GIS: A Well Needed Technology for Development in Lebanon

by

Oussama C. Jadayel and Rita Y. Ibrahim

GIS Center,
Faculty of Engineering,
University of Balamand,
P.O. Box: 100, Tripoli,
LEBANON

oussama.jadayel@balamand.edu.lb
rita.y.ibrahim@balamand.edu.lb

Abstract

In modern day Lebanon, the identification of local needs for future development is dependent on the ability to access and manage spatial information. This article is concerned with the geographical treatment of socio-economic data compiled from the northern Lebanese region of Joumeh, an underdeveloped locality, which extends over 98 km^2 and covers eighteen towns and villages. Field-based surveys acquired from nearly 4800 households reflected living standards of inhabitants in terms of employment, health, education, migration, social activity, role of women, etc. The application of statistical analysis and GIS technologies was instrumental in clearly communicating spatial variations and was successful in quantifying key indicators for monitoring life quality. The objective was to develop a systematic methodology which enables the implementation of local improvements according to regional priorities. Also, it is the intention to integrate the GIS within the municipalities to strengthen the capacity of the local government within the region.

1. Introduction

Development efforts within the Lebanese Republic have historically been concentrated around the capital city and its direct vicinity in what recently became known as the Greater Beirut Area (GBA). Other cities have received much lesser attention from the central government and the more remote rural areas to the north and south of the country have remained very deprived and neglected. Local authorities within these regions, together with international agencies and active non-governmental organizations are extremely keen to see a "balanced" development strategy implemented within the country. Accordingly, they are collectively working to achieve accurate and concise information which enables clear and correct decisions to be made along the lines of:

- Appreciating the available human element within its environment.
- Quantifying available natural resource and its potential.
- Understanding the constraints of social economy, education and health.
- Setting priorities for development.
- Identifying and removing barriers.
- Directing investments and streamlining funds and monetary resource.
- Optimizing project design and maximizing achievable outputs.

A common factor which cuts across all the above variables is no doubt geography. All the above entities are directly related to the place where they actually occur. Consequently, geography becomes a key element according to which all the above elements have to be mitigated. In this respect, Geographical Information Systems (GIS) become vital tools in revealing new trends in behavior which could easily go unnoticed if conventional data analysis techniques were used. Furthermore, spatial patterns, queries and presentations using such technologies render the decision making process, in relative terms, a much easier task.

A typical underdeveloped region in north Lebanon is "Joumeh". This is a region composed of eighteen towns and villages that cover an approximate area of 98 km^2. Joumeh is characterized by a green diverse landscape which extends from the plain of Akkar eastwards towards high mountainous slopes. It enjoys rich soils and plentiful waters which have resulted in a rich eco-system, some old and wild forests, in addition to widespread agricultural activity. Despite all this, the ongoing neglect Joumeh continues to suffer from the central government has resulted in a lacking basic infrastructure in terms of transport, electricity, telecommunications and sewers. Additionally, it has reflected considerable insufficiency in the basic sectors outlets of education, healthcare, commerce and industry. Consequently, the local community bears the heavy burdens of poverty, illiteracy, unemployment, over and above the loss of social and professional opportunity.

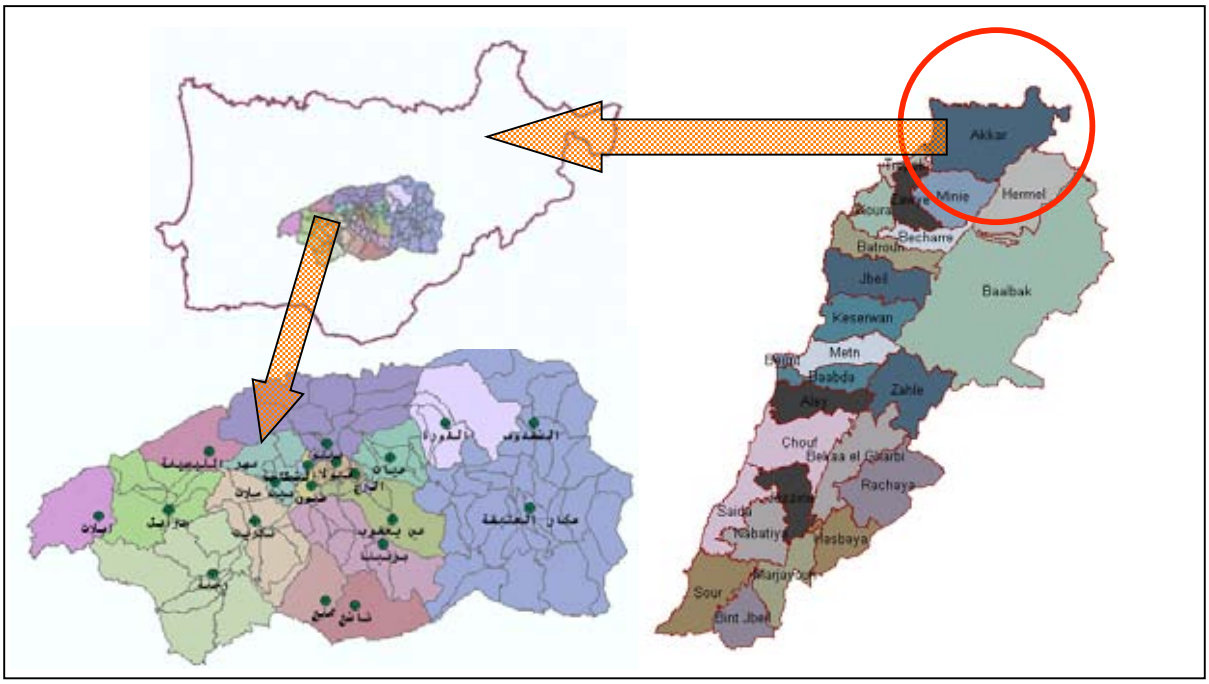

Figure (1): Maps of Lebanon, the caza[1] of Akkar and the region of Joumeh and its villages

The aim of this paper is to show how a systematic methodology, based on GIS, could be adopted specifically for the purposes of development. The region of Joumeh within the caza of Akkar was the subject of an extensive study conducted by five organizations which joined forces in order to assess the conditions affecting the livelihood of the local population. These were:

[1] An administrative division in Lebanon subdivided into municipalities.

- United Nations Development Programme (UNDP): The Lebanon country office is constantly in need of new data upon which it can base it development policies.
- Lebanese Council for Development and Reconstruction (CDR): An arm of the government responsible for setting strategies and implementing development projects within the country.
- Fares Foundation: A non-governmental organization, very active in Akkar, and concerned with funding development projects.
- The University of Balamand GIS Center: An academic center of GIS technology in the area of North Lebanon, in which staff and students direct their efforts towards the community welfare whilst conducting research, development and capacity building.
- The Union of Municipalities of Joumeh: This is a unified body formed by eighteen heads of municipalities who work together in order to improve living conditions in the region and who are equally keen on adopting modern technology in their local governments.

2. Data Acquisition and Geographical Attribution

Data acquisitions in this project were of two types, geographic and descriptive. Geographically, there was a need to locate buildings and roads within the region. As there were no accurate or complete cadastral maps available for Joumeh within the Lebanese private or public sectors, ortho-rectified satellite imagery of 100 cm resolution was used for digitizing those features. However, in places where building boundaries could not be adequately identified on such images, particularly within highly congested areas, Global Positioning Systems (GPS) were relied upon for recognition. On the other hand, spot elevations and contour data were later incorporated using 1:50,000 topographical charts prepared by the Lebanese Army. Preparations of the GIS were conducted by teams of students at the University of Balamand, who carried out feature digitization and GPS data acquisitions.

Socio-economic data, on the other hand, was acquired through a comprehensive and thorough field survey. Groups of surveyors organized by the Union of Municipalities of Joumeh, and operating under the supervision of UNDP personnel, met with occupants of each and every household or closed built-up unit. They filled in questionnaires relating to individual households within buildings, as well as social and economic situation of the occupants.

In order to link descriptive field data to their geographic locations, a unique identifier, referred to as HHID, was developed for each occupied housing division or unit. This was a combination number consisting of 8 sections and 18 digits:

- Above or below ground level House-Unit: One + or – sign digit (+ above, - below).
- Mohafaza[2] ID: Two digits indicating the mohafaza number in Lebanon.
- Caza ID: Two digits indicating the caza number in a mohafaza.
- Village ID: Three digits indicating the village number in a caza.
- District ID: Three digits indicating the district number in a village.
- Building ID: Three digits indicating the building number in a district.
- Floor Number: Two digits indicating the floor number in building.
- House-Unit Number: Two digits indicating the house-unit number on a floor.

[2] An administrative division in the Lebanese Republic, which is subdivided into cazas. There are six mohahazas in Lebanon.

Accordingly, and by adopting such a numbering scheme, every single household could now be uniquely identified both geographically and descriptively anywhere within the Lebanese Republic. This unique number makes it possible for the current work to be extended to cover the whole country.

3. GIS Design and Methodology

The overall methodology adopted in the development of the current project involved three main steps.

3.1 Building a GIS data model: This step consisted of preparing two logical groups of thematic layers:

- Administrative boundaries layers which are polygons representing the boundaries of defined administrative areas such as North Lebanon mohafaza, Akkar caza, and Joumeh village boundaries, and,
- Land-base boundaries layers such as districts, street centerlines, buildings, households and landmarks layers. Figure (2), shows the data types of the different features within the landbase.

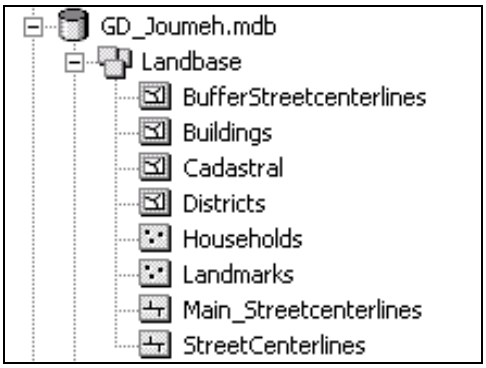

Figure (2): Joumeh geo-database features

The value-valid tables, or domain tables, used to describe buildings and households are their the number of stories for the former, as well as usage (residential, non-residential, mixed, under construction, vacant, etc.), residential category (e.g. primary, secondary, seasonal, etc.), and type of occupancy (owner, tenant, etc.) for the latter.

3.2 Establishing the relational socio-economic database: A rugged and flexible database had to be designed for storing and manipulating the data acquired during the field surveys. In addition to information relating to residents of the villages in the region, this database included characteristic data of the buildings and households those residents live in. Students from the University of Balamand entered the data relevant to each municipality in Joumeh. The database consisted of thirteen descriptive tables, as well as forty-five value-valid tables. Figure (3), shows a simplified schematic of the logical relations implemented in the database design. The unique household key identifier HHID, discussed in section 2, was implemented in building relationships between some of these descriptive data tables, and between these tables and the spatial data.

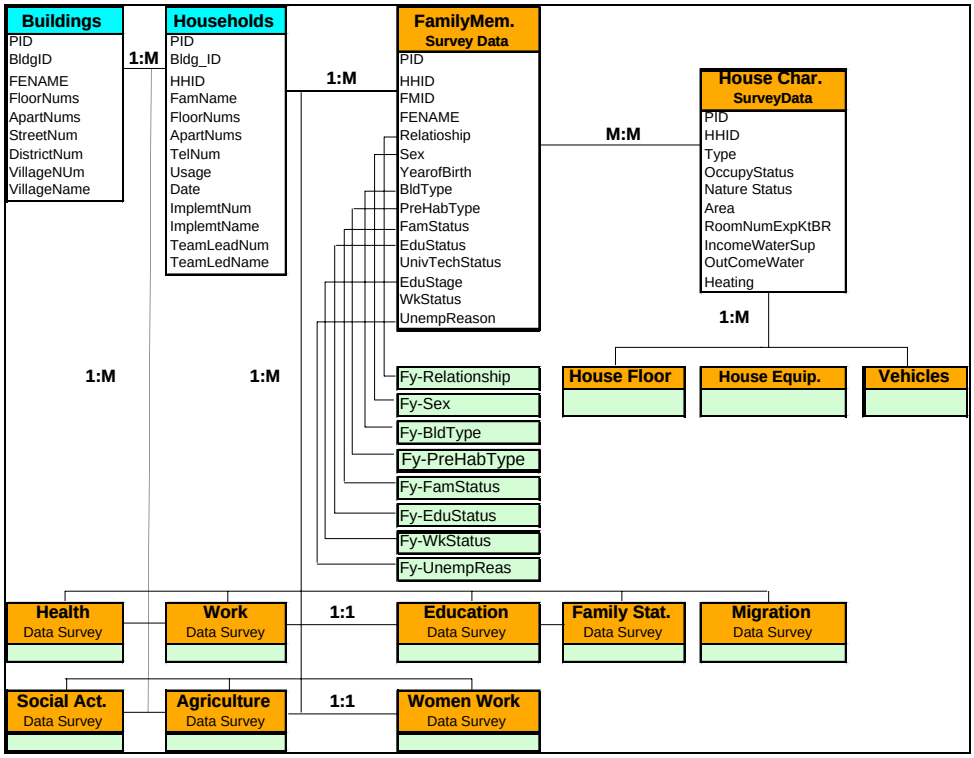

Figure (3): Schematic of the database conceptual design

3.3 Building Custom Forms for Editing and Quality Control: This was a final step in which customized forms were designed in order to facilitate data quality control procedures as well as the setting up of database queries. Due to the huge database, and the complex relationships present, a quality control form was customized to display data from thirteen different tables in one single window as shown in figure (4). This form also helped users communicate with descriptive data in a simple way and locate them geographically.

Figure (4): A form which allows viewing descriptive data during quality control operations

Another customized form was designed in order edit or update data by selecting the appropriate value from the drop-down list to avoid typographical errors is shown in figure (5).

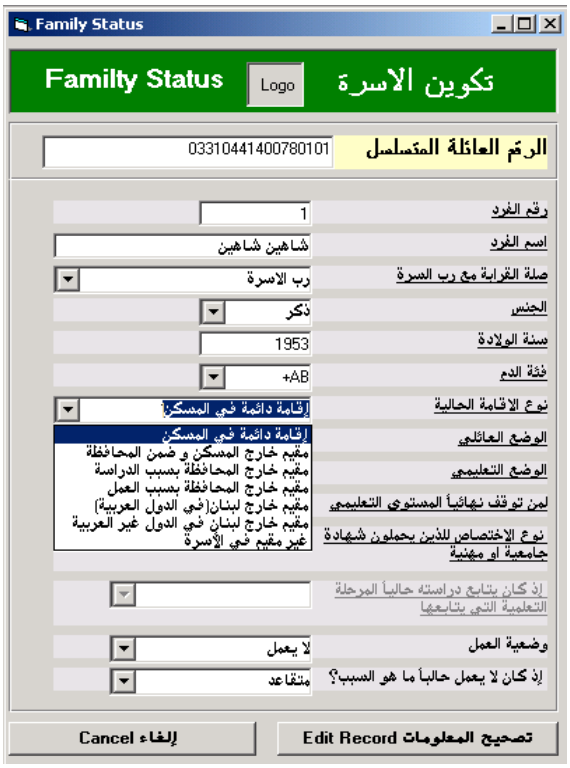

Figure (5): The editing form

4. Sample Results and Discussion

The sheer breadth and depth of the data acquired during the field surveys permitted information to be viewed, correlated and queried on the basis of either individual villages or the Joumeh region as a whole. Both, conventional database type analyses and as well as geographical mitigation could be made. In this paper, and in order to show the wide spectrum of the data and appreciate the capabilities of the GIS, only spatial patterns will be shown. In particular, some overall demographic details will be shown for the entire region, while specific socio-economic indicators will be given for a couple of individual villages.

Perhaps the first piece of information which needs to be evaluated is the number and locations of buildings within the region. These are shown in figure (6). Also shown in that figure are the boundaries of the individual villages in addition to number of buildings in each. The total number of buildings can also be found in the figure. In order to have an indication of the proportion of the residential areas, buffer zones of 100 m were projected around each building. Those were made to merge into an overall residential “cloud”. GIS analysis showed that those residential areas covered 29.38 km^2, approximately 30% of the total surface area of Joumeh, with the rest being covered by forests, vegetation or natural virgin territory.

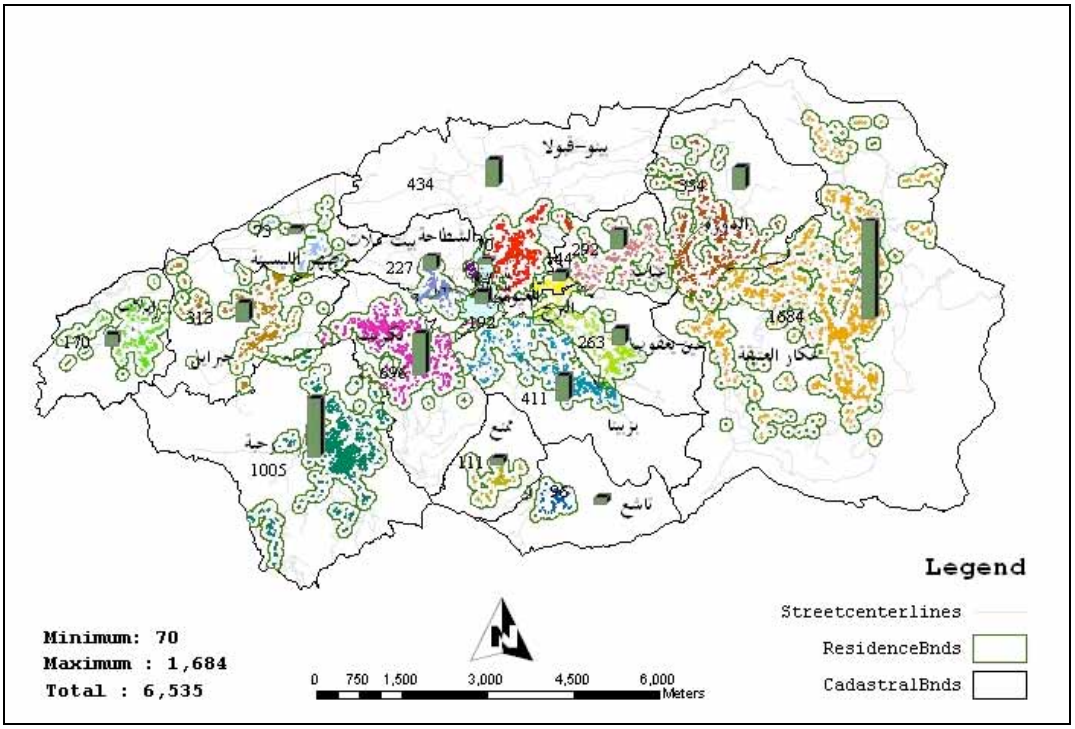

Figure (6): Buildings and residential areas in Joumeh

Figure (7) shows the population details. The number of resident inhabitants and the number of families are shown for each village. The total number of inhabitants in the region was found to be 30,089 living permanently in the residential areas calculated earlier, thus giving an overall population density of 1024 person/km^2.

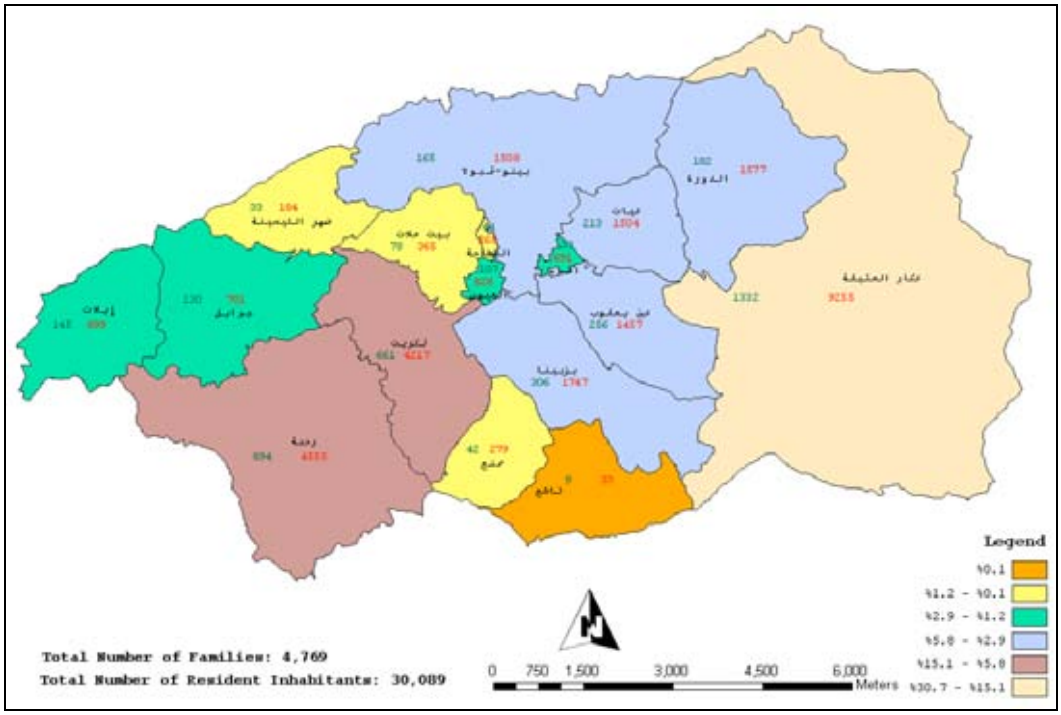

Figure (7): Population distributions within Joumeh

Some results revealing information relating to the socio-economics and life standards in some of the villages are also illustrated. Figure (8) gives the “addresses” of all the permanent

residents of the village of Jebrayel, who are healthy, of a suitable age and capable of donating blood type A+ if required. Also in the figure are the classifications of the building as to the number of stories each has.

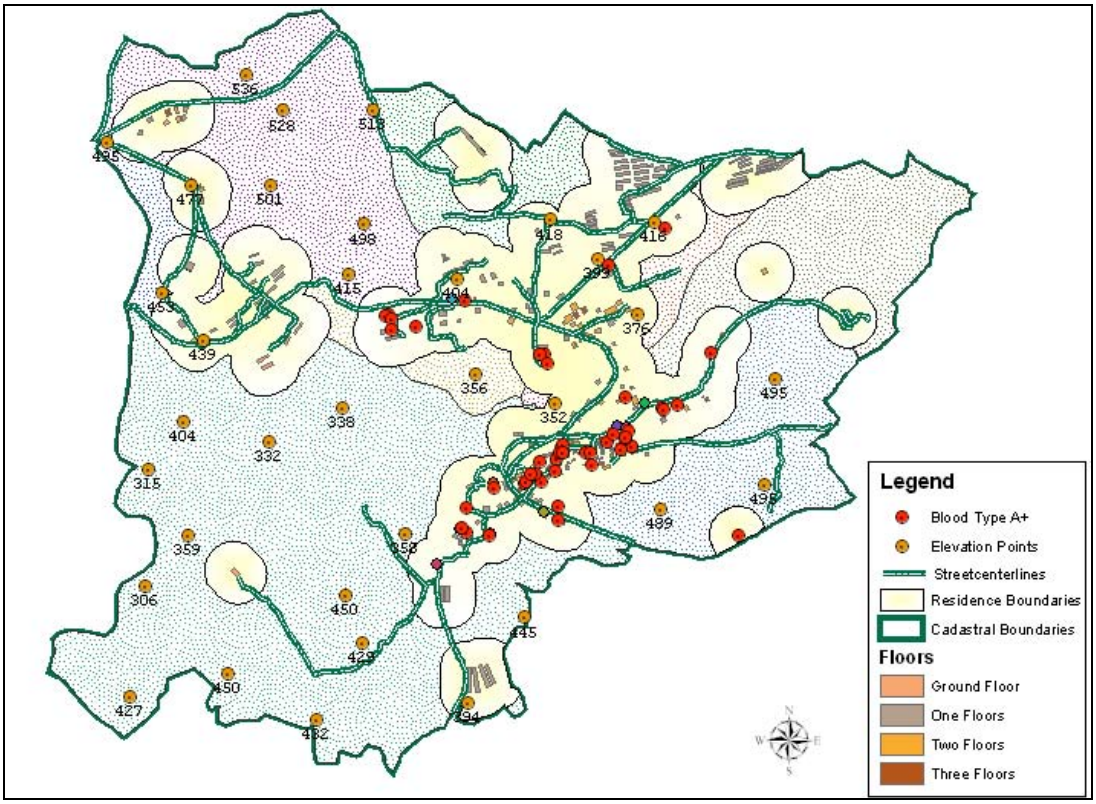

Figure (8): Addresses of permanent residents in Jebrayel capable of donating blood type A+

Another aspect considered herein is the work status in the village of Ayyat. Two of the criteria used to study the work status of an individual were whether an individual is unemployed and lives in Lebanon or has immigrated to work abroad. In order to have an exact number of the unemployed capable of working, some groups had to be excluded from the population. These were students, people under legal working age, retired individuals, handicapped and people with medical conditions, as well as individuals undergoing their military-service. The results reveal that 8.50 % of the population is unemployed or searching for work. On the other hand, immigration for "overseas travel to work" data, which excluded persons who returned back to Lebanon, reveal that 5.3% of the total population of the village is currently outside Lebanon. Figure(9) shows the spatial location for the persons who traveled to work outside Lebanon. The red circles indicate that they are still outside Lebanon while green circles indicate that they came back to the village to settle permanently.

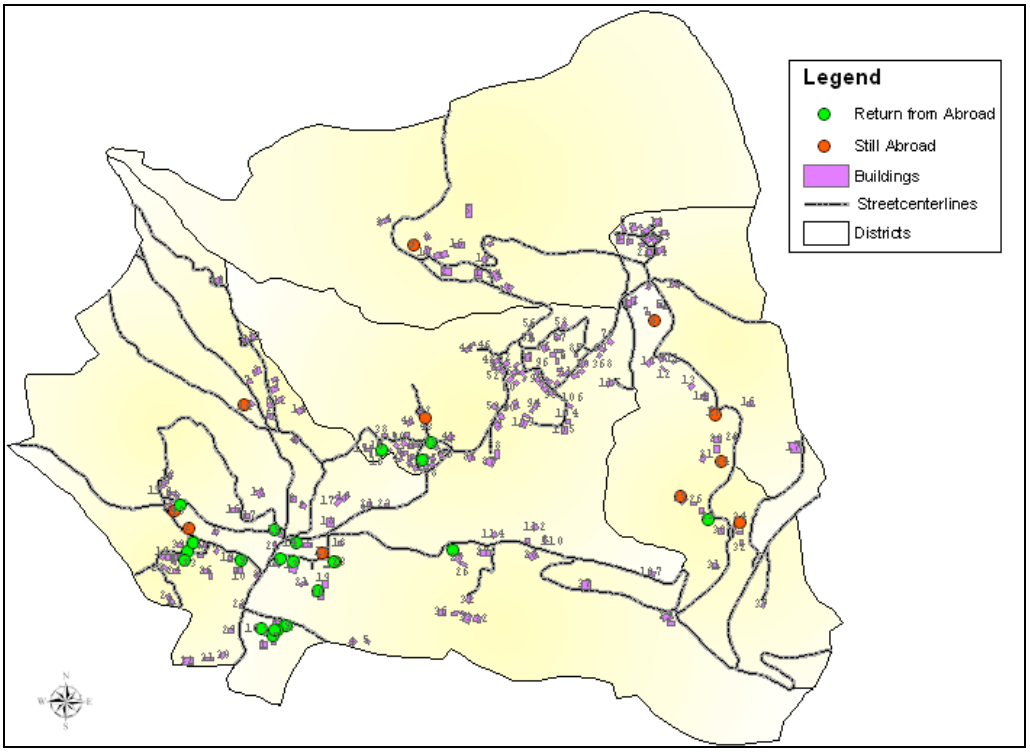

Figure (9): Spatial distribution of the residents of Ayyat who immigrated for work

An interesting result is given in figure (10). It relates to the source of water available to individual households in the village of Ayyat. In answer to the question as to whether a household receives its water supply from the national network or from a closeby underground water hole, it becomes clear from the figure that the north and east sides of the village are not connected to the water network at all(red circles). This is a very important indicator which would have been impossible to achieve from non-geographic analyses or without visiting the site.

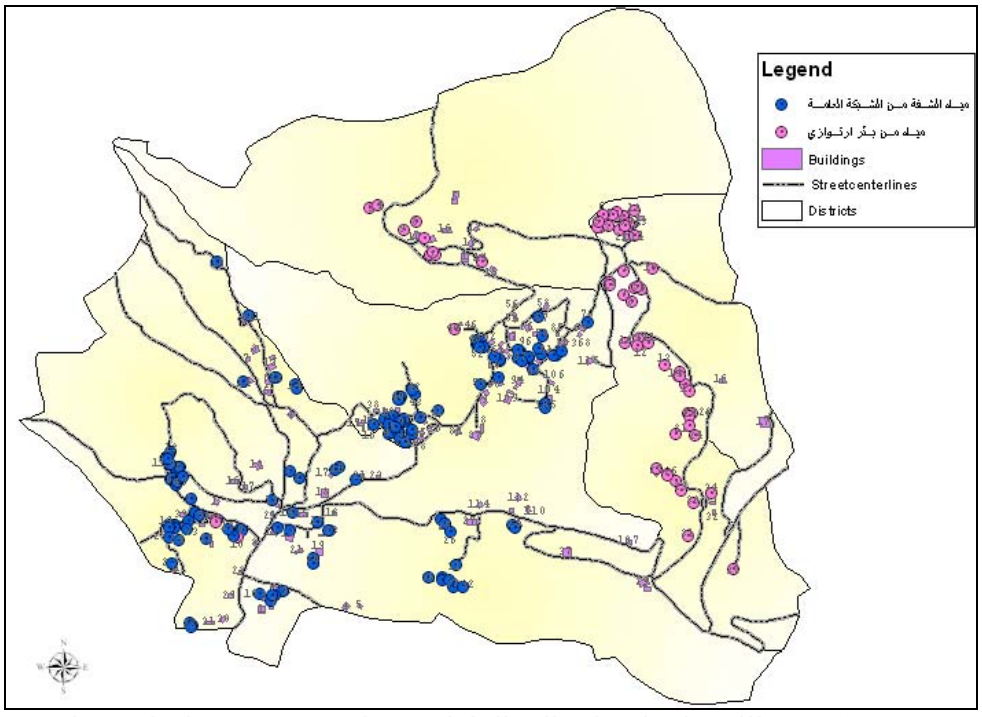

Figure (12): Water supply spatial distribution in the village of Ayyat

5. Conclusions

In this work, the powers of GIS were harnessed for purposes of development in rural areas in Lebanon. It was evident that geographical mapping, coupled with appropriate attribution of descriptive data yielded powerful conclusive indicators on the social, demographic, and economic levels. Specific characteristics and requirements of the residents were investigated and quantified in ways which allow appropriate decisions to be made regarding social and economic improvements. Mitigation of various parameters affecting life quality could be conducted either on a regional scale or on the basis of individual villages. Cross village comparisons also became possible thereby enabling policies, strategies, priorities and policies to be set.

As with every GIS, an end of a phase is always the start of another. In this respect, future work can be contemplated along many different lines. Perhaps the first should be the integration of the infrastructure utilities such as electricity, water and telephone networks. The system could always be enhanced to investigate issues of land use and land development especially that the region is agriculturally oriented. Another aspect which should never be overlooked, is the capacity building of local government personnel on the use of the system so as they could operate the system and update it independently.

Acknowledgements

The authors would like to thank the following organizations and persons:

- UNDP Beirut Office, Fares Foundation and the Lebanese Council for Development and Reconstruction for their financial support and for allowing some of the results to be published.
- The Union of Joumeh Municipalities.
- Students in the University of Balamand, for their enthusiasm and support in digitizing spatial data and entering descriptive data on a daily basis.
- The University of Balamand for providing its facilities for the success of the present work.

References

- "Administrative Boundaries Data Model Template", Grise S, ESRI, Redlands, Nov. 21, 2002.
- "Automated Interpretation of the Spatial Distribution of Socio-Economic Conditions", Massey, J, GIS Development, Geospatial Resource Portal, Map India 2002. http://www.gisdevelopment.net/application/urban/overview/urbano0032.htm
- "Designing Geodatabases: Case Studies in GIS Data Modeling", Arctur, D. and and Zeiler, M., ESRI Press, September 28, 2004.
- "Geodatabase Case Studies, Census Units and Boundaries", Arctur D., and Zeiler, M., ESRI, Redlands, California, July 2, 2003.