
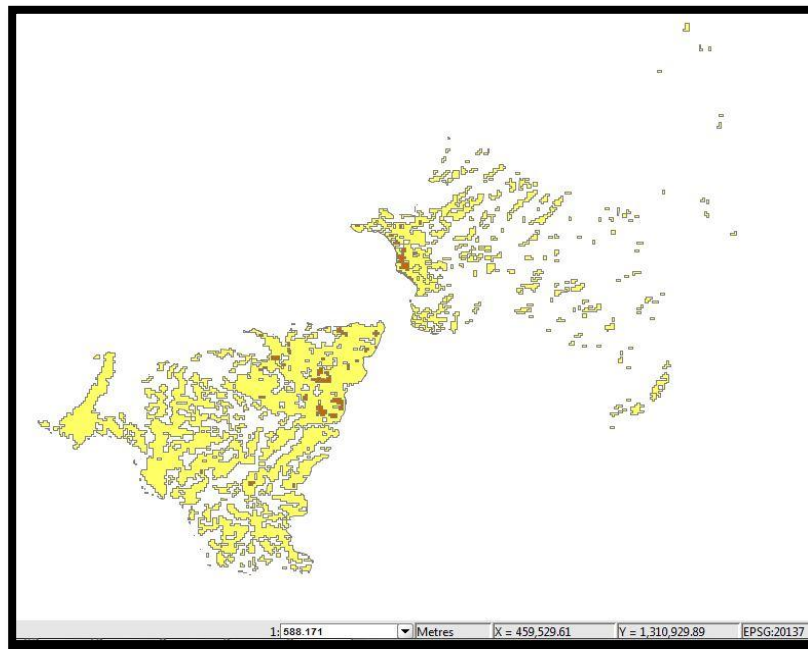
Figure 18: Visualization of the cultivated areas.

6- **Calculate the slope ranges in the area.**

For this task, we need a Digital Elevation Model (DEM) of the area that permits us to identify the most threatened areas in it due to higher slopes. We used a gridded DEM of the northern Ethiopia with a cell resolution of 7.5 Arc-Seconds (250x250m),

(GMTED2010 Data Tile #44, from

http://eros.usgs.gov/#Find_Data/Products_and_Data_Available/GMTED2010)
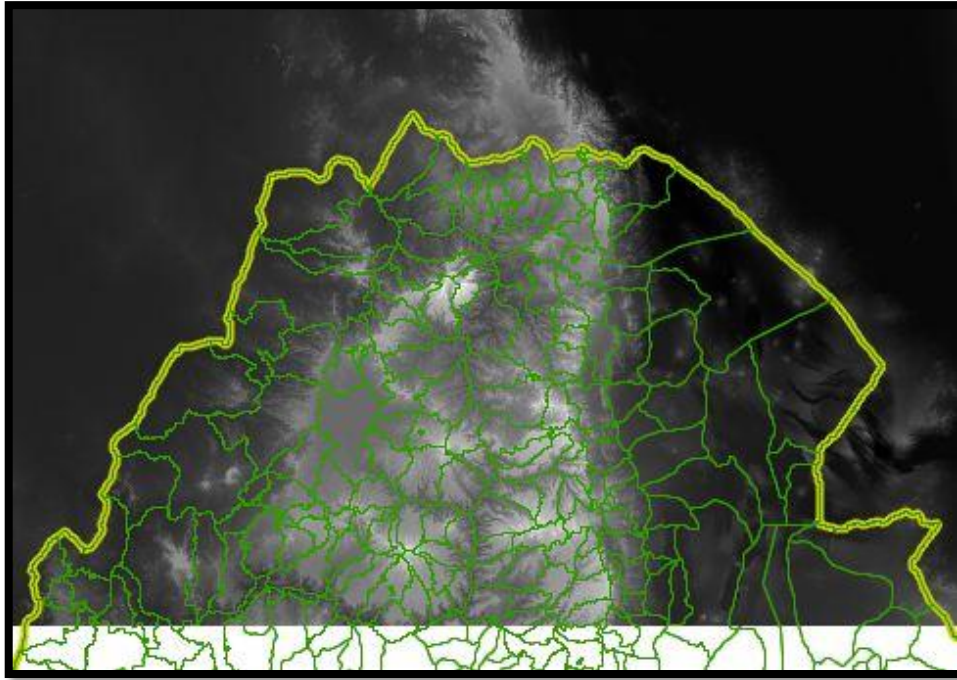
Figure 19: Digital Elevation Model for the north region of Ethiopia.

Slope Map then was created from the raster DEM using SEXTANTE geomorphology toolkit included in gvSIG.

7- **Slope classification and legend**. Slopes were then classified into eight classes, the limits of which were defined according to values found in the literature. Used slope classes are the following: 0–1%; 1–2%; 2–5%; 5–10%; 10–15%; 15–30%; >30%.
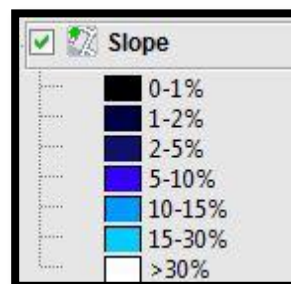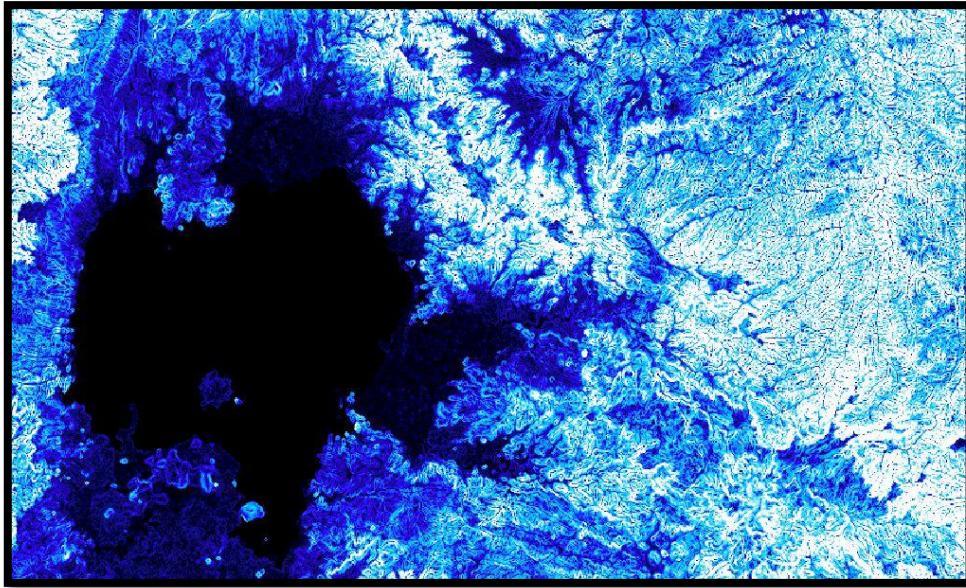
Figure 20: Slopes map of the region.
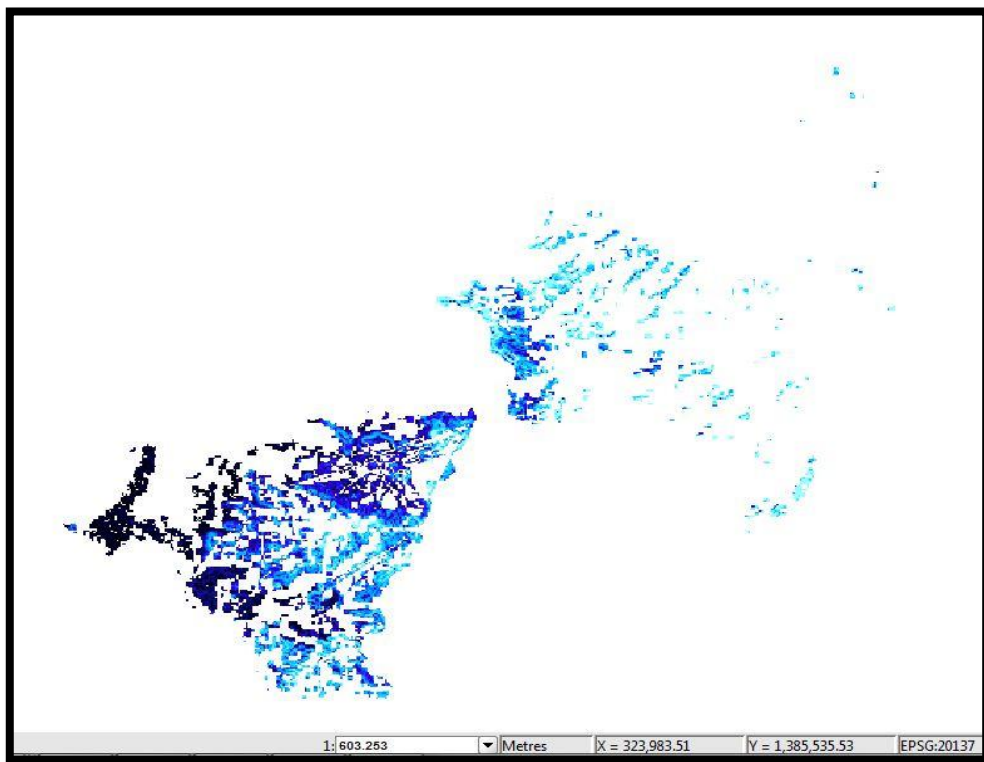
Figure 21: Slope map within the area of interest.

8- **Combine the resulting map of Slopes with the map of cultivated areas in the areas of study.** Thus, we can discern which cultivated areas are under slopes of 15%. Over this slope, it is considered to be a high risk of soil erosion.

9- **Check these results on the field.** For this task, the leaders of the rural communities, helped by the staff from BDU, will go to the field and, using the GPS devices and the tablets purchased, they will be able to verify which zones are actually cultivated and weather they coincide or not with the type of cover shown in the LC map. In case the reality differs from the resulting map, they will collect data about the actual type of LC in this specific area. Besides this, they will collect information about what practices are being used in each area, with especial focus in soil conservation practises. For instance, they will check weather terraces are in use or not.

The final results will lead to a list of recommendations for rural community's leaders and farmers about agricultural good practices and advices to help in the task of soil conservation. It should be noted that this case of use is just one example of what can be done. The next step is to extrapolate these type of exercises through participatory activities and VCA carried out in all farming communities and create new scenarios where GIS has a key role in the resolution of problems related to food security.

Figure 22. Participants during a training DRR/CCA workshop in Fogera (January 2012, tablet pictures)

Field work

One of the activities planned during our stay in Ethiopia was to see first hand the real situation in the rurar areas of Amhara region. We considered this as a key point to get a realistic idea of what was the situation there. On that purpose, a visit to the Fogera *woreda*, around 50 kilometers Northeast from the city of Bahir Dar, was scheduled.

Once there, we had the opportunity to meet farmer communities and their way of life. They explained to us how they deal with the different agricultural crop species, and also how the climate variations affects them. As we knew, there are two extreme seasons in Amhara. One period of rain, responsible of the fact that almost the entire rural area is flooded for several months (June-September) and a second season caracterized for a dry period that ends normally with intense drought (March-May). The agriculture tools were very elementary and primitive. Pastoralism is also an important activity for those families. We could see the animal productionl, composed mainly by cows, oxes and goats. Finally, we were explained about the organization for the children education, which could be defined as very elementary and precarious. Pictures of agricultural practices and pastoralism can be found on Appendix G of this work.

3.6   SPATIAL DATA INFRASTRUCTURE

Once the data will be collected in the field by experts and farmers and after the required revision and preparation of those, the next step would be to publish this G.I. to be accessible remotely. Therefore, the implementation of SDI would be the next step to be carried out in order to help the goal of optimizing the access to the G.I. by potential users.

In order to understand what the SDI are and how this model can be helpful to optimize the utilization of geographical data, some background is given next.

The Global Spatial Data Infrastructure (GSDI) defines an SDI as "*the important accumulation of technologies, institutional norms and plans that facilitate the availability and the access to spatial data. The SDI provides a base for the discovery of spatial data, with evaluation and application for users at all the governmental*

levels, commercial sector, non lucrative institutions, academic sector and general public."

The justification of the establishment of a SDI is related to two fundamental ideas:

1- The need to make easy, comfortable and efficient the use of existing G.I.

2- The opportunity to reuse the G.I. generated in a project (often with a high cost of production) for other different purposes.

The fundamental objective of a SDI is therefore to facilitate the access to the existing cartographic resources. Against previous systems like the corporative GIS, a distributed GIS or SDI is characterized by the fact that the system is the network (Intranet/Internet) and the communication is done through standards (Web Services). The advantages of a SDI in an organization who works with G.I. are the compatibility of the model, the fast access to the information, avoiding duplication of works and the instantaneous update of the information.

For the establishment of a SDI three components are necessary. Of course, the *data* which will be available, *metadata* ("data that describe the data"), and *services* which offer functionalities useful to a community of users and follow some standards.

All efforts to establish a SDI include some common principles:

• **Institutional framework**: establishment of agreements between the producers of G.I., especially among official producers to generate and maintain fundamental spatial data for most applications based on GIS.

• **Standards**: setting of rules required for the G.I. exchange and interoperation of the systems that manage it.

• **Technology**: establishment of the network and computer mechanisms that allow: search, query, find, access, supply and use spatial or geographical data.

• **Data Policy**: establishing policies, alliances and partnerships necessary to increase the availability of spatial data and to share technological developments.

Regarding standards, the Open Geospatial Consortium (OGC), as the international organization leading the development of them for geospatial services and defining open and interoperable standards within the GIS, persecute agreements within the

sector that make possible the interoperability of the systems and the interchange of the G.I. to the benefit of the users. The most important standards of the OGC are:

- *Web Map Service (WMS):* Service of maps in the web that produces maps with image format to the demand to be visualized by web or in a client.
- *Web Feature Service (WFS):* Service allowing requests for geographical features across the web using XML-based GML format.
- *Web Coverage Service (WCS):* Analogous to the WFS but for raster data.
- *Web Catalog Service:* Search client that offers the possibility of locating geographic data sets that are available on a determined scale, of a particular zone, on a specific subject, and in a date or interval of dates.

In Europe, the INSPIRE Directive proposes norms related to the G.I. for the E.U with the goal to make it available, arranged and of quality. Unfortunately, such an Initiative doesn't exist yet for Africa. Nevertheless, some efforts have already been done, as we can check in http://geoinfo.uneca.org/sdiafrica/

3.6.1 SDI in developing countries

The increasing interest in the use of the GI in our days has taken to many countries and organizations to adopt SDIs. However, this revolution affects and benefits more developed countries, while in developing countries the change is still getting started.

A developing country can be defined as a country with a relatively low standard of living, undeveloped industrial base, and moderate to low human development index (World Bank, 2006). Policymakers in developing countries do not have the adequate access to accurate (geo) information needed to make rational management decisions. Besides the dependency on (external) funding sources, developing countries are facing other challenges to establish and implement SDIs (Akinyede and Boroffice, 2004). According to Rajabifard and Williamson (2003), the main limitations of SDIs in developing countries arise from the lack of appreciation of what an SDI can and cannot do, the lack of resources and trained personnel, inefficient bureaucratic processes, and the lack of data. For an SDI to be successful, governments must participate and support the SDI developments. However, in developing countries is

frequent that foreign donors drive the initiatives instead of the respective governments (Lance, 2003).

Indeed, among the 120 countries that had initiated projects for SDI development in 2002 (Crompvoets, 2003) only one existed in the African continent (University of Maine survey, 2002).

To sum up, SDIs are increasingly recognized as an indispensable part of the national infrastructure of countries that need to be established and maintained as are other elements of the infrastructure. They are a robust response to the challenges that governments and societies confront in the use of spatial data and its transformation into information and knowledge that are needed for decision-making. SDI encompasses the policies, technologies and institutional arrangements involved in delivering spatially related information from many different sources to the widest possible group of potential users (SDI Africa, an Implementation guide).

3.6.2 SDI establishment at BDU

The last step for the BDU GIS lab establishment will be to publish online the data collected and prepared in terms of projection, attributes and legend, in order to make them accessible by potential users.

Frequently, to use a SDI means accessing a geoportal for searching, displaying and maybe downloading data from remote services. However, professional GIS users may want to combine SDI data access with a work flow that requires a heavy client, a Desktop GIS application. In that sense, both options are planned to be used in this project.

As a geo portal solution, one can visualize data, make queries and even use the basic features of the online services available by using just a browser and connecting to a geo portal where geographical data have previously been organized and upload on. We could mention various examples of those geo portal tools such as GeoCommons, Wikimapia, OpenStreetMaps or ESRI Geoportal Server.

However, to build up an SDI we need more than the tool to access the spatial data. Besides it, databases are often used to store the data that have been acquired. If other

people should use the data, then a web server and client software may be useful to deliver the data online.
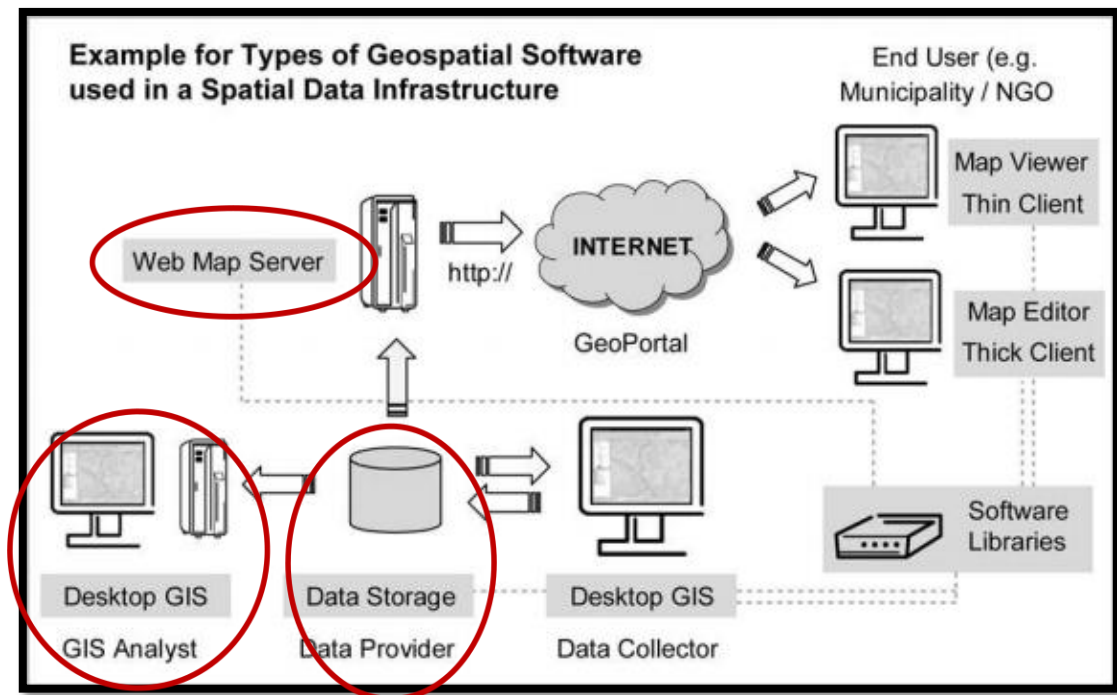
Figure 23. Types of geospatial software used in a SDI

A SDI should enable the discovery and delivery of spatial data from a data repository, ideally via one or more web services. Hence, the basic software components of an SDI consist of (Steiniger and Hunter, 2010):

1- a software client that can display, query, and analyse spatial data,
2- a catalogue service for the discovery, browsing, and querying of metadata or spatial services, spatial datasets and other resources,
3- a spatial data service that enables the delivery of the data via the Internet, and/or processing services such as datum and projection transformations,
4- a data repository,
5- GIS software that permits the creation and maintenance of data.

In our case, the plan is to set up, at least, a web map service to connect to, a geospatial database and of course, to provide the desktop tool that permits us to access those data from our computers (see Figure 12).

However, the spatial data sets are at the core of any SDI and essential for GIS usage. That means that the SDI will not be developed until the data gathering phase will be finished. Of course, also fundamental spatial data should be included as a base, but it needs to be added to other important data that will not be ready until the farmer data collection campaign will finish. Regarding those fundamental data, we can mention the following (World Bank, 2011):

1. Administrative boundaries
2. Transportation
3. Hydrography
4. Cadastral maps
5. Geodetic controls
6. Topographic maps
7. Facilities
8. Satellite imagery & aerial photographs

Therefore, the SDI establishment at BDU rests as one of the further tasks for this project. Perhaps that will be the moment to contact Government agencies and ask for support on the SDI creation, taking into account, as seen, that policies are need to impact on SDI driving forces and build those fundamental data, technologies, standards and education.

For the moment, a short description of the steps to be taken is given next. This process is not easy to achieve, however, we think that it is worth to make the effort to go ahead.

Data preparation

Once the desired data will be gathered or collected from the field, the second step will be the adequacy of those data before its introduction into geographical Databases. Frequently, most of the data are already prepared to be published, however other may need some intermediate step, such as the geo referencing process for instance.

Online services. GeoCommons

As remarked, as soon as the geographical data are adequate they can be published online in order to improve the interoperability and easy access to them by the potential users. This fact can be very helpful to BDU and RCRC staff in their day-by-day work and also to anyone that might need it. A SDI is actually a set of services that offer a variety of features that are useful and interesting to a user community; the emphasis is, therefore, on the utility.

As a first step, the data gathered from internet search for the preparation of the GIS seminar has been uploaded into a platform named geoCommons. geoCommons is the public community of users who are building an open repository of data and maps for the world. The platform includes a large number of features that empower users to easily access, visualize and analyze their data. One can search for maps and datasets, upload its own data or make some visual analysis.

geoCommons can be used as the common space for sharing geodata within BDU, at least until the training of their staff on SDI will be improved. The choice of this platform is based on the geoportal characteristics, which can be considered as advantages especially for non expert users (Usher, 2010):

- **Simplicity**. Provides easy data processing and analysis for novice GIS users.
- **Customizable**. Provides a very rich interface for creating compelling and beautiful thematic maps.
- **Wizard-driven interface**. It guides users through the process of selecting datasets and choosing thematic views of the information.
- Allows users to **share** their creations as KML file downloads

In our geoCommons profile we can currently access to a library of layers with the data that we have uploaded so far: administrative boundaries, hydrology, and communications (see Figures 24, 25 and 26). This profile is public and it has been shared with the BDU team as a basis to start working with the online services available.
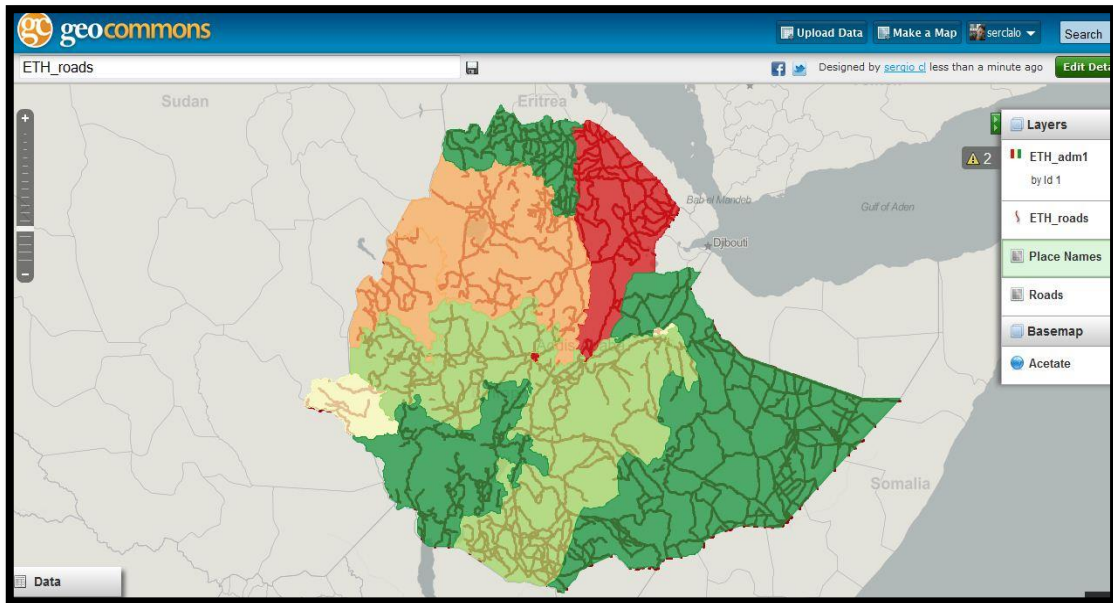
Figure 24. Map creation within the GeoCommons interface.

Figure 25. Metadata creation within the GeoCommons interface.

The dataset is available in our Geocommons library at www.geocommons.com
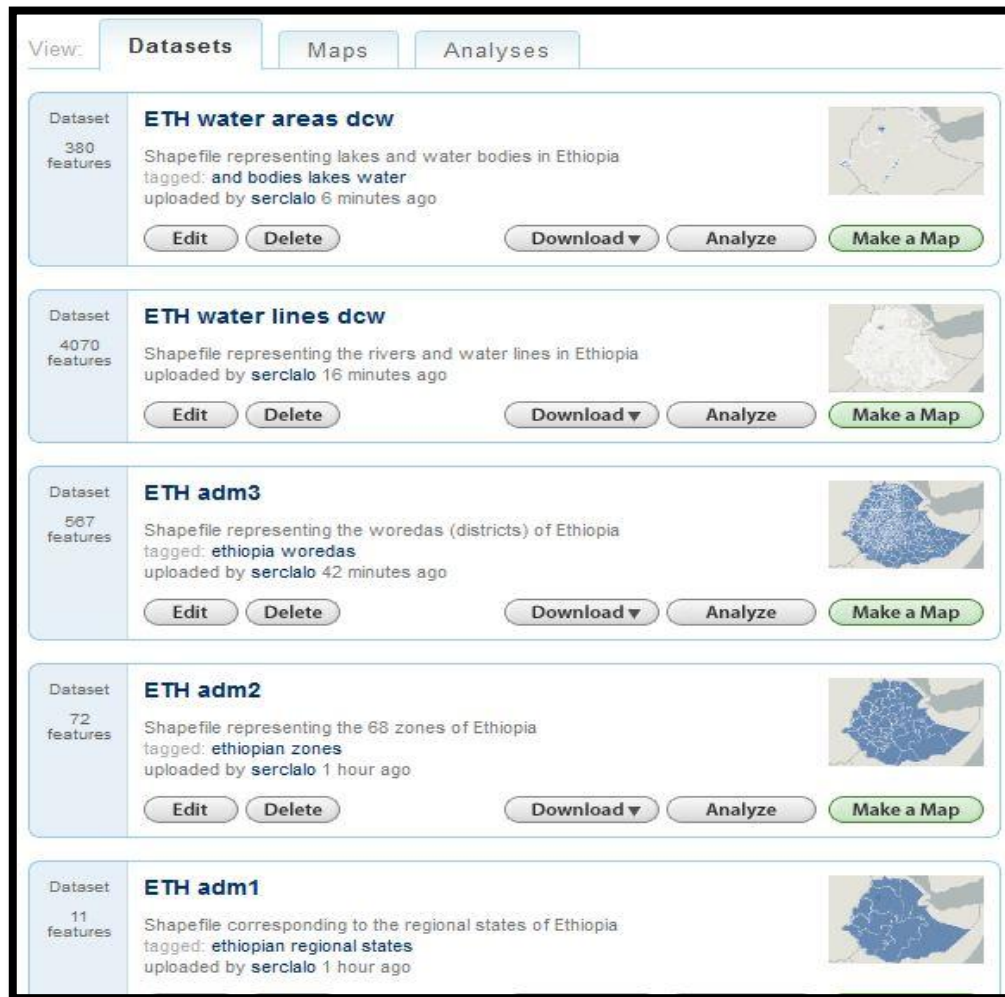
Figure 26. Layer library in our GeoCommons profile.

Web Map Services (WMS)

Its aim is to visualize geographic information. It provides a representation, an image of the real world for a required area. This representation can be from a GIS data file, a digital map, orthophoto, a satellite image, etc.

Web Feature Service (WFS) and Web Coverage Service (WCS)

Other online resources can be implemented as well. It is the case of Web Feature Service (WFS) and Web Coverage Service (WCS). With WFS one can have access to the attributes of a geographical phenomenon, represented in vector mode, with a geometry described by a set of coordinates, while WCS is the analogous service to a

WFS but for raster data. It allows raster display information not only as the offered by a WMS but also querying the value of the attributes stored in each pixel.

Geographical Database

The plan is to finally set up a geo database where upload all the geographical information available in order to make it easy the access by anyone that might need to use them. PostGIS database can be considered as an option for that purpose. PostGIS is a module that adds support for geographic objects to the PostgreSQL relational database for its use in GIS. It is an important component for open source projects with spatial component and it is released under the GPL. However, when the time comes, other alternatives may be also considered depending on the BDU specific requirements.

Due to the lack of specific training in databases for BDU staff this task has not been developed yet. It is planned for the advanced training during the Phase II.

Metadata creation

A metadata is information about data. Creating GI metadata allows us to obtain a catalogue which facilitates the discovering of data, hence its importance. As catalogue servers, two main software are recommended: Geonetwork (OS tool for the creation and management of metadata, developed by FAO) and Deegree.

In this regard, metadata will allow the potential users of the SDI to discover the data and access to them easily by making queries and search through the catalogue functionality.

A recommendation would be to start by capturing one's own metadata, using free metadata capturing tools. Moreover, explaining how metadata can be used to locate data sets, is a very powerful demonstration of the benefit of capturing metadata.

Server hosting

Both the cartography and their metadata ought to be hosted into servers that will permit users to access to all the GI of the future SDI. This will be the last step in the SDI implementation. Mapserver, Geoserver and Deegree software are several of the open source alternatives to use as map servers.

Into those map servers will be hosted all the spatial data that BDU team is collecting from the field and also the data gathered from the rural communities. The latter will need to be previously geo referenced during the data preparation phase. In addition, general base maps of Ethiopia or Amhara region which might be available can also be uploaded, such as the current layers on our GeoCommons platform library.

To sum up we can conclude that the establishment of an SDI in a developing country such as Ethiopia is a complex process even if our goal is to limit the scope to a specific area of interest. Nevertheless, from literature we can check some recent experiences and lessons learnt that may be helpful in this case.

The Implementation Guide for SDI in Africa is a good example to be consulted (http://geoinfo.uneca.org/sdiafrica/default1.htm).

4 DISCUSSION, RECOMMENDATIONS AND FURTHER WORK.

Even the fact that we know more and more about future climate-related threats and patterns of vulnerability, this knowledge remains quite underused by humanitarian organizations and people at risk. New inputs for decision making need to be integrated into humanitarian work. As recently published, "In Africa, innovation is using new technologies to solve old problems" (El País newspaper, 2011).

The purpose of the present work is to build the effective strategies that permit the utilization and integration of GIS technologies in the institutional and humanitarian works that are being carried out in the northern region of Amhara in Ethiopia. This area suffers severe droughts and food insecurity continuously.

In the next table we find a summary of the different tasks related with the GIS capacity building provided.

WORK PLAN	NEEDED
SWOT analysis	100%
GIS plan	
GIS lab	
Equipment	100%
Software	100%
Training	
Phase I	100%
Phase II	0%
Data	
Experts	20%
Communities	20%
Risk Mapping	
Hazard/vulnerability Research	20%
SDI	10%

Table 4. GIS work plan summary with tasks evolution.

After analyzing the situation within the study area, identifying their strengths, weaknesses, opportunities and threats, we proceeded to the planning and implementation of measures whose execution is expected to improve the situation.

The situation in Ethiopia regarding droughts that lead into food insecurity and produce famines is worsen by the threat of terrorism in the neighbouring countries, existing conflicts in the border territories and also the current global crisis that will probably be translated into a huge reduction in funds for cooperation programs. Thus, we realize that we are facing a very hard scenario.

As positive aspects we can mention that in a newbie area in relation to new technologies, the establishment of those implies a major step and a big improvement for the local community, even if it is developed through small actions. As experienced, the team at BDU, ERCS and rural communities' representatives are receiving those actions with great enthusiasm and gratitude.

Certainly, all the stakeholders involved in the project – UJI, ERCS, BDU and, as final beneficiaries, the rural communities of Amhara - are strengthening their collaboration day-by-day. It is precisely the BDU team who acts as a link between UJI and those communities, bringing actions throughout all the year, not just specific activities as the ones accomplished during our visits to Ethiopia. They are the ones who best know the situation and this is very positive to take action on the right track. On the other hand, the ERCS as NGO that carries out humanitarian actions is always very engaged in helping during crises like the current one. That is the main reason why the GIS training carried out has those two targets as main focus.

The project aim of integrating the available GIS tools into the humanitarian actions is being accomplished. We believe, therefore, that we are in the correct direction. We have introduced the use of GPS technologies, the utilization of maps of all kinds and even more, as a forthcoming step, the promotion of the SDI that will help to integrate the GI as something used every day.

In order to continue with this work, the following recommendations can be mentioned:

Continuing the technical input by further training actions directed to the ERCS and the BDU team is a key recommendation and will take place during the Phase II of the project. Training and raising the awareness of these about GIS tools has proven to be an effective option.

The expertise on using geographical data and tools needs to be more developed. The ERCS and the BDU, assisted by UJI, are expected to develop more programs on GIS capacity building for students, instructors and other stakeholders involved in helping farmer communities. While the first steps have been done, the process needs to be continuous and to grow exponentially. One day workshops without follow-up have little impact. The forthcoming GIS e-learning seminar will be a way to gain deeper knowledge, as well as the regular online meetings, support mailing list and other activities with the aim of keeping technological issues at BDU and ERCS agenda. In addition, it is recommended to strengthen the responsibility of the local coordinators in order to help to develop capacity of the staff around them. These coordinators need to be engaged with the different actors and keep in a frequent touch with the UJI team, as it has been done so far.

Farmer community input on observed climate changes and on hazard and vulnerability mapping of the different cultivated areas needs to be systematically collected. Carrying out VCA activities helps to ensure that real impacts are considered. Participatory tools to gather climate and agricultural information by rural communities are very beneficial. In that sense, the advice of BDU and ERCS workers and the use of mobile devices with GPS capabilities, mapping visualization, cameras, etc. play an important role. The idea is to combine participatory risk assessment (based on GIS and GPS) and community-based monitoring of physical variables through mobile devices equipped with video tools (e.g.: the tablet pc) for training and mobilizing workers, volunteers, and people at risk.

Taking into account that the farmers are the ultimate decision-makers about actions taken on the field, it is crucial that they understand and adapt to the risks arising from climate change. It is important to continue increasing the G.I. awareness which targets key stakeholders and farmers. The given training of BDU and ERCS staff on the basic concepts of mapping, GIS and geo localization tools has been just a first step and needs to be continued in the future. The spatial data campaign started will

be crucial for the continuity of further steps, such as the online data publication through an SDI.

Closer collaboration between both BDU and ERCS and the public agencies responsible of producing geographic and climate data is also recommended to contribute avoiding the usual refusal to share data. In the same way, ERCS in Amhara should work in closer collaboration with BDU itself. Specific research topics should be provided to BDU departments, such as the Disaster Risk Reduction one, as topics for joint reflection.

5 CONCLUSIONS

In order to summarize the achievements of the present work some conclusions have been pointed out. It has been discussed how the introduction of GIS and new technologies can affect in a positive manner the development of the needy nations, by making easier the decision making processes. We have seen how a little change can change a lot, and it has been noticed the great potential of information technologies to monitor and manage disasters like floods, droughts or agricultural low productivity.

Regarding the GIS plan designed to face the BDU needs, we can state that we are still in the first stage. The establishment of a GIS laboratory at BDU has been started. In terms of equipment and software required the necessities are now covered. There is no need of upgrading or purchasing licences, due to the free nature of the software in use, and this is a good benefit in terms of saving costs.

In this case, we consider that the selected software covers the needs and functionalities required for the analysis to be performed. Given our experience in this type of technology, we believe this lets us to give better advice to the BDU and ERCS staff, key stakeholders in this project. They are in a way responsible for assisting with decision-making processes and help farming communities to improve agricultural productivity.

Capacity building has begun and the first phase of the GIS training has been accomplished at BDU. However, it is not enough to simply insert new information and tools into existing institutional and humanitarian structures. We have noticed that its use for decision-making needs a continuous training of the people involved. In this regard, feedback and follow-up is necessary after every training action. We could state therefore this objective has not been accomplished totally, due to the limited time of this research. Nevertheless, the geographical awareness of local staff has greatly increased and the forthcoming training actions will hopefully permit to go deeper and spread the use of GIS technologies. Moreover, the design for the coming e-learning program on GIS and food security is already done.

A great enthusiasm by the local staff has been shown when the risk mapping use case and the seminar were developed. This fact shows and encourages the technicians to continue performing this type of activities in the GIS lab, with the participation and feedback of rural communities.

The lack of spatial data in Amhara region has been one of the biggest limitations of this work. In order to increase the availability of those, a data collection campaign has been launched. Technicians of BDU and farmer communities living in the selected *woredas*, have been trained to start collecting those necessary data by using GPS tools. These participatory activities raise the motivation and engagement of the affected people from the first stage of the process, benefiting the accuracy of the results. In that sense, the development of VCA participatory activities within the communities is a key point for the continuation of this work. We need not only to work *for* them but *with* them, including farmers as an active stakeholder in the data collection process.

Related to the latter, the objective of the establishment the Spatial Data Infrastructure that hosts the data gathered has not been achieved yet. The phase II of this work will be important to continue the GIS and SDI training of the BDU members. The increased availability of GI, its best knowledge, optimization and sharing of the resources through SDIs is expected to serve as basis for the boost of the use of such information.

The limited geographical scope of this research has permitted us to notice some improvements quicker. A closer relationship with the BDU staff has been accomplished. This fact allowed us to see firsthand the actual use of the technical equipment provided, as well as the improvements achieved after the appropriate training given. The GIS capacity building has produced a quick change on the actions they take day-by-day. The creation of hazard, vulnerability and risk maps by affected stakeholders is a fact. Geo-location using GPS is a great leap in this direction, as well as the use of GIS to digitize, create and visualize information that can be analyzed by BDU and ERCS technicians almost automatically.

On the other hand, it is still a need to strengthen the collaboration between BDU and the ERCS. The presence of ERCS staff in the activities has been poor and we believe the participation of this NGO will be a positive fact regarding related humanitarian actions in the region.

The objective of sharing this experience within the G.I. Community it is being accomplished by the participation in meetings such as the gvSIG International Conference 2011, where the topic had a positive reception and interest.

To end, it is worth to clarify that this work is just the first step of a real project and that it is still much work to do. In that sense, the recommendations given in the previous section can be an effective guideline for further work that will hopefully improve and develop this research. While this thesis is ending, the PCI is not, thus it is expected to achieve new and positive results in the coming years.

BIBLIOGRAPHIC REFERENCES

ANGUIX A., DíAZ L., 2008. *gvSIG: A GIS desktop solution for an open SDI*. Journal of Geography and Regional Planning Vol. 1(3), pp. 041-048. (URL: http://www.academicjournals.org/JGRP/PDF/Pdf2008/May/Anguix%20and%20D%E Daz%20.pdf; accessed on 10-12-2010).

ASMAMAW T., 2012. *Flood Risk Reduction Action plan, Kokit Kebele, Fogera Woreda. Community based Disaster Risk Reduction and Climate Change Adaptation planning.* Department Of Disaster Risk Management and Sustainable Development, Bahar Dar University, in collaboration with Universitat Jaume I.

BIRKMANN J., 2006. *Measuring Vulnerability to Natural Hazards: Toward Disaster Resilient*. Japan Societies: United Nations University Press, 2006.

BDU, 2011. Information on the College of Agriculture and Environmental Science, (URL: http://www.bdu.edu.et/index.php/acadamics/colleges/agriculture-and-environmental-science, accessed on 03-11-11)

CLAY, D. et al., 1999, *Food Aid Targeting in Ethiopia: A study of who needs it and who gets it*, Food Policy, 24(4): 391-409.

DEVEREUX S., 2000. *Food insecurity in Ethiopia*. A discussion paper for DFID (URL: http://www.addisvoice.com/wp-content/uploads/2010/03/FoodSecEthiopia4.pdf, accessed on 16-02-12)

ECONOMIC COMMISSION FOR AFRICA, 2004. SDI in Africa: an Implementation Guide (URL: http://geoinfo.uneca.org/sdiafrica/, accessed on 09-10-11)

EL PAIS newspaper, 2011, *Journey through the Digital World – Africa*, Report. (URL: http://www.itu.int/ITU-D/sis/newslog/2011/11/14/ReportJourneyThroughTheDigitalWorldAfrica.aspx, accessed on 15-11-11)

Encyclopedia of Nations. (URL: http://www.nationsencyclopedia.com/Africa/Ethiopia-CLIMATE.html, access on 10-10-2011)

ERCS, 2007, Site of the Ethiopian Red Cross Society (URL: http://infomedtec.com/ercs/index.php, accessed on 16-01-12)

FAO, 2006. Food security in Ethiopia, (URL: http://www.fao.org/ag/magazine/0602sp2.htm (accessed on 20-12-11)

FAO, 2006. Information about GeoNetwork project, (URL: http://www.fao.org/geonetwork/srv/en/main.home, accessed on 18-09-11)

FSF, 2000. Free Software Foundation website (URL: www.fsf.org)

Forum Geografico–IGP, 2007, *gvSIG: un cliente avanzado para IDEs*, (Available online at : http://www.igeo.pt/servicos/CDI/biblioteca/PublicacoesIGP/imagens/Forum_Geografi co_n2.pdf, accessed on 05-12-10)

GAVIN E., *Building SDI in Africa: a South African experience*. Hatfield, Pretoria, South Africa.

gvSIG Association, 2009, Site of the gvSIG Association (URL: www.gvsig.com, accessed on 13-11-11)

gvSIG Project, 2005. Site of the gvSIG project (URL: www.gvsig.org, accessed on 12-11-11)

HARVEY, F. AND D. TULLOCH. 2006. *Local-government data sharing: Evaluating the foundations of spatial data infrastructures*. International Journal of Geographical Information Science 20 (7): 743-768. (URL: http://dx.doi.org/10.1080/13658810600661607, accessed on 07-07-11)

IFRC, 2010, Site of International Federation of Red Cross and Red Crescent Society (URL: http://www.ifrc.org/en/what-we-do/disaster-management/ , accessed on 05-01-12)

Intered, 2011. Disminution of funds for Cooperation in Spain, summary table. (URL: http://www.intered.org/sites/default/files/files/Noticias/recortesccaa.pdf)

JAMES J.2007, *The Digital Divide Across All Citizens of the World: A New Concept*, (URL: http://www.springerlink.com/content/f3n744607606k028/, accessed on 04-01-12)

LAND COVER DATA OF ETHIOPIA (GLOBCOVER REGIONAL), (URL: http://www.fao.org/geonetwork/srv/en/main.home, accessed on 08-11-11)

LE BISSONNAIS Y. ET AL., 2001. *Mapping erosion risk for cultivated soil in France.* Institut National de la Recherche Agronomique, Centre de Recherche d'Orleáns, Service d'Etude des Sols et de la Carte Pédologique de France

MUHWEZI B.J., *Consolidating efforts for achieving a sustainable SDI in Uganda*. Geoinformation Services, Uganda Bureau of Statistics.

NUSHI B.- *Multi-view SDI assessment of Kosovo. Developing a solid base to support SDI strategy development.* GIMA Master Thesis, Utrecht.

NYS Tug Hill Commission GIS Strategic Plan 2008 (URL: http://www.thram.org/index_files/GIS_Strategic_Plan_2008.pdf, accessed on 29-09-11)

OSGeo Foundation site (gvSIG chapter), (URL: http://www.osgeo.org/gvsig, accessed on 15-12-10)

OSI, 2000, Site of Open Source Initiative, (URL: www.opensource.org, accessed on 07-12-10)

QADIR U., 2009. *Integrating Climate Information into Humanitarian Efforts*. Final Internship Report. (URL: http://portal.iri.columbia.edu/portal/server.pt/gateway/PTARGS_0_2_6433_0_0_18/Ujala%20Qadir,%20final%20report.pdf, accessed on 10-10-11)

RAMSEY P., 2007, *The State of Open Source GIS*. Refractions Research. (URL: http://www.refractions.net/expertise/whitepapers/opensourcesurvey/survey-open-source-2007-12.pdf, accessed on 03-12-10).

SDI Cookbook, Global Spatial Data Infrastructure Association (URL: http://www.gsdi.org/, accessed on 17-12-11)

STEINIGER S. AND BOCHER E. *Why Open Source? An Overview on Current Free and Open Source Desktop GIS Developments.* (URL: http://www.redhat.com/about/whyopensource/, accessed on 03-12-10)

STEINIGER S. AND HUNTER A. J. S., 2010. *Free and Open Source GIS Software for Building a Spatial Data Infrastructure.* Dept.of Geomatics Engineering, University of Calgary, Canada. (URL: http://freefr.dl.sourceforge.net/project/jump-pilot/w_other_freegis_documents/articles/sstein_hunter_fosgis4sdi_v10_final.pdf, accessed on 13-10-11)

SUAREZ P., 2009. *Linking Climate Knowledge and Decisions: Humanitarian Challenge.*University of Boston, The Frederick S. Pardee Center for the Study of the Longer-Range Future. The Pardee Papers / No. 7 / December 2009

UJI, 2008. Site of Univeritat Jaume I de Castelló, section News, (URL: http://www.uji.es/ES/noticies/detall&id_a=26973762, accessed on 12-12-11)

UNISDR, 2004. *Living with Risk: A global review of disaster reduction initiatives.* Report.

USHER, A. 2010. *Communities Eclipse Governments in Mapping the World.* The Web of Geospatial Collaboration (URL: http://www.imagingnotes.com/go/article_freeJ.php?mp_id=259, accessed on 12-10-11)

WAWER R., STEENBERGHEN T. , 2008. *Evaluation of FOSS4G software projects for environmental applications. Evaluation of gvSIG.* (URL: https://lirias.kuleuven.be/bitstream/123456789/239295/1/Evaluation_FOSS4G_software_projects_environmental_applications-gvSIG.pdf, accessed on 02-12-10)

WIKIPEDIA, Information on SWOT matrix, (URL: http://en.wikipedia.org/wiki/SWOT_analysis, accessed on 30-10-11)

WIKIPEDIA, Information on Fogera woreda, (URL: http://en.wikipedia.org/wiki/Fogera, accessed on 14-11-11)

WHEELER, DAVID A., 2007. *Why Open Source Software / Free Software (OSS/FS, FLOSS, or FOSS)? Look at the Numbers!* (Available online at: http://www.dwheeler.com/oss_fs_why.html, accessed on 8-07-11).

WORLD BANK SDI Report - SDI Implementation (in a Developing Country Context) (URL: http://www.osmgb.org.uk/elogeowiki/index.php/World_Bank_SDI_Report_-_SDI_Implementation_%28in_a_Developing_Country_Context%29#Data_Issues, accessed on 13-01-12)

APPENDICES

APPENDIX A: GIS SEMINAR AT BAHIR DAR UNIVERSITY

Introduction to gvSIG as desktop GIS/SDI client

21th - 24th November 2011

Sergio Clark López

The goal of this seminar is to get in touch with the main functionalities of the gvSIG application, a Free Open Source GIS software developed in Spain with public funds. We will use the 1.9 version. We will take a practical look at both commonplace GIS tools as well as more innovative tools that gvSIG provides.

Installation of *gvSIG Version 1.9 for Windows XP*

(downloads from www.gvsig.org**)**

⅄   gvSIG + prerequisites (JRE 1.5.0_12, JAI and JAI Image I/O):
  - ⅄   Download and unzip the Windows installation package from the downloads table (in the downloads section).
  - ⅄   Execute the EXE file and follow the instructions.
  - ⅄   The following components will be automatically installed:
    - ⅄ Java Virtual Machine *
    - ⅄ JAI libraries *
    - ⅄ JAI image I/O libraries *
    - ⅄ gvSIG

* These components will be installed only if they are not present in the system or if the version of the installed ones is not compatible with the program requirements

Or:

Use the installer ready for **Windows XP, Windows 7 and Windows Vista** (called "***gvSIG portable***") if you are using those Operative Systems.

The objective of this distribution is to allow the user running a fully-functional version of gvSIG 1.9 (including extensions) on a computer without the necessity of any software installation.

Exercise 1: Data visualization

When you start gvSIG, you will see the *Project Manager* window (if you need to open this dialog later on, use the *Show / Project window* menu option):
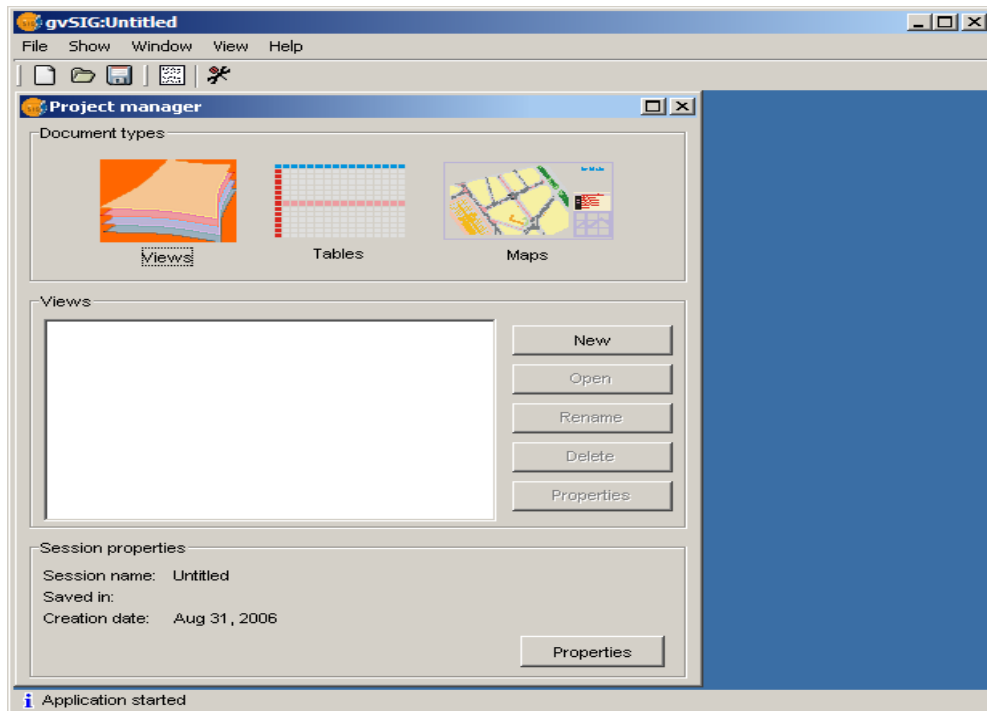
** We should configure first the *gvSIG Preferences* in order to change the GUI to English language (*Preferencias / General / Idioma*).

The gvSIG application manages three *document types* in each project. *Views* display sets of geographic layers, *Tables* include record sets from feature layers added to the views and also alphanumeric tables. *Maps* are graphic layouts combining multiple views and elements like legends, north arrows and scales, usually created for printing.

- **A simple view**

  - Make sure the document type *View* is selected in the Project manager and click on *New*. Select the new view and click on *Rename* to change the default view name (for instance, to *Spain*). Open the view by using the *Open* button or just by double-clicking on its name.

73
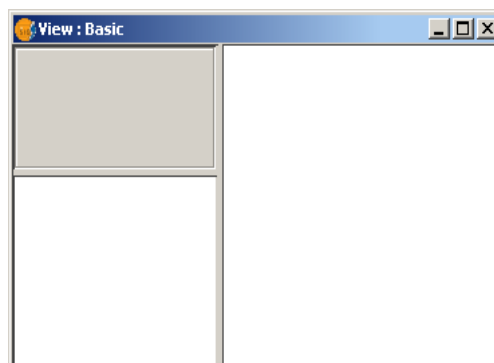
- The view will open, showing three areas: the area on the right is the *geographic view*, the area on the top left is the *Table of Contents (TOC)* where the layers are listed, and the area on the bottom left is the *Locator* area of overview.

- Use the Add layer tool ⧄ that you can find in the toolbar or in *View / Add layer*. The *Open layer dialog* will open. In the *File* tab, click on Add to see a file browser. Since we are going to load a Shape file, keep the default file filter *gvSIG shp driver* and find the layer *esp_provincias.shp,* available in the folder *Data/Cartography/Espana*. Click *Open* and then OK in the open layer dialogue.

- You will now see the layer added to the TOC and the provinces of Spain displayed in the geographic view. Now click on the layer name in the TOC to make it the *active layer*. Many operations in gvSIG will use the active layer or layers.

- Right-click on the layer to open the context menu, and choose *Properties*. In the *Layer properties dialog*, go to the *Symbols* tab and select the *Unique Values* option. Select *COM* (for Community) as the *classification field*, then click on *Add All,* and then on *Apply*.

  In this way, each province will be displayed with a symbol depending on which region or community it belongs. We can also pick the *Intervals* symbology option to classify the features depending on numeric attribute values.

- Now click on the *Labelling* tab to go to the labelling properties. Set the *Enable labelling* checkbox, choose again *NOMBRE99* as the *labelling field* and set a fixed text height of 10 in pixel units and a fixed color. When you click OK, the province names will be displayed on the view.
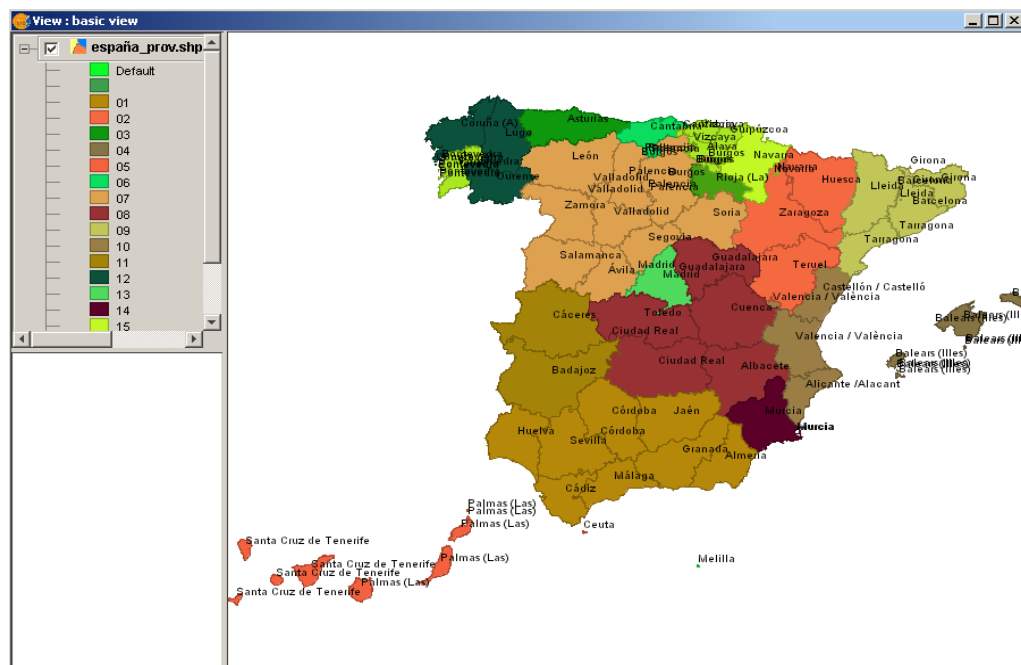
- **Now try yourselves!**

Follow the same process but with your own country, creating a new *View* named

Ethiopia and using the layer *ETH_adm1.shp,* available in the folder *Data/cartography/Ethiopia*. Take into account that the cartographic projection of those data is different from the previous one, so you should first change the View projection into a geographical one (use the EPSG code 4326, the same used by GPS devices).

* ___Tip:___ Use the field *NAME1* as the *classification field* when applying the *Symbology,* and the same field for *labelling* the name of the Ethiopian states. The result should look like this:

And, if haven't done it yet, **SAVE THE PROJECT** in a writable location!!
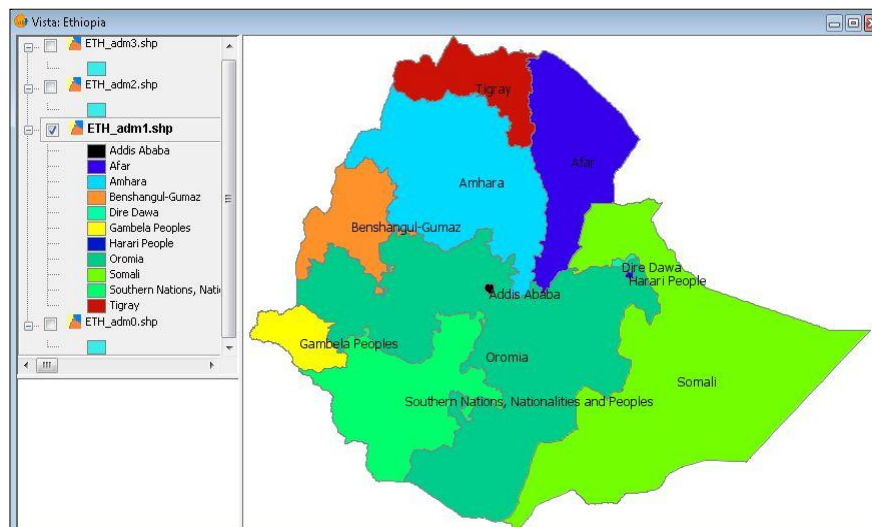
- **Navigation**

  - Keep the *Ethiopia* View open. First, let's set up the locator. Go to the *View / Configure locator map* option, click on *Add layer* and add the *Data/Cartography Ethiopia/ETH_adm0.shp* layer. A general map of Ethiopia will show up in the Locator area, helping us to know in each moment the location of our view in the country. Close the dialog.

  - We can also add to the view other layers, such as the rivers, roads and water bodies of Ethiopia. Also, keep in mind that many other vector formats are supported by gvSIG, such as dxf or dwg CAD formats. Don't forget to select the *gvSIG DXF Memory driver* filter when browsing those kind of files.

  - Now we can use some common *navigation tools* like zoom and panning, from the main toolbar or under *View / Navigation*. We can also directly *zoom to a layer* using this option from the layer's context menu.

  - When navigating, notice that the view area is shown in the *Locator*. We can also navigate by clicking or dragging a rectangle on the locator area.

  - Use the *View/Navigation/Zoom Manager* 🔲 to store the view extent with a name (for instance we can make a zoom around the Addis Abeba region and save it with the same name) and restore the saved extents when convenient.

- **Locate by attibute**

  - A quick way to navigate to a certain place is by using the *View / Locate by attribut*e tool 　[icon]　 and specify the value of an attribute in your feature layer.

  - For instance, find the state where we are, *Amhara,* by entering this information in the Locate dialog (using the field *NAME_1*).

  - Then click on the button *Zoom* to locate the feature in the view.

  - Notice that you can *control the scale* of the view just by typing it in the status bar scale control:

  [1: 17,110,787]
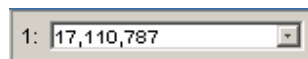
- **Image transparency (change detection)**

  - Let's load two images for the same area, taken on different years. Open now the View named *Spain* and add the following datasets to the view: *Puerto_1980.ecw* and *Puerto_2002.ecw* from *Data/Cartography/Valencia* folder (choose the *gvSIG Raster Driver filter* in the file browser), and zoom to any of them.

  - In the TOC, place the *Puerto_2002.ecw* layer on top. Now, go to its *Raster properties* (in the layer's context menu) and select the *Transparency* tab. If you activate the opacity control and set a value around 50%, you will be able to distinguish the changes in the harbour structures between 1980 and 2002.
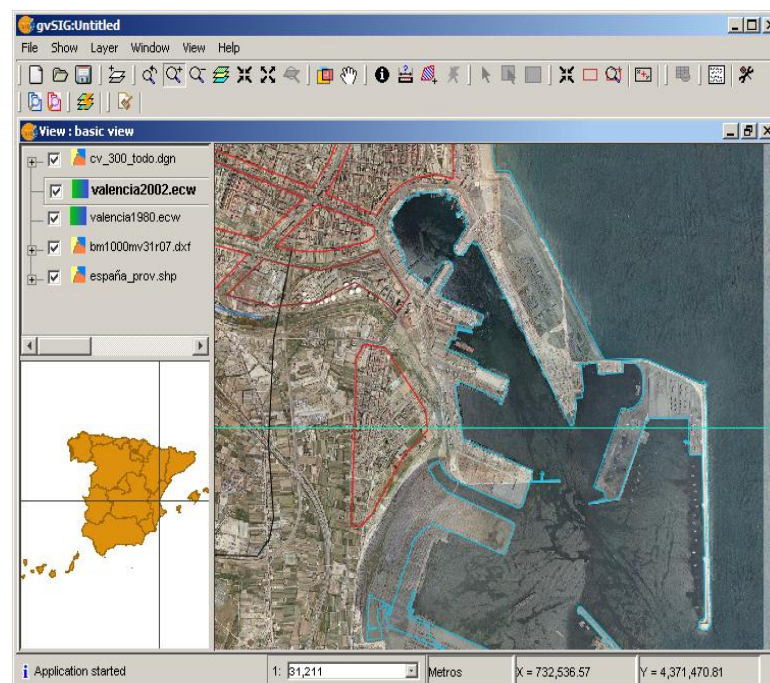
  - Now open again the View *Ethiopia* and try the same process loading two *Landsat* images from the region of Ibnat (Ethiopia), taken in different years:

one in November 1994 and the other in November 2009 (they're inside the folder *Data/Cartography Ethiopia/Images).*

* In order to maintain the correct overlap with the already visible layers you may want to choose the option *Reproject raster to the view projection* when the window asks you. Nevertheless, for this exercise is not necessary, so can leave it with the default option *Ignore projection*.

Exercise 2: Visual analysis

We will take a look now at how to work with the legend, selection and query tools to get useful information at a glance.

● **Create another view**

- Go back to the Project manager window (*Window/Project manager* menu option) and open another view. You can call it *Valencia*.

- Go to the *Spain view*, activate the *Puerto_2002.ecw* layer and use its context menu to *copy* it to the clipboard. Now go to the new *Valencia* view, open the context menu in the empty TOC and choose *paste*. A copy of the layer will appear in the new view.

- Add the center town image: *Data/Cartography/Valencia/ Centro_2002.jp2.*

- Now add the city blocks in *Data/Cartography/Valencia/ manzanas_valencia.shp*. Because we just want to see the boundaries, go to the *Properties / Symbols* of the layer and (leaving the Unique symbol option) uncheck the *Fill* checkbox. You can also increase the *line width* to 2 or change its *color*.
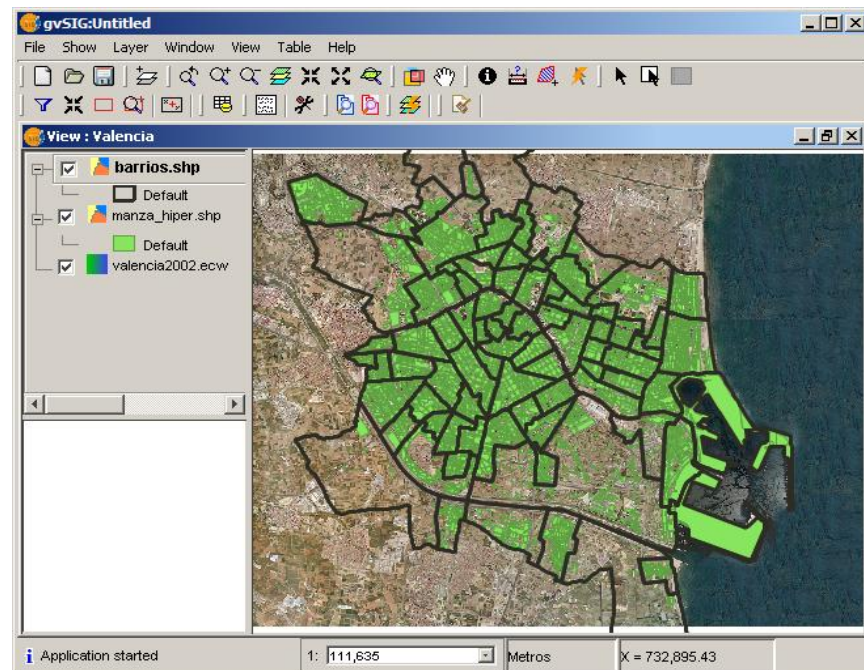
- **Information tool**

  You can use the information tool 🛈 to get attribute information about one or more active layers (select both layers .shp and .jp2 in the TOC with the Ctrl key). The info dialog will show up:

- **Apply a legend for quick classification**

  - The city block data has some area information. We could apply an *Intervals* legend in order to quickly classify this kind of data. For instance, go to the Properties / Symbols page of *manzanas_valencia.shp*, select *Intervals* legend type and AREA as 'Classification field'. Then select *Natural* type intervals, number of them (5), and colours for begin and end. Then click on *Compute intervals.*

  - This will show us an *Intervals legend* with 5 value ranges that classify our shapefile by colors depending of its polygons area.
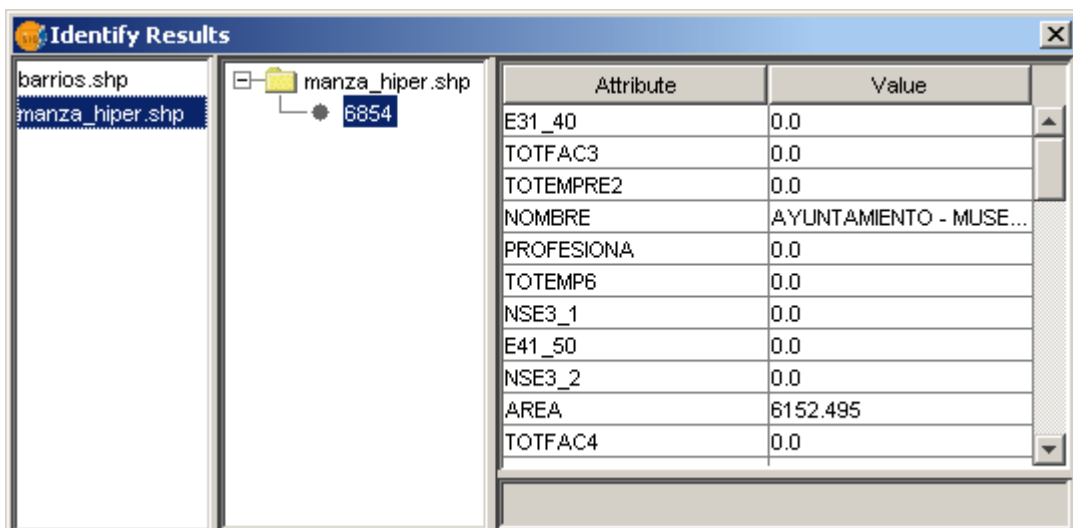
- **Let's do it now with some data from your country!**

  Open the View *Ethiopia* again. Uncheck the satellite images, in order to not visualize them at the moment. Load in the View the layer *ETH_roads.shp* which is inside the *Data/Cartography/Ethiopia* folder and keep visible only this layer and the administrative one.

  We want now to make a nice visualization for the layer *ETH_roads.shp.* by classifying these roads depending on their importance, so we will apply a certain *legend*. On that purpose, make right click on the layer in the TOC, go to Properties/Symbology and choose a *Unique values* legend, classified by the field *RTT_Descri.*

  Of course, we are able to modify each symbol (which corresponds to a different type of road) by changing its colour or width. Try it! And moreover, we can *Save legend* if we'd like to use it in future projects.

Your View now may look something like this:
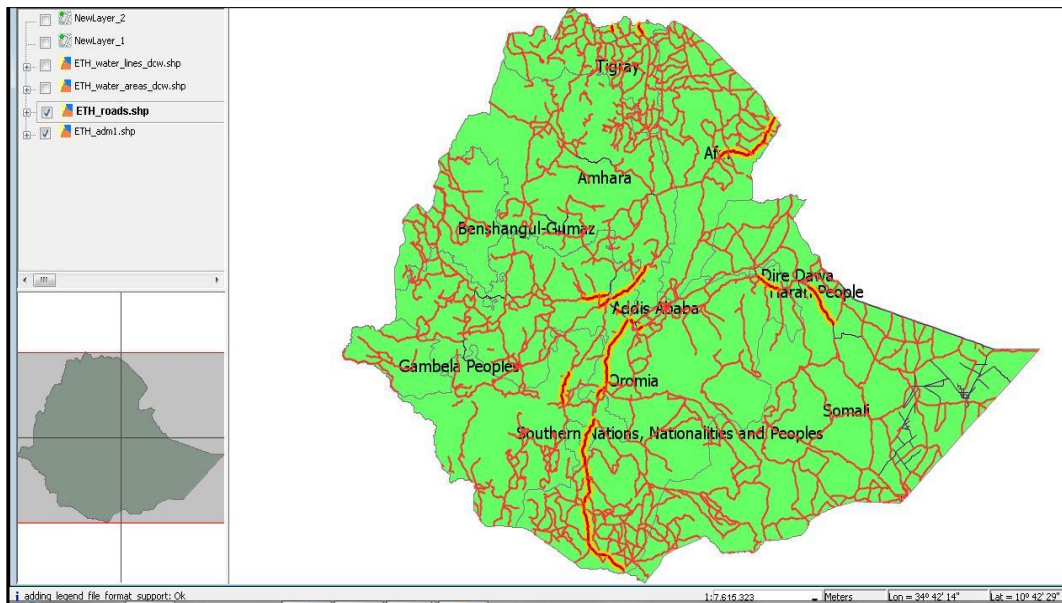
- ● **Using basic selection**

Keep in mind that each layer keeps its own selection set, and selection operations only affect the selection set of the active layer.

- ● Use the *Select by Point* tool to pick one or more features (use Ctrl key for multiple selection).

- ● Try the *Select by Rectangle* tool by dragging a box on the active *blocks* layer.

- ● **Explore the attribute table**

Sometimes it's useful to visualize directly the feature attributes to get a glimpse of the characteristics of our data.

- ● Make a layer active with some selection in it. Go to *Layer / See table of attributes* and open the record table for the layer. Notice that a new set of *tools* is available in the toolbar area. You can, for instance, perform table joins and links here.

- ● Click on a field name (like *Area*) to use the ascending and descending sorting tools. You can also view the Statistics of this field.

- ● Use the *Move selection to top* tool to display the selected elements at the top of the table.

- ● Notice that selection can be performed on the table as well as in the view, and the selection set will be displayed in both with the selection colour.

- ● You can use the *Zoom to Selection* tool in *View/Navigation* to find the selected elements in the view.

- Use the *Layer / Clear selection* menu option to clear the selection set of the active layer.
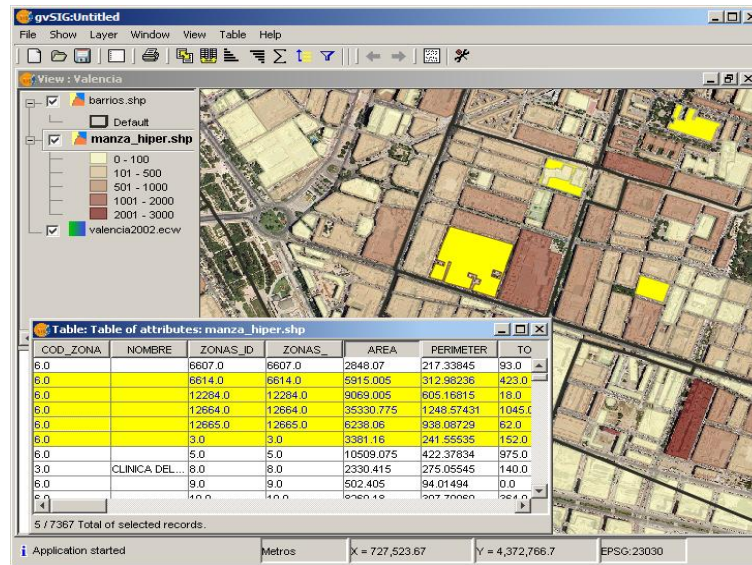
- **Analysis by search and filtered selection**

Suppose we need to find the roads that are "unknown" to make some research about them.

- First, let's find out which of our roads have the atributte "unknown" in the table. Make the *ETH_roads.shp* layer active and choose the *Filter tool* which can be found in the toolbar or in *Table / Filter*.

- In the Filter dialog window, build the expression *RTT_DESCRI = 'Unknown'* by clicking in the Field, Operator and Value areas. Hit the *New set* button and use *Zoom to Selection* to view the location of these blocks. We can use the *Move selection to the top* option. How many *unknown* roads do we have?

- If you want to save a layer's selection to a new dataset, use the *Layer / Export To...* command which will save only the selected features of the layer (or the whole layer if there is no selection). For instance, we could export to KML our selected features. Then, we can load it in *Google Earth* software for instance. Try it!

Exercise 3: Using Remote Services

As an Spatial Data Infrastructure (SDI) client, gvSIG allows us to add and work with remote Geographical Information which is available on internet. The remote data will be retrieve through OGC standard services such as WMS, WFS, WCS, Catalog and Gazetter services. gvSIG can also access other common web services which provide spatial data, such as ArcIMS or ECWP Services.

A third way to retrieve remote spatial data from gvSIG is connecting us to remote spatial databases like PostGIS, MySQL or Oracle via GeoDB, which allows us to use efficiently large geographical datasets.

In this way gvSIG acts like a central meeting point where different kinds of

GeoServices can be accessed and used, becoming in this way a useful and powerful building block in applications that use SDI technology.

- **Using WMS services**

  In the Valencia city scenario that we developed before, we can get some additional information from available WMS resources. First, open the *Valencia* view.

  - To add an WMS service, use the WMS tab in the Open Layer dialog. Select this URL: *http://ovc.catastro.meh.es/Cartografia/WMS/ServidorWMS.aspx* which has Cadastral information, from the default servers list and click on *Connect*. After a while, some text should appear in the Description area.

  - Click Next twice to get to the Layers tab, where you can pick the '*Catastro*' data, then click on the Add button. In the next page, select the png image format (to have transparency values) and the 23030 coordinate system of the view (the one suitable for Spain).

  - If we zoom close to a block that interests us, we'll see the parcels defined in the cadastral census. With the WMS layer active, the info tool can provide us with the Reference Number of a parcel, which is an hiperlink. If we click on it, we will reach to the cadastral census web site that shows us very detailed information (it may be necessary to add an exception and obtain a certificate to access to this web site first time).
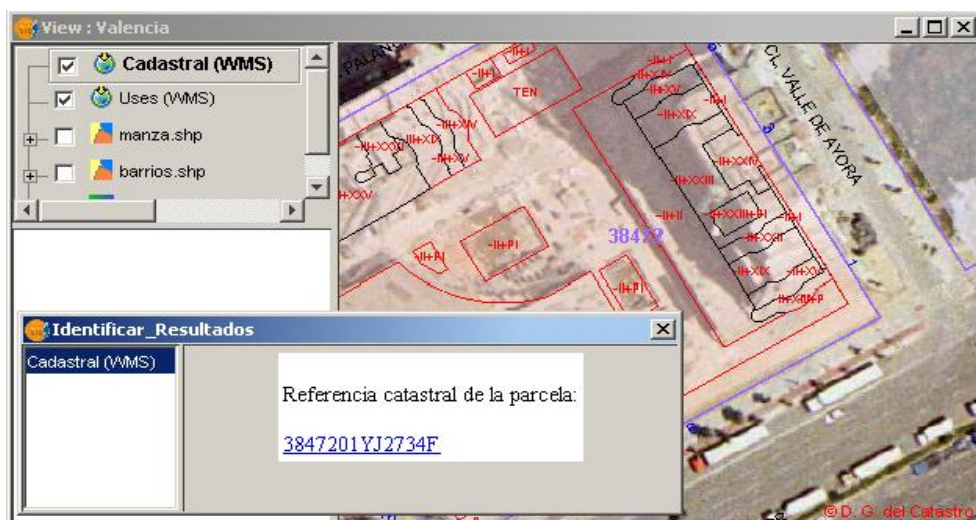
- **Using WFS services**

The Web Feature Service specification is an interface allowing requests for geographical features across the web. It is highly interoperable, as it uses the XML-based GML format for geometry and attribute data exchange.

  - Open a new view.

  - We can load a WFS layer with the WFS tab in the add layer wizard. For this example you can use the OGC Feature Service located at http://inspire.cop.gva.es/geoserver/wfs

  - Select the layer *Comunicaciones_cv300*. At this point you will be required to select all the attribute fields you want to retrieve attached to this spatial data, choose all or some of them. In the next tabs, click OK. Then, make *zoom to*

layer.

- Once the layer is added (it may take a while) you may have a look at the attribute table to see, all the actual attribute data you have retrieve from the WFS.

- We can now use the WFS layer as any other feature layer. We can, for instance, create a legend and add labels to this layer.

- You can see that the WFS layer acts like any other vector layer. We can also export the layer to a local file or database. We can also do editing or any kind of feature geoprocessing (as we'll see later on), and save the changes to a local dataset.

- **Using WCS services**

The Web Coverage Service specification allows access to geospatial 'coverages' or raster data sets that represent values or properties of geographic locations (cell values), rather than just the pictures contained in WMS generated maps. You can work with WCS layers as with any other raster layer. Notice that the Raster properties are all available for them.

- Select the WCS tab, and use this URL:
  http://inspire.cop.gva.es/mapserver/wcs (or another one that you might know and is available). These are satellite images from the Coastal Valencian Region.

- Once the connection is established, click on the next button and select one of the available coverages.

- Before adding the coverage to the view you must select the SRS and the output format you want to get the coverage from the server.

- The last step, you may be requested to choose from the available parameters, like the image bands (for a natural colour image, you'll typically select all the bands)
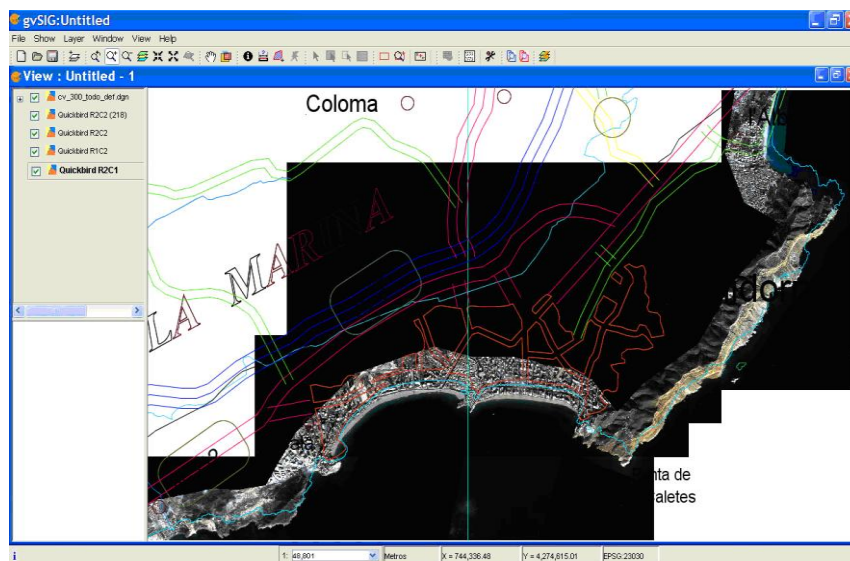
Notice that you can change the properties of each WMS, WFS or WCS layer

without having to add the layer again, just use the specific service properties from the context menu of each layer (i.e: *WMS Properties*)

- **Using Gazetteer and Catalogue web services**

Gazetteer services give you the location of a specific geographic feature that can be searched by name. gvSIG supports standard web services that provide this functionality, and allows you to discover data and locate it in the view.

- Click on the *Gazetteer Search* tool: and connect to the http://inspire.cop.gva.es:80/deegree/wfsg gazetteer. The protocol should be WFS-G.

- We want to locate on this image the city of *Valencia.* Search for it. You will get some result records. Select one and click on the Localize button to find it in the view.

Exercise 4: Editing

In this exercise we're going to digitize some features over the image we have in our *Valencia* view. We'll create polygons that describe different features: buildings, recreation areas and green areas. Then, we'll add alphanumeric info to them. Open the view *Valencia* and keep visible only the image *Centro_2002.jp2,* that will be the base to draw our features over it.

- **Create a new layer**
  - Use *View / New Layer / New Shape File (.shp)*
  - Select *Polygon type* as geometry type. Click next.
  - Add a field named *Use*, leave the default type (String) and lenght.
  - Set a path for the output file in a writable location, like *C:\My_ project\Centre_Project.shp*
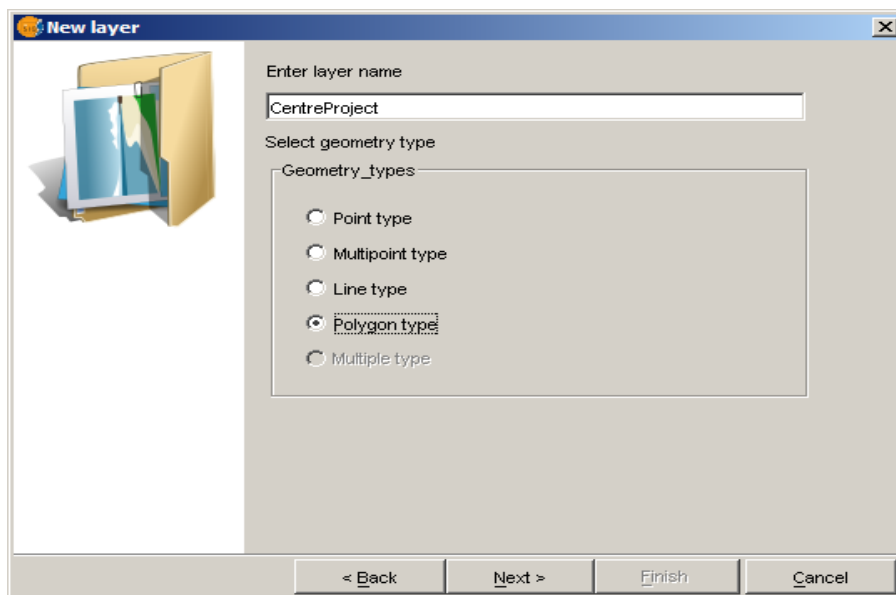
- You should see a new layer added to the TOC, and marked in red, to show that the layer is in editing mode. You will also see that the editing console has opened at the bottom of the view, and a number of new editing tools show up in the toolbar area.

- **Sketch your features**

  - Select the Polyline drawing tool

  - Click on the location for the first point of the feature to draw. Click then on the location of new vertices to draw the outline. To close the polygon make double click or use the context menu *Terminate* option or type *C* in the editing console.

  - You will see that the new polygon is highlighted with the selection color. You can now go ahead and create more buildings, and other polygons for the recreation and green areas of your project. Try combining *line and arc segments* by selecting these options in the context menu. Also, notice how the active *snapping* will help you to place new points on previous vertices or sides of your polygons, so you can easily avoid gaps.

  - If you want to *change the position of some vertex*, switch to the selection tool, click on the vertex that you want to move, release the mouse button and then click on the new location for the vertex.

  - You can use the *undo/redo* tools, or open the *command stack* tool to go back to previous editing states.

84
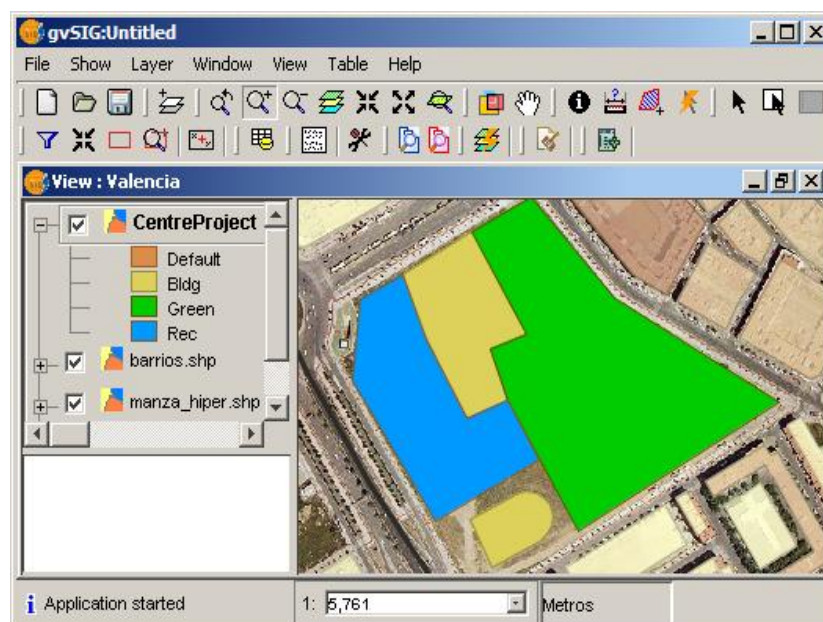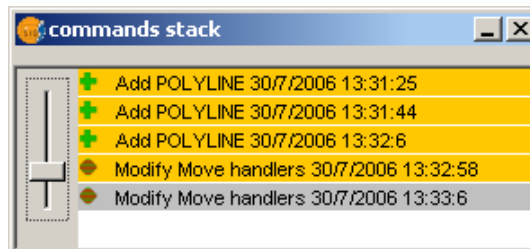
When you are done, make sure the layer is selected in the TOC and use the *Layer / Finish edition* option, choosing *Yes* when asked if you want to save the results.

- **Assign attributes to the sketched areas**

  - Select the *CentreProject* layer in the TOC and choose *Layer / Start edition*

  - Choose *Layer / See table of attributes.* To change the value of any field, click on the table cell, type the new value and hit the Enter key. The polygon whose attibutes you are editing will be selected when you click on the table, and viceversa.

  - For instance, assign values like *Building, Public and Green* to the *Use* field.
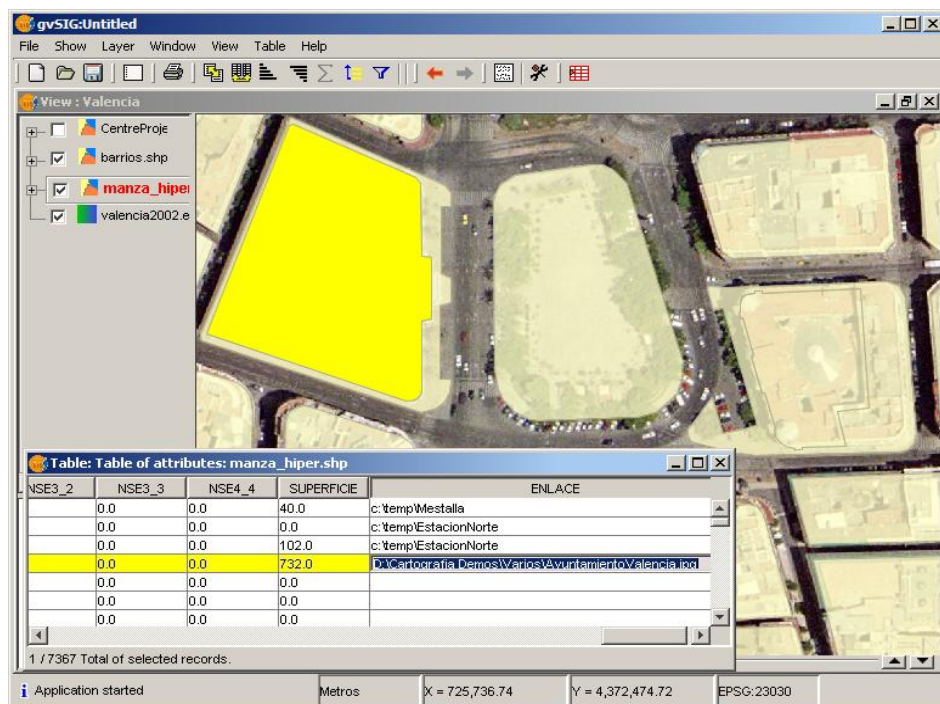
- Close the attribute table and finish editing, saving the results. For a nicer display, choose a *Unique Value legend* for this layer and assign proper colors to each *Use* value.

Now we can try to create and edit some features in the same way, over one of our images from Ethiopia. For instance, open the *Ethiopia* view and create a new SHP file, type polygon, where we will digitize the small lakes existing in the East part of Lake Tana, based on our *Landsat* images already loaded. Then we can add some alphanumeric information, like *name* or *area*.

And don't forget to **SAVE THE PROJECT** from time to time.

- **More editing**

Unlike other GIS packages, gvSIG allows you to edit multiple layers at the same time.

You can also edit any feature dataset as long as you gvSIG can read it (including WFS) and then save the results to writable formats by using the *Layer / Export to...* menu.

Exercise 5: Geoprocessing

We are going to see how to use the *geoprocessing* tools to perform spatial analysis. The idea is to find which city blocks may be affected by work on a proposed new water pipe. Open again the view *Valencia*.

- **Sketch of a water pipe proposal**
  - Create a new shp layer with Line as geometry type, let's say *water_line*. In this case we don't need to add any fields.
  - Use the polyline tool to define the path of the water pipeline over the image of the Valencia city center. Then finish editing and save the results.

- **Calculate a buffer around the water pipe**
  - Open the *geoprocessing wizard* with View / Geoprocessing Wizard
  - Select the *Buffer* operation, and in the next page, enter *water_line* as the input cover.
  - Select the default *buffer defined by distance* option and enter the *distance* (e.g. 100 meters). Choose the option to *dissolve entities*.
  - Browse in a writable location and assign an *output cover* (the file that will be created containing the result). Click on *accept*.
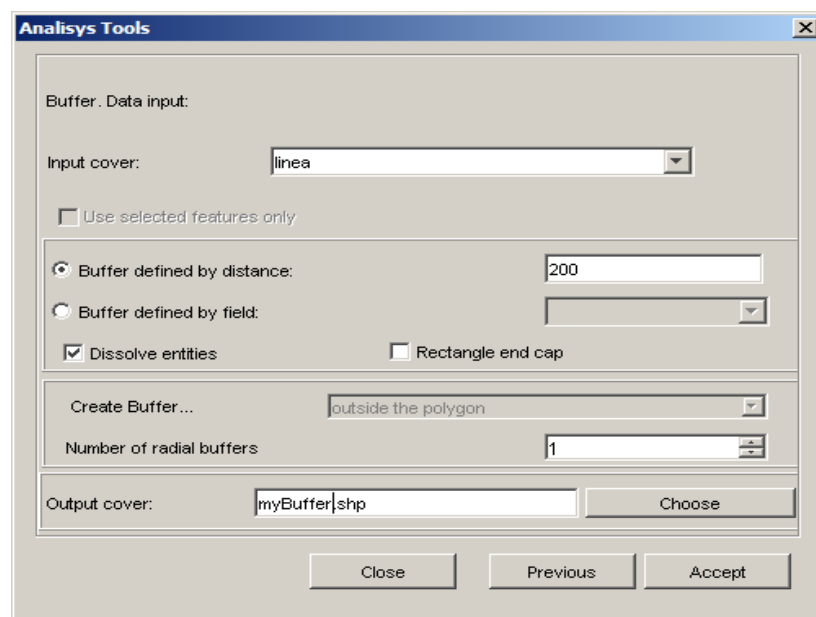
You should see a new layer added to the TOC, containing the buffer area. You can check the buffer distance by measuring it using the *Measure distances* tools. You can also set a transparency value to the legend of this layer to see through the buffer.
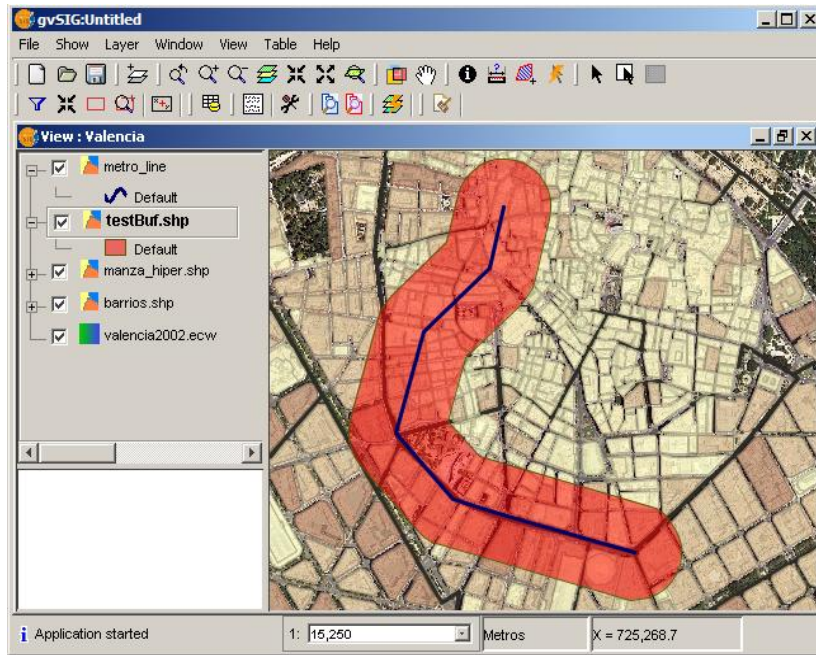
- **Intersect the buffer with the city blocks**

  - Open again the geoprocessing wizard and select the *Clip* operation.

  - Set *manzanas_valencia.shp* as the input cover, the *new buffer layer* as the clip cover and pick a suitable name and location for the output. Click on *Accept*. We don't need a spatial index for the result (it should be quite small).

You should see now a new layer added to the TOC containing the clipped city blocks affected by the waterpipe project. The attribute information is preserved, so we could now do some more analysis on what kind of population is affected and so on.
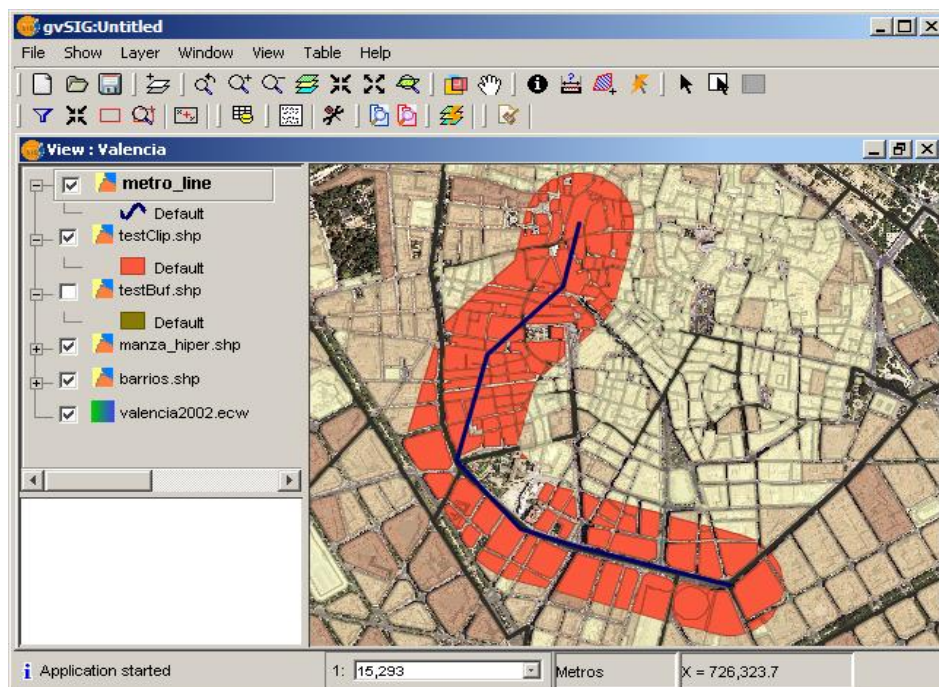
Try it yourselves!

Display over the view of Ethiopia the areas influenced by the existing water bodies, assuming that the maximum distance from the water to any influenced place is 20km. We can even create two rings with different distances around the water bodies, such as 10km for the more humid places and 20km for less humid but still influenced by water.

     * ***Tip***: Create a new View with UTM projection (choose the EPSG code = 20137 inside the Properties of the View, which is the one suitable for Ethiopia).

Then load there the layers: *ETH_adm3_UTM.shp* and *ETH_water_areas_UTM.shp* and crate a buffer layer around the *water areas* layer, with two rings of 10km each.

Use the *ETH_adm3_UTM.shp* layer that contains the provinces to *Clip* the resulting buffer around the resulting water bodies buffer. Go the Properties of the layer to change the colors and label the provinces in order to make it nicer!

The results should look more or less like these:
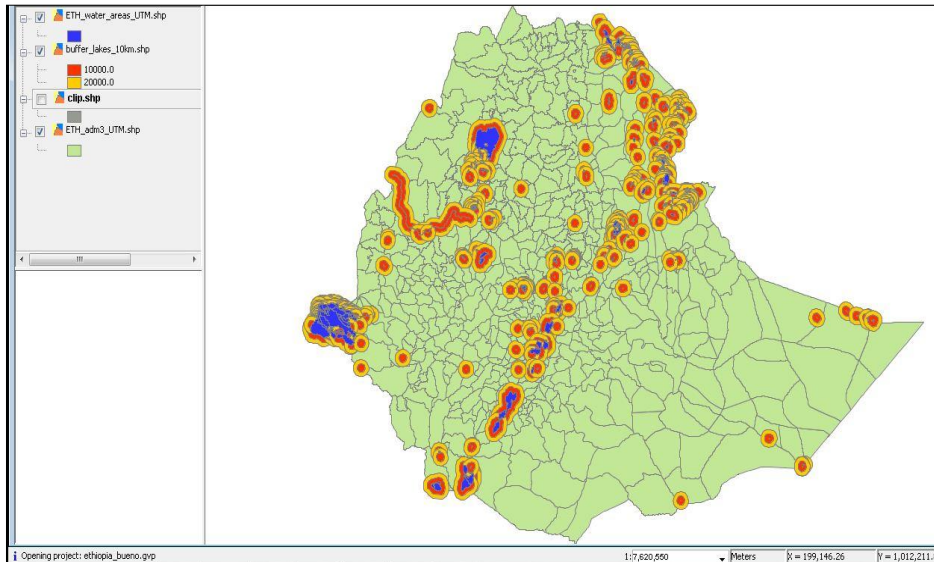
1.Buffer (areas of influence) with two rings (10 and 20km) around the water bodies.
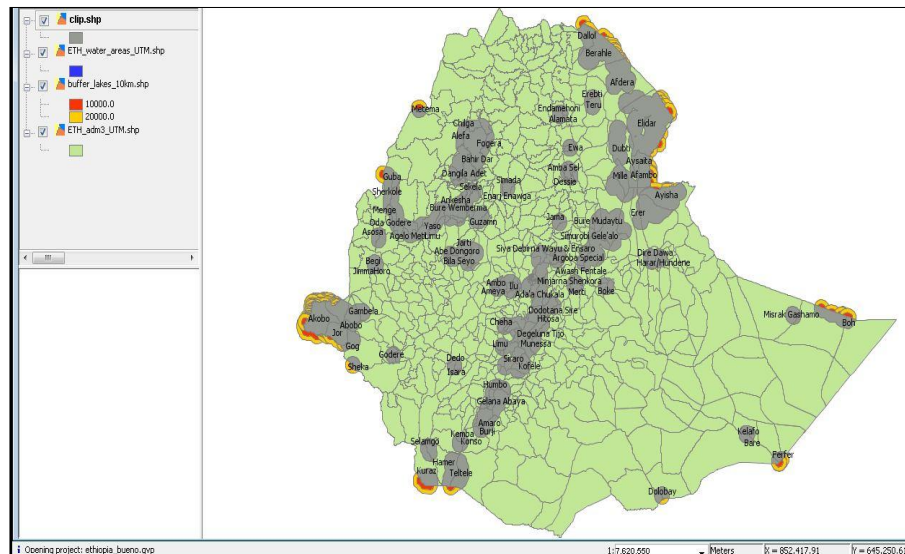
2. Areas actually influenced by water, labeled with the name of each admin.region.

Exercise 7: Map authoring

Creating maps that show accurante and meaningful information is one of the key functionalities of any professional GIS. We'll see at a glance how to do this with gvSIG.

- **Create a Map document in the project**
  - In the Project Manager window, select the Map type of document and click on *New*. You can rename it as you did with Views.
  - Double click on the map name or use the Open button to display the map layout canvas. Notice that a new *Map menu* and lots of new tools are now available.

- **Add Views to the map**
  - Click on the *Map/Insert/View* tool [M] and drag a rectangle on the map layout. You will see a dialog to select one of the views in your project. After you *accept*, the selected view will be displayed on the rectangle. You can repeat the same process with other views.
  - You can navigate on the map layout using the map navigation tools:

  - You can also change the extent displayed within the views in the map by using the View Frame zoom tools (make sure the View is selected):
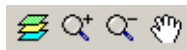
  - In addition, you can *Rotate* a view in the map. Select it and open the *Properties* by using the context menu on it (right mouse button). In the bottom right corner you can specify and preview the rotation angle.
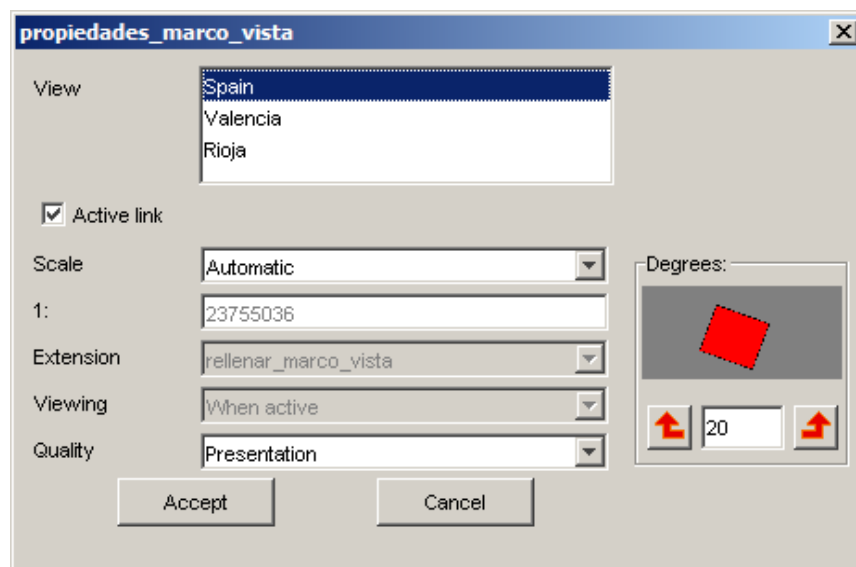
- **Add legends to the map**
  - You will typically add a legend to show what symbols are applied to the layers in your view. To do this, use the Add Legend tool and drag a rectangle. The following dialog will pop up to select the view and layers
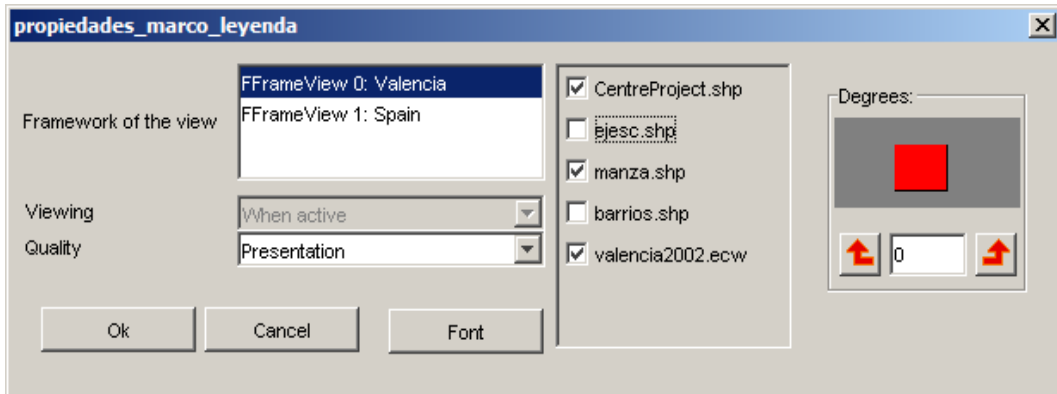
  - Once the legend is drawn, you can refine its design by working with its individual elements. To do this, select the legend and use the *Map / Graphics / Simplify legend* tool.
- **Other map elements**
  - A common map element is the Scale, associated to a view. You can add scales to the map by cliking on the *scale tool* and dragging a rectangle on the layout. The following dialog will let you choose some properties for the scale display:
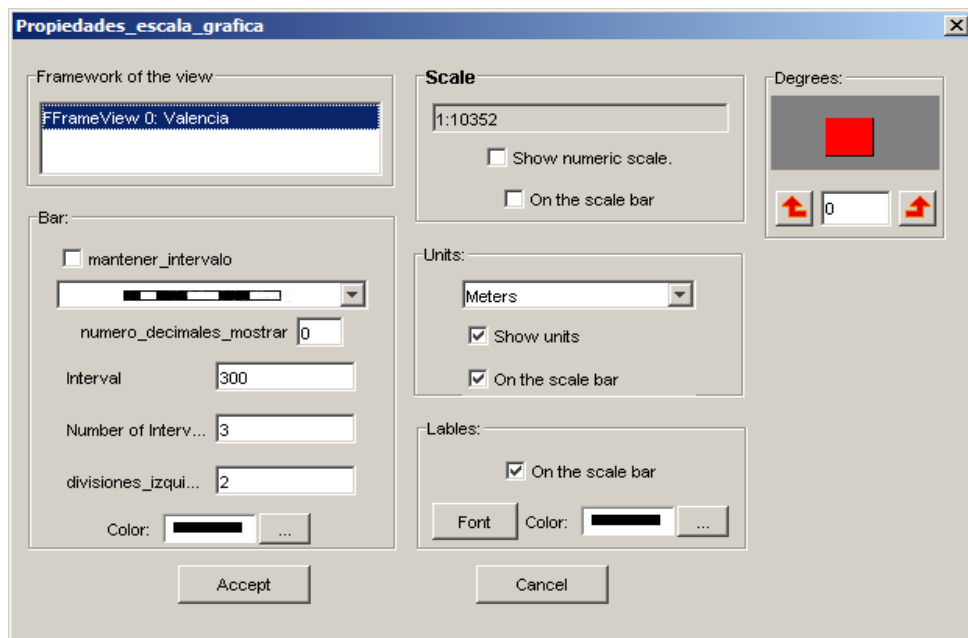
  - Another common element is a North Arrow, that can be added in the same way by cliking on the *north arrow tool*.
  - You can also add to the map graphic elements like text, tectangles, lines, etc. by using the corresponding tools. You can also import images files.

90

- Map elements can be grouped or moved and their depth order changed by using the tools available for these operations.

- The properties of any map elements, like the color of a graphic element, can be modified by selecting it and using the *Properties* option in the context menu.

The following figure shows an example combination of most common map elements displayed in the layout.
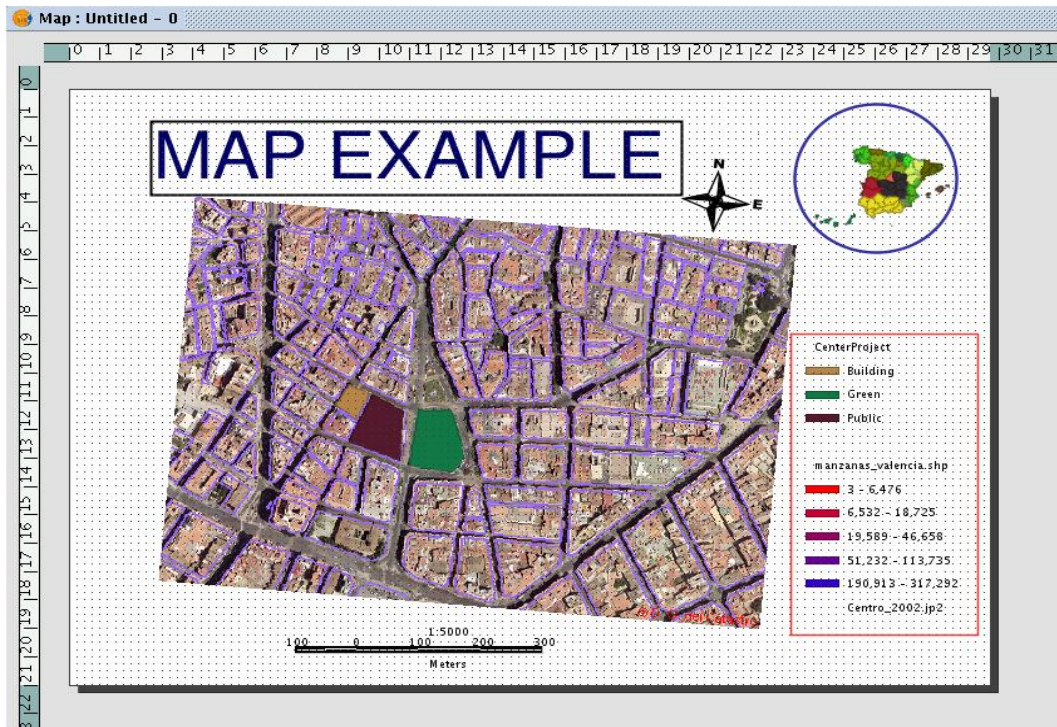
Try it yourselves!

Create a New map with any of the Views from Ethiopia Display over the image of Ethiopia the areas influenced by the existing water bodies, assuming that the maximum distance from the water to any influenced place is 20km. We can even create two rings with different distances around the water bodies, such as 10km for the more humid places and 20km for less humid but still influenced by water.
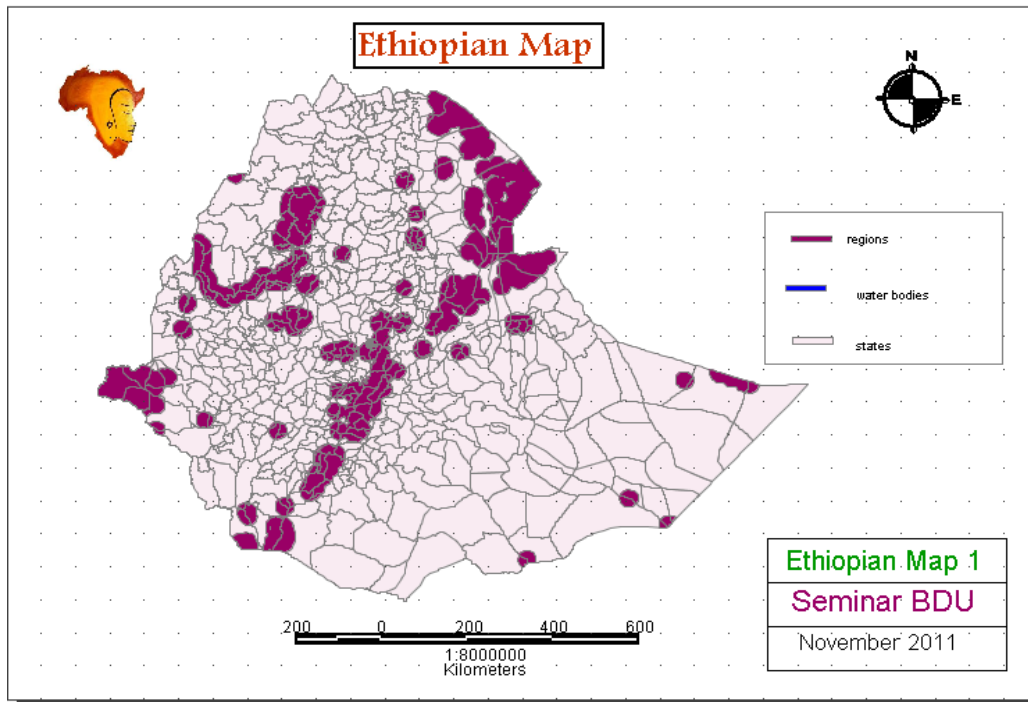
- **Publishing and printing**
  - The map can be *exported* to PDF and PostScript formats by using the options under the File menu.
  - It can also be printed by using the option under the Map menu.

Thanks for your attention

Feel free to try the last releases of *gvSIG*, from this link!!

https://gvsig.org/web/projects/gvsig-desktop/official

User manuals and other info here: www.gvsig.org

For any doubt you can contact me here: serclalo@gmail.com

* Some links used in this seminar:

http://www.diva-gis.org/gData

http://geoportal.logcluster.org/GeoPortal/geoportal.php?sname=4c9184f37cff01bcdc32dc486ec36961&

http://www.logcluster.org/tools/mapcentre/sdit

http://www.ema.gov.et/

http://www.worldclim.org/tiles.php?Zone=27

http://www.usgs.gov/pubprod/

Figure i. GIS training seminar announcement at BDU, November 2011.

Bahir Dar University, Ethiopia

Certificate of Completion

The Universitat Jaume I of Castellón, Spain, and the Department of Disaster Risk Management and Sustainable Development, Bahir Dar University, Ethiopia

Awards a Certificate of Completion to

Alebel Aynalem Derseh

In recognition of the successful completion of the training course entitled
"Introduction to Open Source gvSIG software as a desktop GIS/SDI client"
organised by the Universitat Jaume I of Castellón and the Department of Disaster Risk Management and Sustainable Development of Bahir Dar University from November 22th to November 24th, 2011, at Bahir Dar University, Bahir Dar, Ethiopia
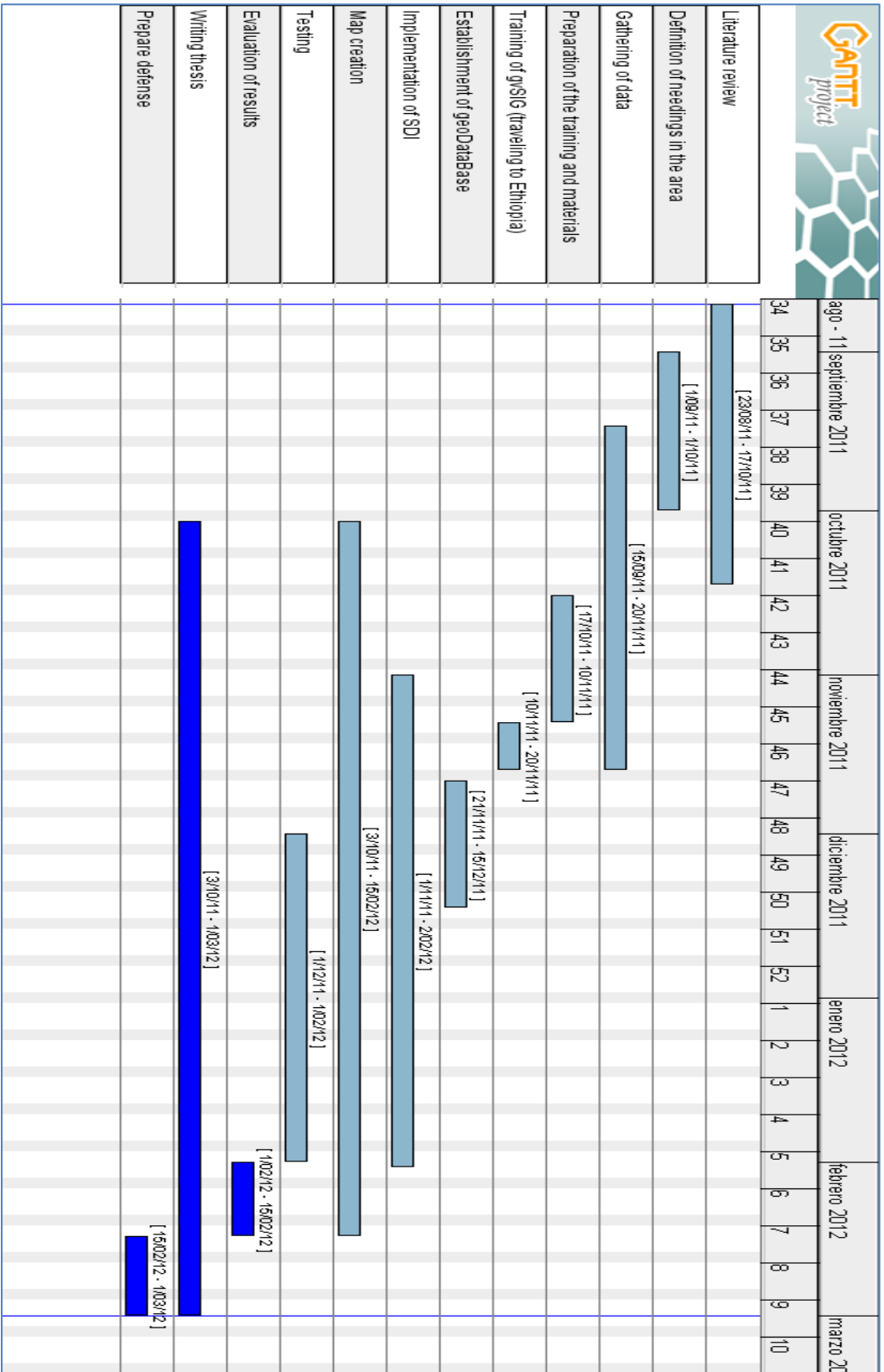
November, 2011

Tesfahun Asmamaw Kasie   Sergio Clark Lopez

Lecturer at the   Training Facilitator, GIS specialist
Department of Disaster Risk Management and   Universitat Jaume I of Castellón, Spain
Sustainable Development,
Bahir Dar University, Ethiopia

Figure ii. GIS training seminar Certificates of Completion.

APPENDIX C: WORKPLAN

Gantt chart showing the project workplan with tasks: Literature review [23/08/11 - 17/10/11], Definition of needlings in the area [1/09/11 - 1/10/11], Gathering of data [16/09/11 - 20/11/11], Preparation of the training and materials [17/10/11 - 10/11/11], Training of gvSIG (traveling to Ethiopia) [10/11/11 - 20/11/11], Establishment of geoDataBase [21/11/11 - 15/12/11], Implementation of SDI [1/11/11 - 2/02/12], Map creation [3/10/11 - 15/02/12], Testing [1/12/11 - 1/02/12], Evaluation of results [1/02/12 - 15/02/12], Writing thesis [3/10/11 - 1/03/12], Prepare defense [15/02/12 - 1/03/12]. Timeline spans ago-11 through marzo 2012.

APPENDIX D: IN THE NEWS

Figure i. Food security project at the UJI News site (December 2011).

GIS software	Free	Open source	Windows	Mac OS X	Linux	BSD	Unix	Web	Other
Autodesk[1]	Viewer(s)[2]	No	Yes	No	Yes	No	No	Yes	No
Cadcorp	Viewer(s)[3]	No	Yes	No	No	No	No	Yes	No
CAPAWARE	Yes	Yes	Yes	No	No	No	No	No	No
CARIS	Viewer(s)[4]	No	Yes	No	No	No	No	Yes	No
Chameleon	Yes	Yes	Yes	Yes	Yes	Yes	Yes	AMP	No
Deegree[5]	Yes	Yes	Java	Java	Java	Java	Java	Yes	No
ERDAS IMAGINE[6]	Template:Viewers & Plug-ins	No	Yes	No	No	No	Yes	Yes	Google Earth Plugin, KML, WMS
ESRI	Viewer(s)[7]	No	Yes	No	No	No	No	Yes	
GeoBase	Trial[8]	No	Yes	No	Yes	Yes	No	Yes	No
Geomajas[9]	Yes	Yes	Java	Java	Java	Java	Java	Yes	No
GeoNetwork	Yes	Yes	Java	Java	Java	Java	Java	Yes	No
GeoServer	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
GeoTools	Yes	Yes	Java	Java	Java	Java	Java	Java	No
GRASS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	via pyWPS[10]	No
gvSIG	Yes	Yes	Yes	Yes	Yes	Java	Java	No	No
ClarkLabs[11] IDRISI	No	No	Yes	No	No	No	No	No	No
ILOG JViews Maps[12]	Viewer(s)[13]	No	Java	Java	Java	Java	Java	Java & DHTML/Ajax	No
ITC[14] ILWIS	Yes	Yes	Yes	No	No	No	No	Yes	No
Intergraph[15]	Viewer(s) 🔒	No	Yes	No	No	No	CLIX	Yes	No
(Vivid[16]) Open[17] JUMP	Yes	Yes	Java	Java	Java	Java	Java	No	No
GIS	Yes	Yes	Java	Java	Java	Java	Java	No	No
Kosmo[18] Saig[19]	Yes	Yes	Java	Java	Java	Java	Java	No	No
LandSerf	Yes	No	Java	Java	Java	Java	Java	No	No
Manifold System	No	No	Yes	No	No	No	No	Yes	No
Pitney Bowes[20] MapInfo	Viewer(s)[21]	No	Yes	No	No	No	Yes	Yes	No
UMN[22] MapServer	Yes	Yes	Yes	Yes	Yes	Yes	Yes	AMP	No

97

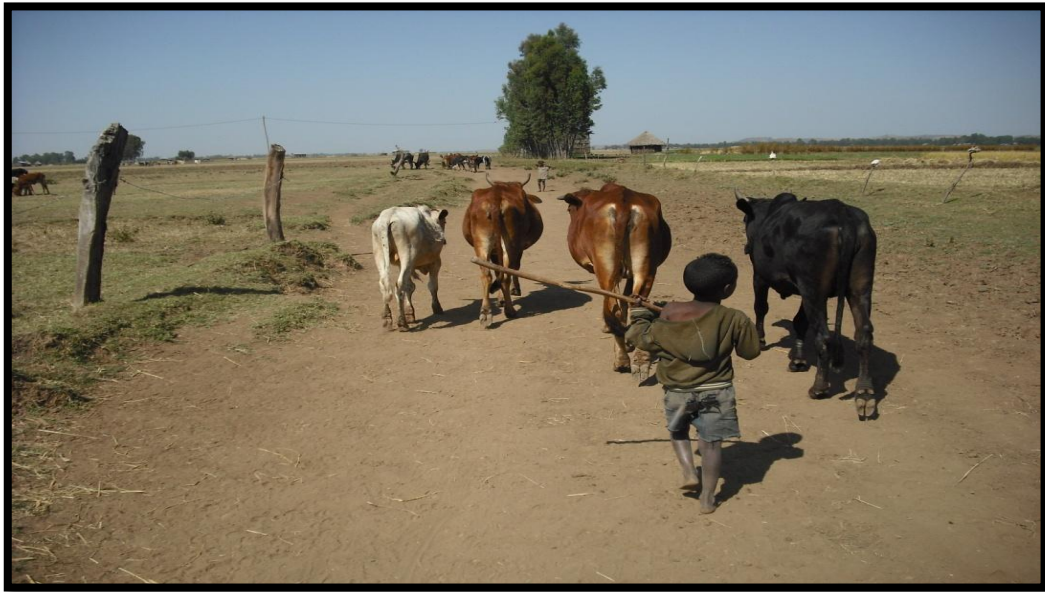| Project/Software (year founded)	Application focus[1]	User level[2]	Supported operating systems	Development platform	Development by	Software license[3]
GRASS (1982) [grass.osgeo.org]	Analysis and scientific visualisation, Cartography, Modelling and simulation	Experienced, ..., research	MS-Win, Linux, MacOSX	C, Shell, Tcl/Tk, Python	Research Institutes, Universities, Companies, Volunteers worldwide	GPL
QGIS (2002) [www.qgis.org]	Viewing, Editing, GRASS-Graphical User Interface	novice, ..., research	MS-Win, Linux, MacOSX	C++, Qt4, Python	Universities, Companies, Volunteers worldwide	GPL
uDig (2004/5) [udig.refractions.net]	Viewing, Editing, Analysis	novice, ..., research	MS-Win, Linux, MacOSX	JAVA (Eclipse RCP)	Companies, Organisations, Volunteers	Core Eclipse RCP is EPL
JGrass (2004)	Interface and GUI for GRASS, raster analysis, 3D visualisation, hydrologic analysis					
DivaGIS (ca. 2003)	Biodiversity analysis					
gvSIG (2003) [www.gvsig.gva.es] [http://gvsig.org]	Viewing, Editing, Analysis	novice, ..., research	MS-Win, Linux, MacOSX	JAVA	Companies, Universities, Government	GPL
Kosmo (2005) [www.saig.es]	Viewing, Editing, Analysis	novice, ..., expert	MS-Win, Linux	JAVA	Companies (project driven, utilities, etc.), Government	GPL
SAGA (2001/2) [www.saga-gis.org]	Analysis, Modeling, Scientific visualisation	novice, ..., research	MS-Win, Linux	C++ (MS Visual C++)	Universities	LGPL (API), GPL
ILWIS (1985) [www.itc.nl/ilwis]	(Raster) Analysis	novice, ..., research	MS-Win	MS Visual C	Universities, Companies,	GPL
MapWindow (1998) [www.mapwindow.org]	Providing core GIS and GUI functions, developing Decision Support Systems	novice, ..., research	MS-Win	MS Visual Studio .NET (C++, C#, VB.NET)	Universities, Companies, Volunteers worldwide	Mozilla Public Licence Version 1.1
JUMP/ OpenJUMP (2002/3) [www.openjump.org]	Viewing, Editing, Analysis	novice, ..., research	MS-Win, Linux, (MacOSX)	JAVA	Volunteers worldwide	GPL
JUMP (2002-06)	Focus on data conflation from different sources (i.e. natural resources management)				Company, Government	
deeJUMP (2004)	Focus on OGC standards				Company	
SkyJUMP	Focus on military facility management ...				Company	

Figure i. Animal production. Fogera *woreda*, November 2011.

Figure ii. Agriculture practices. Fogera, Amhara. November 2011.

Figure iii Agriculture practices. Fogera, Amhara. November 2011.