BMB - LDK
Programme Monitoring Consultants to the
Office of the Minister of State for Administrative Reform
Beirut - Lebanon

Memorandum

To:	Dr Raymond Khoury, TCU Director, OMSAR Mr. Atef Merhi, IDU Acting Director, OMSAR Mrs Roula Kabbani, EU Project Coordinator, OMSAR
From:	Dimitrios Sfikas, PMC Team Leader
Date:	14 March 2002
Subject:	**Geographical Information System Mission Report.**

Please find attached for your review and approval the Geographical Information System Mission Report of the Short term Expert Mr. Robert Brown.

Dimitrios Sfikas
PMC Team Leader

الجمهورية اللبنانية
مكتب وزير الدولة لشؤون التنمية الإدارية
مركز مشاريع ودراسات القطاع العام

Republic of Lebanon
Office of the Minister of State for Administrative Reform
Center for Public Sector Projects and Studies
(C.P.S.P.S.)

ARLA PROGRAMME

LBNB7-4100/IB/97/0687

Document for discussion and not binding OMSAR/PMC or EC

Assistance to the Central Administration of Statistics (CAS)

Geographical Information System Mission Report
February 15 – March 14, 2002

Programme Monitoring Consultants

Robert Brown, M.Sc.
Geographical Information System Expert

OMSAR, Beirut, March 2002

EXECUTIVE SUMMARY

The purpose of the GIS mission was, in co-operation with CAS staff, to design and implement a geographical database system, to be connected to the Oracle database to provide maps and geographical information to execute the fieldwork in all future survey operations, with particular reference to the buildings and establishments survey due this year.

A GIS is present in CAS, this was evaluated and future system requirements drawn up, primarily in terms of staff, data, software and hardware. In addition a prototype for creating geographic information on ilot survey units and buildings was drawn up.

To summarise recommendations:

Digitising of ilots in Beirut should continue.

If ilots/buildings require digitising now to be used in a buildings survey in a few moths time, there is a high immediate workload and staff needs organising accordingly

GIS training is required as soon as possible.

Four new ArcGIS licences and accompanying PCs are recommended immediately to speed the workflow.

The digital topographic maps acquired during the mission require transformation in order to digitise ilots outside of Beirut.

DAG digital aerial photography and CDR space photography need to be acquired for effective field survey and production of building maps.

Stand alone GPS receivers with the mapping data and coordinate systems presently available are not considered appropriate for field survey.

The only rapid and cost effective way to produce a reasonably accurate buildings map is by the use of high resolution imagery, if this is not available an alternative without maps could be considered.

The use of field GIS in combination with GPS should be evaluated in order to begin incorporating the technology into CAS work practices.

Potential constraints were identified as:

Delay in delivery of the new software and PC systems.

Acquisition of re-projected digital topographic maps is required before digitising of ilots outside of Beirut can begin.

Acquisition of the DAG aerial photography should be urgently completed to begin digitising buildings.

Effective organisation of production and supervision of resources and staff scheduling is essential if the proposed digitising is to be carried out in house.

Lack of knowledge of the geographic coordinate system on which the whole system is based is a long term constraint, in particular with the use of GPS coordinates.

RESUME

L'objectif de la mission SIG était de concevoir et de mettre en œuvre, en coopération avec le staff de l'ACS, un Système d'Information Géographique, qui doit être lié à la base de données d'Oracle afin de fournir des cartes d'information géographique facilitant ainsi le travail de terrain dans toutes les opérations de recensement. Ceci, en particulier concernant le recensement des immeubles et établissements prévu pour cette année.

Le SIG, présent dans l'ACS, a été évalué et les besoins futurs du système ont été identifiés, principalement en matière de personnel, données, logiciels et équipements. En plus, un prototype a été développé pour créer l'information géographique à l'échelle d'unités d'ilot et d'immeubles.

Résumé des recommandations :

La digitalisation des ilots à Beyrouth doit être poursuivie.

Si des ilots/immeubles demandent d'être digitalisés pour être utilisés lors d'un recensement d'ici quelques mois, la charge de travail immédiate sera élevée et le staff devra s'organiser en conséquence.

La formation en matière de SIG est nécessaire de toute urgence.

Quatre nouvelles licenses ArcGIS et ordinateurs doivent être acquis d'urgence pour accélérer le flux de travail.

Les cartes topographiques digitales doivent être transformées afin de digitaliser les ilots en dehors de Beyrouth.

Les photos aeriennes digitales DAG et les photos spatiales CDR doivent être acquises afin de pouvoir faire des enquêtes de terrain effectives et de produire des cartes d'immeubles.

Les receveurs GPS individuels, qui incorporent les données actuellement disponibles, ne sont pas aptes aux enquêtes de terrain.

La seule manière rapide et économe pour produire des cartes d'immeubles assez précises est par l'utilisation d'images de résolution élevée ; au cas où celles-ci ne sont pas disponibles il y ait lieu de considérer une alternative sans les cartes.

L'utilisation de SIG de terrain combinée avec des GPS doit être évaluée afin d'inclure cette technologie dans la pratique de travail de l'ACS.

Contraintes potentielles identifiées:

Retard dans la livraison des nouveaux logiciels et ordinateurs.

L'acquisition de cartes topographiques digitales ajustées est nécessaire avant qu'on ne puisse commencer la digitalisation des ilots en dehors de Beyrouth.

L'acquisition des photos aeriennes DAG doit être complétée d'urgence pour commencer la digitalisation des immeubles.

Une organisation efficace des ressources est essentielle si l'on veut procéder à la digitalisation au sein même de l'ACS.

Le manque de connaissance en matière du système de coordonnées géographiques, sur lequel le système entier est basé est une contrainte à long terme, en particulier quand on utilise des coordonnées de GPS.

LIST OF PERSONS MET

Dr. Arij Dekker	Database Expert – ARCADIS BMB-LDK
Mr. Lian Catanis	ICTExpert– ARCADIS BMB-LDK/PMC
Dr. Maral Tutelian	Director – CAS
Mr. Ziad Abdallah	GIS/IT Manager – CAS
Ms. Siba Haidar	IT Analyst – CAS
Ms. Alissar Nasser	IT Analyst – CAS
Ms. Najla Barrouki	Geographer – CAS
Mr. Alaa Hajjar	IT Programmer – CAS
Ms. Jihan Kiwan	IT Programmer – CAS
Ms. Hanan Sleem	IT Programmer – CAS
Mr. Roland Anémian	CERMOC
Mr. Ghaleb Faour	NCRS

ABBREVIATIONS

CAS	Central Administration for Statistics
CDR	Council for Reconstruction and Development
CERMOC	Centre d'Etudes et de Recherches sur le Moyen Orient Contemporain
CF	Circonscription foncière
DAG	Direction des Affaires Géographiques (Armée Libanaise)
ECSWA	Economic and Social Council for Western Asia
EDL	Electricité du Liban

GI	Geographic Information
GIS	Geographic Information System
GPS	Global Positioning System
IT	Information Technology
LEDO	Lebanese Environment and Development Observatory
NCRS	National Centre for Remote Sensing
ODBC	Open Data Base Connectivity
OLE	Object Linked Embedding
OMSAR	Office of the Minister of State for Administrative Reform – Republic of Lebanon.
TOR	Terms of Reference
VBA	Visual Basic for Applications
WGS	World Geodetic System

1 INTRODUCTION

1.1 BACKGROUND INFORMATION

The Terms of Reference are detailed in Annex 1.

The purpose of the mission is, in co-operation with CAS staff, to design and implement a geographical database system, which must be connected to the Oracle database. This database, in connection with the Oracle database, must provide the necessary maps and geographical information to execute the fieldwork in all future survey operations.

The tasks in the TOR can be listed as:

- Assessment of system
- Future system requirements
- Implementation plan
- Design prototype of geographical units
- Design prototype of building fieldwork
- Staff capacity – short and long term.

1.2 MAIN ACTIVITIES UNDERTAKEN

The mission took place from 15 February to 14 March 2002. I would like to acknowledge the welcome and assistance provided by the host organisation, the Central Administration for Statistics, in particular by the staff of the GIS section.

The tasks listed in the previous section were all addressed. In addition a pilot study was undertaken of the main technical issues of digitising ilots, digitising buildings, and connecting the geographic data to the main Oracle database. This involved informal training of the GIS staff in the use of ArcView GIS. Assistance was also provided in a separate GIS project to present *club sportifs* on a map.

The only input external to CAS came from the National Centre for Remote Sensing, concerning sources of geographic imagery, and the utility of GPS for field survey. This is inadequate for an evaluation of this nature, two essential visits could not be made due to resistance from CAS. One was to the Lebanese supplier of the ESRI GIS software used at CAS – Khatib and Alami, as a result it has not been possible to make a software budget for the implementation or recommend the method of software localisation necessary for map printing in Arabic. The second was to the national mapping agency, the Direction des Affaires Géographiques (DAG). As a result the geographic basis of the GIS, which is normally published and even incorporated into mapping software, is unknown and makes accurate conversions of other map data and GPS coordinates impossible.

The digital aerial photographs ordered from DAG have not been delivered yet, so it was not possible to evaluate this important data either at CAS or at DAG.

No other problems were encountered, and a full evaluation, pilot study and recommendations were carried out.

2 ASSESSMENT OF CURRENT GIS SITUATION

2.1 INTRODUCTION

The various components of the current geographic information situation at CAS were assessed. The most critical components are staff and data, hardware and software are not generally limiting as they are standard and easily purchased.

2.2 OBJECTIVES FOR GIS AT CAS

2.2.1 User Requirements

These are the objectives or user requirements for geographical information at CAS, based on discussions with the GIS/IT Manager, the Institutional Development Expert and on the TOR.

1. To produce field maps for enumerators in building/establishment surveys, mapping the ilot sampling areas and individual buildings.
2. To create sampling frames (*échantillons*) for future sample surveys, including studies of production, investments, demographic studies, socio-economic studies etc.
3. To be the geographic reference for a database on buildings, dwellings and establishments, which shall function as continuously updated sampling frames for surveys of households and establishments
4. Presentation and publication of results, using thematic maps and graphs. Thematic maps need to use both the buildings and the establishments data, but are generally at higher administrative levels such as caza.

The following are examples of the statistics presented in tabular form in the "Etudes Statistiques" published by CAS for each *mohafaza* in the 1996 buildings and establishments survey:

- Number if ilots, buildings, units and establishments by *Circonscription foncière*
- Number of buildings in each *caza* by :
  - Year and state of construction
  - Use
  - Number of storeys
  - Presence/absence of a lift...
- Number of establishments in each *caza* by :
  - Legal form
  - Number of workers
  - Area occupied
  - Major activity by sector –
  - e.g. agriculture and primary industry, food and tobacco industries, textile and leather industries, wood and paper, hotels and restaurants, transport...
  - Year of creation...

According to these studies, two geographically referenced files are created, the file of buildings and units within buildings, and the file of establishments.

2.2.2 Maps/geographic data required

a. Administrative boundaries

b. Ilot and other survey areas

c. Buildings

d. Background imagery if available

- Air/satellite photos
- high resolution satellite imagery
- topographic maps.

2.2.3 Language requirements

CAS and OMSAR operate and publish in 3 languages – Arabic, French, English. Software is generally in English, support for both Arabic and Latin (French/English) scripts is commonplace on PC keyboards. Support for Arabic text on maps is required.

2.3 INSTITUTIONAL COORDINATION

CAS is purchasing geographic data from the Direction des Affaires Géographiques (DAG) of the Lebanese Army, which is the national mapping agency.

CAS is one of the collaborating institutions in the Lebanese Environment and Development Laboratory (LEDO), carried out in partnership with the United Nations Development Programme, the European Union and the Environment Ministry. Environmental Statistics and indicators. This project has produced a 1:20 000 Land Use Map for Lebanon.

CAS cooperates and exchanges data with the National Centre for Remote Sensing NCRS.

CAS is involved in a project to publish a Cadastral Atlas in cooperation with the Centre d'Etudes et de Recherches sur le Moyen Orient Contemporain (CERMOC). This involves revision of cadastral and administrative boundaries, using paper and digital maps in ArcView.

CAS has academic links with the American University of Beirut including GIS and the use of satellite photography for identification of buildings.

2.4 STAFF

Staff concerned in GIS are within the IT Division of CAS. Although there is an internal structure to this within the organigramme, not all positions are filled. The staff is composed of statisticians, system analysts, programmers and data entry staff. The staff currently involved or likely to be involved with geographic information are:

- 1 GIS Manager (Ziad Abdallah – Senior Statistician) with experience of ArcView 3.x (attended GIS course at ECSWA (Economic and Social Council for Western Asia) in Cairo.
- 2 IT Analysts (Siba Haidar, Alissar Nasser)
- 3 IT Programmers (Alaa Hajjar, Jihan Kiwan, Hanan Sleem), basic knowledge of ArcView 3.x, no training.

- 1 Geographer (Najla Barrouki), limited knowledge of ArcView 3.x., no training
- 13 data entry staff for Oracle DB
- Vacancies within CAS organigramme for Senior Analyst, 3 Analyst/Programmers, 7 data entry staff
- Enumerators (*Enquêteurs)* for the field surveys are recruited on a temporary basis for the field campaigns.

2.5 DATA

This is covered in greater detail in Section 3.

2.6 HARDWARE

2.6.1 Computers

1 Windows 2000 PC, 3 Windows 95 PCs. All connected in a peer-to-peer Local Area Network and sharing data.

2.6.2 Input devices

Digitiser: Numonics AccuGrid, 48" x 36" table, approx A0

2.6.3 Output devices

Desktop colour printer, A3 : Tektronix Phaser 380 Extended

Large format inkjet colour printer, A1 : HP Designjet 455CA (D – A1)

Desktop printers.

NB: The large format printer is commonly but incorrectly known as a plotter, it in fact is a larger version of the common desktop inkjet printer. Plotters are no longer in common use due to their cost and complexity, and because they cannot print imagery.

2.4 SOFTWARE

ARC/INFO 7.2.1 (workstation), one licence, installed on a Windows NT server, currently not functioning. Upgrade CDs to 8.0.2 which require new licencing.

ArcView 3.2, 2 licences

ArabView, an Arabic supplement to ArcView 3.x, installed but not functioning correctly.

Oracle 7 and 8i is in use as the relational database, approximately 20 licences/seats.

MS Access database is also in use and is the likely front end for data entry to Oracle.

2.7 GEOREFERENCING

2.7.1 Introduction

When working with GIS maps such as ilots and buildings, you must specify their (geo)spatial reference so that they can be viewed and analysed together. The spatial reference includes its co-ordinate system (either geographic using degrees of Latitude and Longitude, or a projected co-ordinate system such as UTM or Lambert Conformal Conic) and its spatial or co-ordinate domain. The co-ordinate system is composed of

a projection, a datum, an ellipsoid, and units. Other elements such as the prime meridian, a co-ordinate shift, and a zone may also be defined.

There are 2 systems commonly in use in Lebanon and it is crucial to understand this and decide on a referencing policy before any major creation of a geographic database. There are various alternatives for this.

2.7.2 Projection and co-ordinate systems

The base maps for Lebanon are the responsibility of the *Ministère de la Défense Nationale, Armée Libanaise, Direction des Affaires Géographiques* (DAG), which is therefore the national mapping agency. Map series are available at the following scales:

- 1:20 000, 121 sheets
- 1:50 000, 27 sheets
- 1:100 000, 6 sheets

The base topographic maps are the 1:20 000 series, based on aerial photos at 1:25 000 from 1962 and published in 1963. A 3 year updating programme for this map series is planned or in progress. The referencing system used by DAG, which can be considered the official system for public administration, is the **Stereographic projection and coordinate system** based on the Clarke 1880 ellipsoid. Further details are in Annex 8, but these are incomplete and insufficient for any geo-processing.

However the **Lambert Conformal Conic projection and coordinate system** based on the Clarke 1880 ellipsoid is also in use, particularly by those georeferencing satellite imagery. The coordinate grid is also present on the DAG maps, but is not as accurate and is a pseudo grid. Further details are in Annex 8, these are believed to be accurate and complete.

2.7.3 Street addresses and postal/zip codes

GIS commonly work with street addressing systems for "geocoding". Street names in Beirut are variable, that is streets have alternative names, so this system is not in common use.

Postal codes are not in common use either, however LibanPost does have "a postal code for every building " ["The Executive", February 2002, p.6]. Postal codes refer to a limited geographical area and are frequently used for searching geographical databases, particularly for commercial purposes.

2.8 FIELD SURVEY TECHNIQUES

Field surveys, whether census or samples, are based on the enumeration areas known as ilots, of which there were approximately 12,000. For the 2002 buildings and establishments survey, the boundaries of Ilots will be revised and changed as required. It is proposed to add an extra 3000 Ilots, which would increase the total number to approximately 15,000.

The 1996 buildings survey used photocopies of street maps and 1:20 000 topographic maps, which were then annotated by hand by the enumerators. Building serial numbers were added and changes to the buildings drawn. The numbers are added

incrementally within an ilot. These building serial numbers were then typed into the Oracle Building and Establishment database.

2.9 ADMINISTRATIVE AND STATISTICAL UNITS

2.9.1 Introduction

The geographic areas required for the collection and presentation of statistics include both administrative boundaries in general use, areas created specifically for statistical purposes, and statistical units connected with buildings and establishments. The following description is based on CAS documents, the "Etudes Statistiques" and "Documentation on the Geographical Database".

2.9.2 Administrative Units

The following units apply to the work of the CAS, in descending size:

1. Mohafaza – 6 in the country
2. Caza – 26 in the country
3. Circonscriptions Foncières – 1546 in the country.

The location of the boundaries of these units is the responsibility of DAG. There are uncertainties and disputes over some of these boundaries, and some conflicting data. There is also an overlap between cadastral or property boundaries and purely administrative areas, therefore property disputes affect the definition of administrative areas.

The basic administrative and geographic unit is the *Circonscription Foncière (CF)* and forms the basis for all administrative boundaries at CAS.

2.9.3 Survey Areas

Ilots

For the purposes of statistical survey and in order to have a more detailed geographic division, large *cazas* are subdivided into *zones* and CF into *ilots*.

The ilot is therefore the smallest geographical unit. It is defined as a group of buildings delimited by streets, roads, rivers and other geographic features. There are approximately 12 000.

The ilot is the basis for all field data collecting at CAS.

Ilots were defined in the 1996 survey by tracing on 1:20 000 topographic maps, mainly using CF boundaries, roads and rivers to define them. The quantity of Ilots in a CF varies from 0 to 100 or so. Ilots are expected to be revised for the upcoming survey. The Ilot code in the alphanumeric database (Oracle) is 2 digit, however these may be insufficient in some cases.

Zones

Zones are used to group ilots for reporting statistics. They are not administrative areas. Both *grandes zones* and *petite zones* are used, due to the different administrative structure in Beirut from the rest of the country.

In Beirut mohafaza:

the *Grande Zone* is identical to the *Circonscription Foncière*

the *Petite Zone* is a group of *ilots*, and is identical to the EDL sectors.

In mohafaza outside Beirut:

Petite Zone is identical to the *Circonscription Foncière*

Grande Zone is a group of *Circonscription Foncières*.

The situation in Beirut

The capital city is treated differently due to the density of buildings and the different administrative structure. Beirut is a *mohafaza*, it is not subdivided into *cazas* but into 12 CF. The division into zones is that adopted by the electricity supply company *Electricité du Liban* (EDL), allowing the integration of that company's statistics.

The subdivision into *ilots* has been made such that they are approximately 40 buildings.

2.9.4 Statistical units

Data is collected on 3 statistical units:

Building *(immeuble)*

Building unit *(local)*

Establishment *(établissement)* – where goods or services are produced.

3 DATA INVENTORY

3.1 ORACLE ALPHANUMERIC DATABASE

3.1.1 Description

The alphanumeric data are stored in Oracle tables, and include :

- approximately 520 000 buildings
- establishments, approximately 200 000
- building units, approximately 1 450 000
- administrative areas (muhafaza, caza, circonscription fonciere)
- enumeration/sampling areas (ilots ' approximately 15 000, petite zones, grande zones)

This is described in the Entity-Relationship Diagrams in the mission report of the Consultant in Statistical Databases, Arij Dekker.

Location components are included in the following tables for 1996:

- Muhafaza – Coordonnées Lambert (Xmin, Xmax, Ymin, Ymax)
- Caza - Coordonnées Lambert (Xmin, Xmax, Ymin, Ymax)
- Circonscription Foncière - Coordonnées (X,Y)
- Petite Zone – Coordonnées (X,Y)
- Center (Muhafaza, Caza, Grande Zone) - Coordonnées (X,Y).

Therefore importance has been attached to geographical components of the data previous to any acquisition of GIS software and data.

3.1.2 Alphanumeric database codes

All units have codes or serial numbers as unique identifiers. In the case of administrative and sampling areas these are concatenated such that the units they belong to can be identified.

A circonscription foncière is identified by a 5 digit code, the ilot consists of the CF code plus a 2 digit ilot part.

The ilot is the smallest geographical unit, and is based on a code consisting, in descending order of size, of:

Beirut – Muhafaza, Caza, Circonscription Foncière, Petite Zone, Ilot.

The ilot 1055201 is in Petite Zone 10552, which is in CF 105, which is in Caza 10, which is in Mohafaza 1.

Outside Beirut – Muhafaza, Caza, Grande Zone, Circonscription Foncière, Ilot.

So the ilot 3525301 is in Circonscription Foncière 35253, in Grande Zone 352, in Caza 35, which is in Muhafaza 3.

Building (*bâtiment*) serial number – consists of the Ilot code plus a 3 digit serial number.

Establishment (*établissement*) serial number consists of the building serial number plus a 3 digit serial number.

3.2 DIGITAL GEOGRAPHIC DATA

Details of the geographic data considered useful are provided in Annex 3.

3.2.1 Digital Geographic Data from DAG

Most of the digital geographic data currently available at CAS has been purchased from DAG, which is responsible for cartographic issues in Lebanon. No metadata, information on the source and meaning of the data, is available. Data is in a mixture of shapefile and coverage format, these are both ESRI formats and can be read with the current GIS software. The coordinates are in the Stereographic projection.

Summarising the useful data:

- Most importantly all the CF boundaries are included, which form the basis for all ilots.
- Major roads and settlements as points are available at the national level.
- Streets and buildings are included for the major towns (approximately 65), covering approximately 1759 out of 12000 ilots.
- In Beirut buildings as areas are included, and also a city map backdrop.

3.2.2 Arcleb

Arcleb is a CD of data from ESRI GIS suppliers Katib & Alami in Beirut, created as part of an Electricity project. No metadata, information on the source and meaning of the data, is available. They in the Lambert coordinate system and are not immediately compatible with the DAG data.

The data includes Mohafaza and Caza, roads – major and secondary, electricity and other utilities.

3.2.3 Digital topographic maps

During the mission scanned 1:20 000 DAG topographic maps were acquired from the NCRS in digital form, georeferenced to the Lambert system.

3.3 HARDCOPY GEOGRAPHIC DATA

3.3.1 Air Photos

A set of standard hardcopy black and white photos in 9" format are available for the year 1991, at 1:10,000 scale, prepared by Maps Geosystems. They cover the *littoral* or coastal area, particularly near Beirut but excluding the south, and cover approximately a limited area of the country. The photos overlap allowing them to be viewed in stereo.

Similar photos are available for a more limited coastal area for 1994.

3.3.2 Maps

Paper topographic maps are available at 1:20,000 – the base scale of the country, and at 1:50 000.

3.4 DATA SOURCES EXTERNAL TO CAS

This information based on discussions with the National Centre for Remote Sensing. It should not be taken as an authority on data availability.

- KVR2000 Russian black and white satellite photography, 2 metre resolution, acquired for Council for Development and Reconstruction (CDR). Dates from 1994-97. Georeferenced by GIS Transport.
- Ikonos high resolution satellite imagery of Beirut (11x11 km) for December 2001, 1 m panchromatic imagery merged with 3 m multispectral imagery (Pan-sharpened imagery). There are shadow problems from high buildings due to the season.

4 ANALYSIS

4.1 STAFF

4.1.1 Objectives

It should be noted that GIS is a support function to the primary function of CAS to provide statistics, although it is likely to become an important function.

There is a good IT knowledge within the staff concerned, due to the nature of statistical processing. Geographic or spatial knowledge is more limited, and it is important to increase this with appropriate training. Geographic Information (GI) is not solely another branch of IT, as the work expands a good grasp of the geographic concepts involved, such as projection and coordinate systems, issues of scale and metadata etc, will become increasingly important. CAS may well find themselves as one of the leading GI institutions in Lebanon.

4.1.2 Training

Training of the current staff is required in the use of ArcGIS software. The programming staff require training in GIS programming for customisation and

specific functions that are likely to be required. In ArcGIS this uses standard programming languages such as Visual Basic and C++.

As part of GI knowledge, the specialist use of satellite and aerial imagery (remote sensing) within GIS will become more important as this data is incorporated into CAS work. Basic training will be required, although not at the initial stage.

Basic GPS training is advisable when the CAS equipment is available, to ensure staff have a basic grasp of the concepts and practice.

4.1.3 Positions and recruitment

The GIS section should not be expanded until it has had chance to settle down with the software and tasks assigned. However to conduct the initial heavy workload of data preparation in a reasonable time, longer use of the GIS equipment will be required by some combination of overtime and recruiting of temporary staff. For this a GIS supervisor able to schedule workloads and manage deadlines is required.

Routine functions of GIS Manager, GIS Programmer, Geographic Database Co-Ordinator and GIS Operators should be covered from existing staff after the recommended training has been carried out. During the initial stages the services of a GIS adviser on a temporary or part-time basis to advise on implementation and techniques is required. This should be a Lebanese national someone with a relevant degree and good technical experience of ESRI GIS.

4.2 CONNECTION BETWEEN THE ALPHANUMERIC AND GEOGRAPHIC DATABASES

The principle is that alphanumeric data such as building and establishment information which has been entered and managed within Oracle tables should reside there and be joined to the GIS maps. Spatial data, such as maps of *circonscriptions foncières* and *Ilots*, will stay in the geographic database (ArcView or ArcGIS).

It is possible for spatial data to be kept in Oracle and be managed with the level of security available, but this requires extra software (Oracle Spatial and ArcSDE) and at the current stage of development imposes unnecessary sophistication and management overheads.

Equally it is possible to copy Oracle data into the geographic database and be directly associated with a digital map. This should be discouraged to avoid creating multiple copies of data with discrepancies between them. There may be times when it is convenient to do this however, for example when you wish to take maps away form the office network.

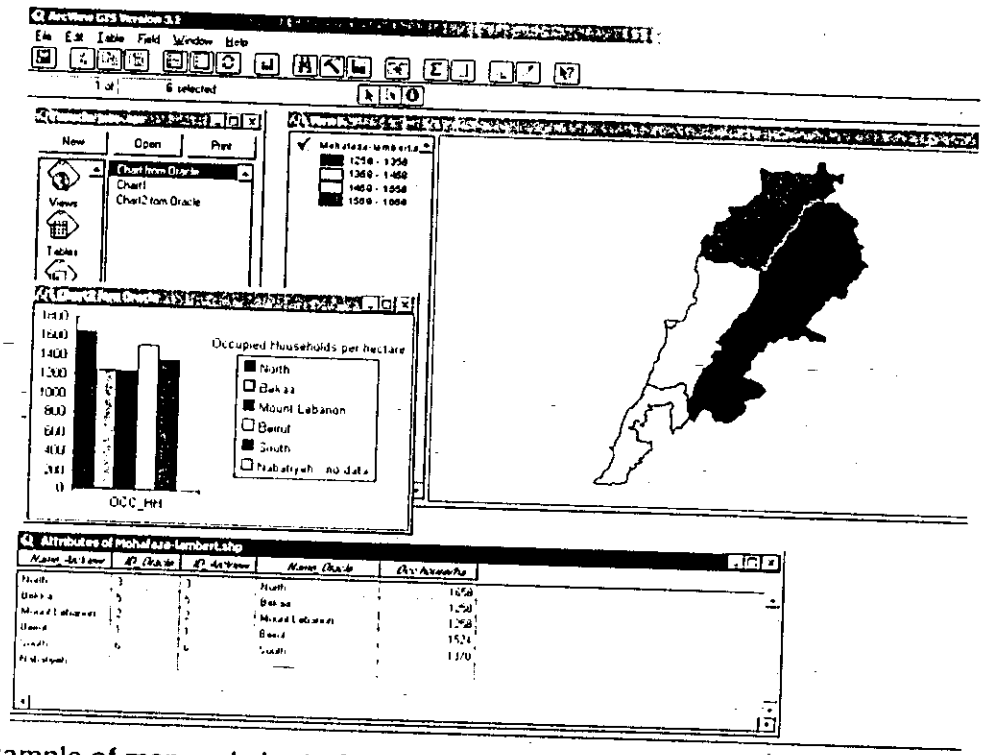
The technical details for both system and table connections are given in Annex 2.

4.2.1 System connection

Oracle tables can be joined to Dbase or .dbf tables associated with ArcView maps in shapefile format. To connect to SQL databases such as Oracle, ArcView 3 uses Microsoft's ODBC (Open DataBase Connectivity) standard. ODBC is Microsoft's open interface for accessing data in database management systems.

When you save a project containing a join, ArcView saves the definition of the join rather than saving the joined data itself. The next time you open the project, ArcView rejoins any joined tables by reading their files from disk or re-executing the SQL queries they are based on. In this way, any changes to the source or destination tables

that have taken place since they were last joined are automatically included in the project, and reflected in any views, tables, charts or layouts based on the joined data.



Example of map and chart of Mohafaza representing data held in a CAS Oracle table – occupied households per hectare

The data can be copied into the GIS for working without the Oracle connection, but normally this would not be the preferred method. This has been successfully tested at CAS both on a standalone PC and using the network.

4.2.2 Table connections

The spatial component should be taken from the map elements. The existing centroid data for administrative and survey areas is not relevant, and is generally in Lambert. In this case the building codes/serial numbers for existing mapped buildings (either point or polygon) features can be created in the GIS, based on the code referring to administrative and enumeration areas, adding a part for the building. Keeping part of the code referring to the ilot is a check on gross location errors.

In this way enumerators can fill in the attributes/survey information, on an Oracle form including the building serial number used by both the Oracle building table and the ArcView shapefile attribute table/geodatabase. Only this common linking field need be held in the GIS tables, the census data resides in Oracle.

4.3 DATA AND GEOREFERENCING

4.3.1 Formats

The standard format for the current work should be the ArcView shapefile. Migration to the ArcGIS geodatabase is advisable in the long term but the shapefiles can continue to be used within ArcGIS.

4.3.2 Georeferencing

The Stereographic system is the de facto standard required for CAS, due to the base mapping data coming from the national mapping agency or DAG. It has not been possible to determine the basic parameters for this system, which means that no conversion of data is possible. Other data may however be required, for example imagery in Lambert and GPS coordinates in Latitude/Longitude. Without the basic information they cannot be properly converted to this standard referencing system.

In ArcGIS differently referenced data can be projected "on the fly" within a viewing window to enable visualisation, however without correct referencing information this is unlikely to work correctly without some good guesswork. In order to project data to a different map projection, data must have a defined projection to start with.

4.3.3 Metadata

Metadata is supporting descriptive information about data. Metadata includes descriptive information such as date, creator, geographic extent, co-ordinate system, and attribute domains. Metadata gives your data credibility and in many situations your data may be impossible to interpret or use without it. An example is the 3 different sources of building maps for Beirut, none with any metadata describing date or method of creation, each with different numbers of buildings.

It is vital that metadata is managed as part of the geographic database creation. ArcGIS includes excellent and easy tools and standards to make this documentation easier.

4.3.4 Quality

The quality of the data is part of its metadata. In practical terms there is often no idea of the quality or accuracy of the data. For practical purposes data from DAG has to be taken as authoritative, and new data documented in the metadata.

4.3.5 Further data required or desirable

In order to create new CAS data for ilots and buildings, reference or base mapping is required, preferably in digital form. Digital topographic maps have been acquired, but need re-projecting into Stereographic to be compatible. Aerial or Space photography is the ideal data for digitising buildings. The date of the data is significant, unless commissioning of a new aerial survey is feasible, then readily available and processed photography from a few years ago is more than adequate, updating will always be required.

Digital maps of the mohafaza and caza in polygon structure should be acquired from the DAG, the files in line structure are not fit for purpose, that is they cannot be associated with any descriptive data such as their identification.

4.4 DIGITISING ILOTS AND BUILDINGS

4.4.1 Ilots

Without digital ilot maps it will be very difficult to plan field survey and give enumerators sufficient information. If a paper/photocopy alternative is used as in 1996, this will also entail a lot of work and will suggest the GIS investment is wasted.

No digital data of the ilots was available before this mission. Digital data for all CF boundaries are available, and for buildings and streets for the major towns.

A pilot study was undertaken to test the digitising methodology. Annex 4 details the techniques used. There are 3 scenarios :

1. BEIRUT – data: sector limits, buildings as polygons, full street map with other reference points; e.g. Gharbi sector.
2. MAJOR TOWNS/VILLAGES - data: CF limits, major roads, settlements as points, buildings as points; eg Ain Saade CF.
3. OTHER TOWNS/VILLAGES - data: CF limits, major roads, settlements as points, no buildings; with no buildings – eg Joub Janine CF.

Outside of Beirut the data is insufficient to digitise the ilots, where ilot boundaries do not coincide with roads/streets (many of which have changed vis-à-vis the paper source maps) then there is no basis for the location of the ilots.

4.4.2 Buildings

Digital building maps from the DAG are available for Beirut as polygons, and for the other major towns as points. There is no metadata for the buildings, therefore until field survey we have no idea of the quality of this data and how much updating will be required. To illustrate this point, there are 2 building files for Beirut, one as polygons and the other as points. The number and location of buildings in the 2 files is different, and neither corresponds exactly with the scanned street map.

It is not considered practical to relate the current buildings with the 1996 buildings data at the individual level, therefore a new buildings database will be constructed for 2002. Comparisons can then be made at the aggregated levels – ilot, CF, caza etc.

Assuming that you have digitised the ilot boundaries, there are 3 scenarios:

1. BEIRUT – buildings as polygons - changes/new buildings can be created as points using existing data.
2. MAJOR TOWNS/VILLAGES with buildings as points - reference information is needed to update changes/new buildings.
3. OTHER TOWNS/VILLAGES with no buildings – no base for updating and no reference information.

Outside of Beirut there is no way of reliably digitising buildings with the existing data. Without going to the expense of using ground survey with surveying instruments such as survey grade GPS, there are 2 practical scenarios.

4.4.3 Scenarios for ilot geographic database

In Beirut, the street maps can be used to digitise the ilots, this has already been successfully tested.

Outside Beirut the ilot boundaries can be digitised on screen over digital DAG topographic maps acquired through NCRS, using the same features as have been used on paper. This however depends on these maps being reprojected to the Stereographic co-ordinate system so that all data can be overlaid. This is required to work with the current ArcView 3 setup.

Recommendation: Authorise the payment to NCRS to reproject the topographic maps.

4.4.4 Scenarios for building geographic database

Scenario 1:

a. Digitise the Geographic database for Ilots.

b. Do not create a building geographic database, use an alphanumeric database only for buildings.

c. Aggregated statistics and maps can be shown for ilots, caza etc, but not at building level.

Scenario 2:

a. Digitise the Geographic database for Ilots.

b. Buy KVR-2000 satellite photos in digital form, as used by the CDR, georeferenced (licence offered by GIS Transport, subject to confirmation of terms, for $25000). Use this as to digitise individual buildings as points, creating a geographic database for buildings.

In terms of the data presentation there is no requirement for building maps, the requirement lies in the field maps for enumerators.

4.4.5 Building serial numbers

Serial numbers include a part identifying the ilot, therefore numbering needs to be at this level. Additionally the numbering standard involves clockwise numbering within a street block, a process difficult to automate with a computer programme. Spatial joining of building and ilot tables, merging on the shape field, has been tested at CAS to be effective in adding the correct ilot code to building points. This code can be concatenated to the 3 digit building ID to produce the complete 10 digit building serial number.

To create the ID, it is recommended to create a new file of points over the appropriate backdrop data in the required order. The rows in the table are then in the correct order for semi-automatic numbering using an Avenue script or similar (Avenue is the ArcView 3 programming language).

4.5 LOCATION OF BUILDINGS

4.5.1 Building location requirements for enumerators

1. Beirut – mapped areas (polygons) of buildings and streets are available and there is no need for further locating. However there is a need to deal with changes to buildings/new buildings.

2. Major towns/villages – points for buildings, streets are available, this is insufficient to ascertain correct building location. There is also a need to deal with changes to buildings/new buildings.

3. Other towns/villages – no location information available.

4.5.2 Alternative techniques

Alternative techniques for locating buildings, both for field survey and within the GIS.

Survey grade GPS receivers

These employ differential correction which correct the signal to a greater accuracy. This requires more sophisticated receivers, the use of an international differential correction service or an independent base station. Accuracy can then be of the order of 3-5 metres, or less than a metre with increasing sophistication and cost. This is in effect surveying and requires surveying staff, and does not really fall within the remit of CAS. If a cartographic grade survey of buildings is really required this should be contracted out to a suitable company.

Handheld/leisure GPS receivers

With the end of Selective Availability in May 2000, manufacturers such as Garmin and Trimble expect horizontal accuracy of 7m to 15m for newer 12 parallel channel units in good reception conditions, and 20 to 35 metres with older 8 channel units. There are a number of environmental conditions, particularly operation next to tall buildings, that can affect GPS accuracy due to varying satellite signal reception conditions and can therefore lead to better or worse accuracy. Lebanese projection systems are not normally available in these units, therefore positions are collected in latitude/longitude and have to be converted within the GIS.

Is accuracy of approximately 10 metres sufficient to clearly identify buildings? In any case the enumerators should not use the GPS in isolation from other information, i.e. they should have access to topographic maps and aerail photos if possible to locate themselves, and it would still be advisable to sketch their location on the field maps printed out from the GIS. This accuracy has also to be assessed in relation to the maps the points will be visualised in. It is not possible to collect the coordinates in the same system as the maps, because there is no definition available of the map system in use.

The experience of NCRS and of a field test together with CAS and the consultant, suggest that using this quality of GPS used as a secondary issue within the buildings survey will not provide worthwhile answers, particularly when operators are paid per building completed. Combining variable position quality, work amongst buildings, coordinate conversion and uncertainties over the coordinate systems in Lebanon is liable to give mapping of uncertain quality. It is considered preferable to have no mapping than confused and inaccurate mapping.

Nevertheless CAS GIS staff should conduct trials with current handheld GPS in conjunction with field GIS, as the technology will prove useful in certain circumstances and in future developments. Currently 12 channel receivers claim better accuracy under tree cover than the 8 channel unit tested, WAAS signals are under development claiming 3 metre accuracy but are not yet properly implemented and degrade amongst buildings : the technology is evolving rapidly. The increased sophistication and greatly increase cost of survey grade GPS is not appropriate for the remit of CAS.

Digital Imagery

Georeferenced or map-accurate aerial photos (orthophotos) or equivalent can be used as a map background to the ilots, street maps and building files. At scales of 1:10 000 and better individual buildings can be identified, and enumerators can use the photo background for navigation.

Digital aerial photos are expected from CAS to cover a similar area to the building and street files, i.e. situation 2. These have not been evaluated.

Russian black and white satellite photography from the KVR2000 satellite for the whole of Lebanon has been acquired, covering dates in 1995 to 1997, georeferenced in the Stereographic projection in a format compatible with ArcView on behalf of the Council for Reconstruction and Development (CDR). CAS has an opportunity to buy a licence to use this imagery from the contractor GIS Transport for $25 000 (terms and prices to be confirmed). Although the quality is not as good as conventional photography, with 2 metre spatial resolution they are effective at scales between 1:5 000 and 1:10 000. This represents an exceptional opportunity to acquire nationwide digital imagery without commissioning a new aerial survey and is recommended if CAS requires a geographic or map database of all buildings.

The only satellite imagery that can currently be acquired that would enable identification of buildings is IKONOS (www.spaceimaging.com). A sample of this for Beirut can be accessed by the NCRS. Acquisition requires programming of the only available satellite and is considered less practical than commissioning an aerial survey. A new aerial survey is the ideal method, but does not fall within the remit or budget of CAS nor the timetable for the buildings and establishments survey.

4.5.3 Budget

A budget has been proposed of $30 000 for 200 stand alone GPS receivers, equal to $150 each. As a result of the above analysis it is recommended that this budget be used to acquire the space photography, and a small system of field GIS, including GPS, for approximately $2000. This data will also benefit all other GIS operations.

4.5.4 Enumerator Control Method

Where ilots retain the same boundaries as used in the 1996 buildings and establishments survey, an individual ilot can be joined to the 1996 buildings table. This information can then be used to assess the likely accuracy of the 2002 survey in areas where limited change in the number of buildings is expected.

4.6 HARDWARE

4.6.1 PCs and Network

GIS software runs on standard desktop and notebook PCs, there is no requirement for dedicated hardware. For example for ArcInfo 8 the recommendation is Windows NT4/Windows 2000, minimum RAM 128 MB, recommended RAM 256 MB.

A standard Windows 2000 environment with a minimum of 256 MB RAM for effective display of large geographic databases across a network, and large screens, is required. The minimum screen size for desktops should be 17", and 14" for notebooks. CD-Rom and diskette drives should be included, see below for CD Writers.

The ArcInfo licence should be installed on the Applications server as a concurrent or floating licence. ArcView licences should be installed for single use on individual PCs.

4.6.2 Input devices

Scanner

An A4/A3 200 dpi scanner has been proposed as part of the general IT equipment requirement, with the objective of bulk digitising of CAS documents to improve access and free up archive space.

For GIS a scanner could be used to digitise the base paper maps on which the 1996 Ilots were delineated, but as image documents NOT georeferenced images. They could be attached however to a geographic unit such as CF or caza; or simply accessed through a file hierarchy. Although many are larger than A3 it is not considered worthwhile scanning larger than A3 as the composite nature of these documents mean that they would not be suitable for drum scanning and require a flatbed scanner.

Air photos could also be scanned, again this would be as image documents not georeferenced images, as the orthocorrection of air photos is a specialised task requiring appropriate software and knowledge.

The ideal resolution for this quality of scanning should be A3, 400 dpi, 8 bit colour flatbed, which is higher than the current proposal. A higher specification would be required to scan adequately for use as precise geographic data, but occasional work required can be contracted out.

Digitiser

The current digitiser is adequate, all future digitising is likely to be on-screen. If digitising of paper maps is required, the appropriate method is to contact out high quality scanning and then to digitise on-screen after georeferencing.

4.6.3 Output devices

Printers

There is a large format printer. For convenience and bulk output of A3/A4 colour maps for enumerators, standard office colour inkjet printers should be purchased.

CD writer

CD writers are required for data backup and data distribution. Internal writers installed in desktop PCs are preferred.

4.6.4 Field survey hardware

As discussed above in the section on *Location of buildings*, GPS and related field survey equipment is not recommended for widespread use in the planned survey. However evaluation and trials in this rapidly evolving area should begin. A stand alone GPS receiver, a GPS receiver suitable for use with a field GIS and a pocket or palmtop PC with download to desktop PC will be required.

4.7 SOFTWARE

The current versions of ESRI GIS software (ArcView and ARC/INFO) in use at CAS are not the current versions. This is significant because the software has been completely rewritten since these versions. This is significant because:

- Although there is a rudimentary ArcTools system, the workstation ARC/INFO is based on a command line or DOS style interface which is not intuitive to use

الجمهورية اللبنانية
مكتب وزير الدولة لشؤون التنمية الإدارية
مركز مشاريع ودراسات القطاع العام

and requires significant training, and is difficult for users to master without regular use. ArcGIS however is very similar in feel to standard Windows applications.

- The database structure (the geodatabase) is different and is designed far more to integrate with industry standard databases such as Access or Oracle, in particular for multi-user databases.

4.7.1 Core GIS

ArcGIS is a suite of GIS software which replace the versions of ArcView and ArcInfo currently in use at CAS. The editing tools are far superior for ilot digitising, lines can be traced and copied from existing layers such as roads and CF boundaries, giving a much more accurate map and avoiding different versions of the same line due to recreating the line in another layer. On-the-fly projection allows the combination of data in different projections (assuming they have the correct projection information) within a view window. ArcGIS runs on Windows NT and Windows 2000. Facilities for associating metadata with geographic data allow better knowledge of data sources and quality, a data catalogue similar to Windows Explorer enables clearer data management, and customisation/development can be carried out in-house using in-built Visual Basic for Applications (VBA) or external languages such as C++.

ArcGIS is available in 3 licences of increasing functionality and cost, all using the same interface – ArcView, ArcEditor and ArcInfo. Despite the name branding they are completely new software packages. A total of 4 licences is recommended. ArcView 8 enables most routine viewing, editing and analysis tasks. ArcInfo 8 has all possible data conversion and analysis functions, and will enable the conversion of any geographic data that CAS may wish to acquire. It is recommended that this is a floating or concurrent licence so that it can be made available to various operators, only 1 licence is required.

4.7.2 Database access

ODBC is adequate to access the Oracle databases.

ArcSDE (spatial database engine) is an interface between ArcGIS and multi-user databases, but which imposes another management overhead. IT would allow more than one user to edit files in a geodatabase, and manage multiple versions and long transactions. This is not expected to be a requirement in the foreseeable future.

4.7.3 Image processing

Image processing is not a major task for the CAS GIS section, but the use of topographic maps, aerial/space photography and potentially satellite imagery requires a certain capability. Image Analyst is an image processing extension for ArcView 3. It includes functionality to georeference imagery to shapefiles, GPS points, or reference images; perform image enhancement; automatically map feature boundaries, including potentially buildings; perform change detections; perform land cover mapping and data extraction; mosaic imagery from different sources and different resolutions. It should be noted that the preperation of scanned aerial photos such as those held by CAS in hardcopy requires other specialist software and is not recommended.

Images can occupy large volumes of disk space. Although this may not be an immediate problem with large disks on desktop PCs, it is still important for field GIS

on palmtop PCs with limited space. Image compression is now a highly effective and efficient technology with ratios of 1:10 to 1:100 easily achievable for geographic imagery. MrSID format by LizardTech is recommended for this due to its compatibility with ArcGIS software. The ArcGIS extension MrSID Encoder for GIS is appropriate.

4.7.4 Field GIS

ArcPad is the field version of ArcView. This will run on palmtop or pocket PCs, in conjunction with GPS receivers if required. Data can be carried using memory cards, currently using 64 MB, and updating can be done in the field on shapefiles. These files can then be downloaded to the desktop or laptop. ArcPad can convert GPS points in degrees of Latitude/Longitude to Lambert Conformal Conic coordinates, but not to Stereographic.

Images – topographic maps and aerial/space photography – will need to be compressed using the MrSID format to be easily carried on the palmtop PC.

4.7.5 Free viewing software

GIS data need not be confined to the GIS section, and indeed should be available for viewing more widely to justify the expenditure and investment in the system. Free software for viewing, not changing, geographic data similar to internet browsers is available for download from www.esri.com.

ArcExplorer is a GI browser and can read shapefiles and images and their attribute tables. ArcReader is a map browser for reading digital map documents.

4.7.6 Localisation of software/Language support

Arabic text is required for map output. Although Arabic and Latin text is routinely supported across Office applications, Arabic text cannot reliably be typed or copied into ArcView 3 which is not fully Windows compliant. This is likely to work in ArcGIS but has not been tested.

ArcView 3 has a fully localised language support in French but not Arabic. There is no support yet available in ArcGIS from ESRI. Arabview may be upgraded to ArcGIS, it has not been possible to ascertain this.

4.7.7 Software support and maintenance

ESRI GIS products, ArcGIS etc., are only licensed to be sold in Lebanon by the company Khatib & Alami. Although equipment will be put to a local tender process, unless the software is provided by a non-Lebanese supplier the software will come through the local dealer. Although it may be possible to provide the software cheaper from elsewhere, it is vital that CAS has access to local support, even if only for such mundane but time consuming problems as printer installation.

4.7.8 Customisation and development Of CAS Applications

ArcGIS can be customised using built-in VBA scripting to extend existing functions, or new tools and functions can be developed using external standard programming languages including Visual Basic, C++ or other COM compliant languages.

During the prototype phase using ArcView 3, development uses the Avenue language available within ArcView 3.

4.8 DATA SECURITY

Data security is considered a major issue at CAS. In particular all map data, including coordinates and projection information, is considered confidential.

This also explains the requirement for using an Oracle database over, for example MS Access. The latter may be more appropriate in terms of cost, complexity, training and management overheads; and is sufficient to keep the current volume of data. Even if data volumes later exceed Access capabilities, upgrade facilities are simple. However the more intrinsic security aspect of Oracle is preferred by CAS.

It is perfectly feasible to store geographic data in an Oracle database, but there is a cost. Extra software is required – the Oracle Spatial extension, and a higher level of management and training. This option is not recommended, and it can be upgraded to at a later date if required.

The alternative security for geographic data is to use the Windows NT system management facilities. Using this access and write permissions can be effectively managed using the user login method, along with simple but very effective techniques like password protected screen savers. This security is negated if users logon as administrators for routine work, therefore it is important that GIS work is done as a user and not as an administrator or system manager.

Geographic data will be connected to the Oracle database, Oracle manages these connections very effectively, requiring a user login and service name. Again, it is vital that access to Oracle for GIS work is as a user and not as system manager. The ODBC connections must be constrained as read only access. This has been implemented during the prototype.

5 RECOMMENDATIONS AND IMPLEMENTATION PLAN

5.1 STAFF

5.1.1 Staff resources

During the initial stages the services of a GIS adviser on a temporary or part-time basis to advise on implementation and techniques is required. This should be a Lebanese national with a relevant degree and good technical experience of ESRI GIS or similar.

However to conduct the initial heavy workload of data preparation of creating ilot and building maps in time for this year's survey, in a reasonable time, longer use of the GIS equipment will be required by some combination of overtime and recruiting of temporary staff. For this a GIS supervisor able to schedule workloads and manage deadlines should be recruited.

Estimates of the effort that will be required for the initial data preparation are given below, these are preliminary but indicate the amount of staff time that will be required. Preparation of the paper reference documents and administration of data will also be required.

Ilot digitising

Approximately 20 minutes are required to digitise the ilots in 1 CF, therefore the ilots for 3 CF will take 1 hour. There are 1546 CF in the country, equalling 515 hours, which in 6 hour days equals 86 staff-days.

Allowing for short days and other activities, dividing by 5 days gives an estimate of 17 staff-weeks of work.

Building digitising

Approximately 15 minutes are required to digitise 100 buildings and code them, assuming there are reference images. Therefore 400 buildings would be prepared in an hour. There are 520 000 buildings, equalling 1300 hours, which in 6 hour days equals 217 staff-days.

Allowing for short days and other activities, dividing by 5 days gives an estimate of 44 staff-weeks.

5.1.2 Training

Tutorial exercises and data are provided with all ESRI software and their use should be encouraged.

Training in GIS is essential and should start as soon as possible, according to the specification below. The recommended training is detailed in Annex 6. This includes:

- 5 days Introduction to ArcGIS (required as soon as possible)
- 2 days GIS Programming (required in Phase 1)
- 1 day GPS training (not required until Phase 2)
- 2 days Image Analyst training (not required until Phase 2)

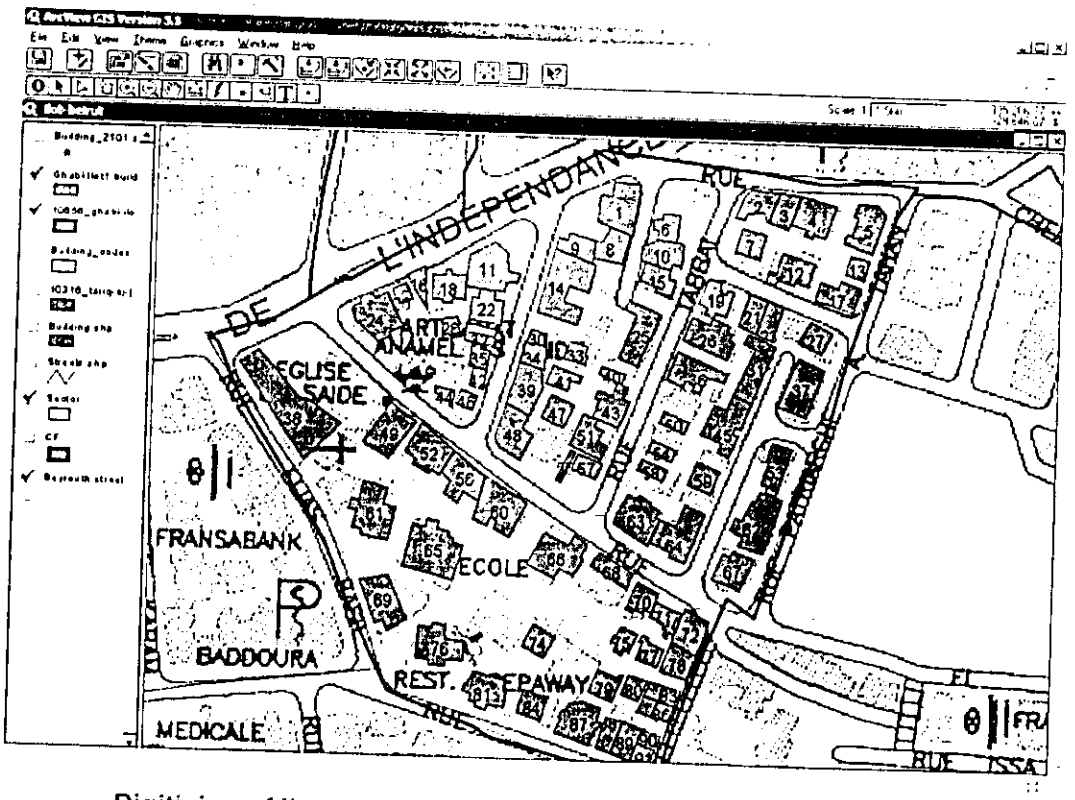
Introduction to ArcGIS is the priority. Part 1 includes displaying data, querying the database, working with spatial data, working with tables, editing, georeferencing and presenting data. Part 2 includes ArcCatalog, advanced cartography, displaying tabular locations, customising the interface, designing a GIS database, automating data, editing the database schema, editing spatial and attribute data, spatial analysis and data management, and a practical project.

GIS programming should teach general VBA programming concepts as they relate to the customisation of ArcMap and ArcCatalog applications, as well as programming with ArcObjects.

5.2 GEOGRAPHIC INFORMATION SYSTEM

5.2.1 Prototype

Informal training and digitising of ilots and buildings as shapefiles has begun. The current set up of ArcView 3 is being used. The methodology is detailed in Annex 4. All necessary data is available for Beirut which can be completed. An example is shown below.



Digitising of ilots and coding of buildings in a test ilot in Beirut

Connection to Oracle tables using ODBC links and SQL has been tested, the methodology is detailed in Annex 2.

5.2.2 Hardware

The recommended specifications are detailed in Annex 5. There is no modification to the previous PC specification which is more than adequate.

Standard A3 colour inkjet printers for printing of enumerator maps are included.

Field survey hardware is detailed, a simple GPS receiver (e.g. Garmin GPS12) and a more advanced receiver (e.g. Trimble Pathfinder pocket receiver) to work together with a pocket or palmtop PC (typically a Compaq Ipaq) are detailed.

5.2.3 Software

The recommended specifications are detailed in Annex 5. The basis consists of 4 licences: an upgrade to the existing ArcInfo (preferably as a floating or concurrent licence, this is not essential if the applications server is not acquired), 2 upgrades to the existing ArcView licences and 1 new ArcView licence.

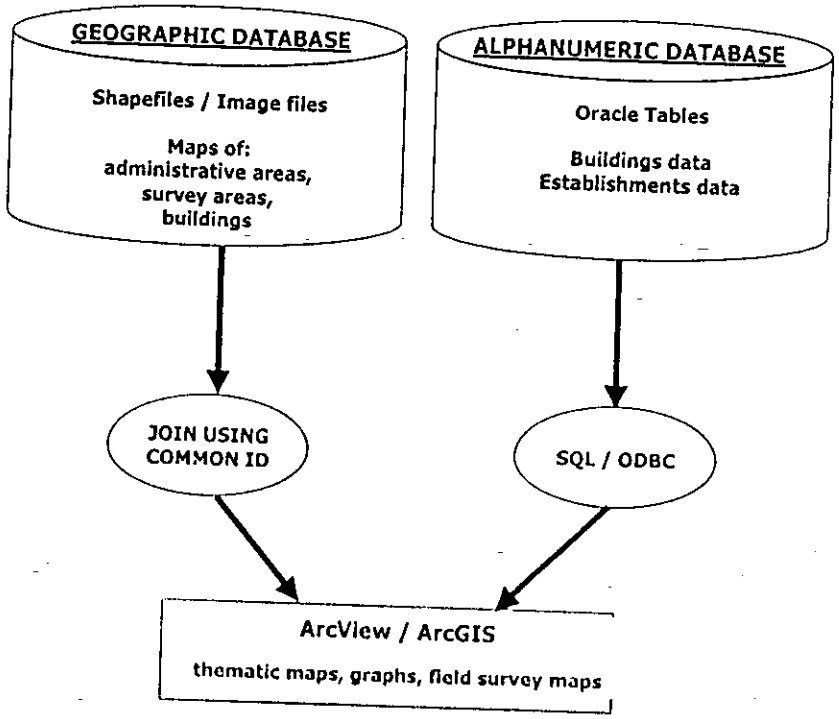
Image Analyst extension for image processing, MrSID encoder to compress images for field use, ArcPad for field use and Arabic software localisation are included.

5.2.4 Security

The network administrators should ensure that user logins and permissions for reading and writing of data are correctly set up. Data should be regularly backed up using the CD writers in PCs, according to normal procedures.

5.2.5 Design of the geographic database

Based on the objectives and user requirements outlined above, the following simple logical design of the geographic database is proposed. The geographic basis for all CAS work is building, ilot and Circonscription foncière. Details of the physical design are given in Annex 7.



Logical design of GEOCAS – the CAS GIS

5.3 DATA ACQUISITION AND PREPARATION

5.3.1 Metadata

Metadata should be systematically created for all data acquired and created, even before the acquisition of ArcGIS which has tools to facilitate this.

5.3.2 Data acquisition

The digital topographic maps should be transformed into Stereographic projection by the NCRS.

The DAG aerial photography already contracted should be acquired. Polygon mohafaza and caza maps should also be requested from DAG.

The KVR space photography should be purchased, subject to it fulfilling the following conditions:

- imagery is georeferenced to Stereographic projection compatible with DAG data
- the entire country is covered

- the file format is compatible with ArcView 3.2 (GeoTiff, Imagine, BIL)
- CAS has a licence to use the data freely within its work and to print copies for field work and other operations.

5.3.3 Creation of ilot geographic database

Digitising of ilots in Beirut should continue according to the methodology in Annex 4.

Once the topographic maps are available in Stereographic digitising of ilots outside Beirut can proceed using these as backdrop images.

When ArcGIS is installed this should be used due to its superior editing tools.

5.3.4 Creation of building geographic database

Option 1:

Create only the alphanumeric database for buildings. Aggregated statistics and maps can be shown for ilots, caza etc, but not at building level.

Option 2:

Buy KVR satellite photos in digital form ($25000).

Digitise individual buildings as points (approximately 520 000!).

Maps can then be produced at building level.

Updating of buildings as a result of field survey will then be required.

5.4 FIELD SURVEY METHODOLOGY – GEOGRAPHIC COMPONENT

Enumerator maps should be printed with ilot boundaries and number labels, building files as available with labels, and background topographic maps or aerial/space photography.

GIS staff should conduct evaluations of field GIS using and field GIS in poorly mapped areas.

5.5 INSTITUTIONAL COORDINATION

CAS should be involved in any movements towards a National [geo]Spatial Data Infrastructure or NSDI to coordinate geographic data. This is happening in many countries, and statistical agencies are often major players, for example INDEC in Argentina and the Census Bureau in USA. Existing links with DAG, LEDO, CERMOC and AUB should be fostered to encourage dissemination of knowledge and data.

5.6 FUTURE DEVELOPMENTS

ArcGIS can be customised using built-in VBA scripting to extend existing functions, or new tools and functions can be developed using external software including Visual Basic, C++ or other COM compliant languages.

ArcPad on a palmtop PC can be used to start direct building data collection/editing in the field.

Publications could in due course be produced on CD using interactive maps. The statistical agency in Argentina, INDEC, sells such CDs. The geographical component

is created using ESRI's MapObjects (embeddable mapping and GIS components for application developers) and Visual Basic programming.

5.7 SUMMARY OF RECOMMENDATIONS

5.7.1 Implementation

1. Digitising of ilots in Beirut can continue, all resources are there to finish this.
2. If ilots/buildings require digitising now to be used in a buildings survey in a few moths time, there is a high immediate workload. Staffing would need to be organised to cope with a production schedule, including a GIS supervisor and temporary technical adviser.
3. GIS training is essential to avoid GIS being seen as purely an IT matter, and is required as soon as possible to make effective use of GIS resources, in particular the Introduction to ArcGIS.
4. Four new ArcGIS licences and accompanying PCs are required immediately to speed the workflow.
5. The digital topographic maps require transformation to the CAS standard – Lebanese Stereographic coordinate system, in order to digitise ilots outside of Beirut.
6. DAG digital aerial photography and CDR space photography need to be acquired for effective field survey and production of building maps.
7. Stand alone GPS with the mapping data and coordinate systems presently available is not considered appropriate for field survey, in particular with an undefined co-ordinate system. Survey grade GPS equipment with differential correction is not within budget or manpower constraints.
8. The only rapid and cost effective way to produce a reasonably accurate buildings map is by the use of high resolution imagery, if this is not available the alternative is to use a buildings alphanumeric database with no corresponding map, buildings can then be geographically visualised at ilot level upwards.
9. The use of field GIS in combination with GPS should be evaluated in order to begin incorporating the technology into CAS work practices.

5.7.2 Constraints

1. Delay in delivery of the new software and PC systems recommended will hamper a production style workflow, editing is far easier and accurate in ArcGIS. The GIS training recommended is on the new version, ArcGIS (ArcView 8), and therefore will not be effective until the same software is available in the workplace.
2. Acquisition of re-projected digital topographic maps is required before digitising of ilots outside of Beirut can begin. There is however no constraint on digitising ilots in Beirut which could be completed soon.
3. Acquisition of the DAG aerial photography should be urgently completed to begin digitising buildings, particularly if the space photography cannot be acquired or is delayed.

4. Effective organisation of production and supervision of resources and staff scheduling is essential if the proposed digitising is to be carried out in house.

5. Lack of knowledge of the geographic coordinate system on which the whole system is based is a long term constraint which should normally be solved at the beginning of a project involving significant amounts of data acquisition and creation. Problems with conversion of non DAG data are to be anticipated, in particular with the use of GPS coordinates.

ANNEX I : TERMS OF REFERENCE FOR THE GEOGRAPHICAL INFORMATION SYSTEM EXPERT

ARLA-PMC Project

1. Background Information

One of the major activities planned by the Central Administration of Statistics (CAS) for the year 2001 is to update the 1996 Buildings, dwellings and establishments database. The first step in implementing this activity is to create an internal geographical database for all Lebanese territory.

In this database the borders of Lebanese administrative geographical units (*Mohafazat* and *caza*) will be in digitised form but complemented with the CAS division into enumeration areas (ilots), which was used in the 1996 database with buildings located and numbered on hand-drawn maps. In the new geographic database the division into ilots will be revised. The location of buildings will be digitised and connected to an existing Oracle database containing information on the buildings as well as on dwellings and economic establishments in the buildings.

The connection between the new digitised geographic database and the existing Oracle database via common coordinates for buildings must be finally established by fieldwork in which the data on buildings, dwellings and economic establishments are also updated.

2. Proposed specific objectives

The purpose of the mission is, in co-operation with the CAS staff, to design and implement a geographical database system, which must be connected to the Oracle database. This database, in connection with the Oracle database, must provide the necessary maps and geographical information to execute the fieldwork in all future survey operations.

3. Main activities to be undertaken

The expert must assist the CAS staff in the following activities:

a) Assessment of the present system and requirements of the future system in terms of the design of the geographical database, the network and the platform for the system in terms of hardware and software;

b) Development of an implementation plan to reach the new system, specifically to design the prototypes of the system to digitise the geographical units at CAS and to design the fieldwork operation to ensure the precise connection between buildings identified in the geographic database by coordinates and information in the Oracle database on buildings, dwellings and establishments;

c) Planning staff capacity and capability needed in the short run to establish the new geographic database as well as the corresponding needs for the longer term with the system in a routine mode of operation.

Location

Central Administration of Statistics, Beirut.

4. Profile of the expert

The expert should have:

- A university degree in geography or other relevant discipline with at least 10 years of post graduate experience, including at least 5 years of experience in Geographic Information Systems design and implementation preferably in a national statistical institute;
- Familiarity with existing GIS software systems in the market and knowledge in ORACLE, UNIX and NT environment;
- Proficiency in English or French.

5. Expected duration and start date

One man-month. The mission is foreseen for the first quarter of 2002. However, the precise date will depend on the availability of temporary staff to execute the task, the necessary maps and logistical (hardware and software) conditions in CAS.

6. Expected outputs

A global report including the task fulfilled.

7. Reporting arrangements

The report should follow the PMC guidelines for mission reports of short Term Experts. Deviations are possible, provided these are discussed with the PMC Team Leader.

ANNEX 2 : GIS TO ORACLE DATABASE CONNECTIONS

ArcView3

See page 58 of the ArcView manual in CAS on which this is based.

ODBC

You use the ODBC Administrator (or the ODBC Control Panel option) to add, modify, and delete ODBC drivers and data sources. In the Main group in the Microsoft Windows Program Manager, double-click the Control Panel icon. In the Control Panel window, double-click the ODBC icon and set up System Data Source Names using the Oracle ODBC Driver.

The Oracle Administrator must establish the Service Name and the GIS user, giving read-only access to the relevant Oracle tables. Read-only access is also enforced in the driver setup.

The data sources established will appear in ArcView's SQL Connect dialog and Add Database Table. The Add Database Table utility is recommended, all permitted tables and columns are displayed and SQL queries are facilitated. The Database Access extension must be loaded in ArcView 3.2 for this to be enabled.

Join

You can join a table to the active table based on the values of a common field found in both tables. *Join* establishes a one-to-one or many-to-one relationship between the destination table (the active table) and the source table (the table you are joining into the active table). Typically, the source table contains descriptive attributes of features that you wish to join into a theme's table so that you can symbolize, label, query and analyze the features in the theme using the data from your source table.

When you save a project containing a join, ArcView saves the definition of the join rather than saving the joined data itself. The next time you open the project, ArcView rejoins any joined tables by reading their files from disk or re-executing the SQL queries they are based on. In this way, any changes to the source or destination tables that have taken place since they were last joined are automatically included in the project, and reflected in any views, tables, charts or layouts based on the joined data.

Link

You can link a table to the active table based on the values of a common field found in both tables. *Link* establishes a one-to-many relationship between the destination table (the active table) and the source table (the table you are linking to the active table). One record in the destination table is related to one or more records in the source table. Typically, the source table contains descriptive attributes of features that you wish to link to the features in a theme's table so that you can select features from this theme on a view see which linked records in the source table are selected.

Unlike joining tables, linking tables simply defines a relationship between two tables, rather than appending the fields of the source table to those in the destination. When tables are linked, neither table is changed - they are just linked to one another. After a Link is performed, selecting a record in the destination table will automatically select the record or records related to it in the source table. If the destination table is the

feature attribute table of a theme, selecting one of the theme's features in the view selects that feature's record in the attribute table, and therefore automatically selects the records related to it in the source table. Selecting a record in the source table does not select the corresponding record in the destination table. This is because the link only exists in the destination table.

An example of a one-to-many relationship is building occupancy. One building may have many units and/or many establishments. In ArcView, if you have a source table of establishments and a theme representing buildings, you could link the table of establishs to the table for the buildings theme. In this way, selecting one of the buildings on the view will also select the records for the establishements of that building in the establishments table.

Common fields

Tables are joined or linked based on a field that is found in both tables. Tables are joined based on a field that is found in both tables. The name of the field does not have to be the same in both tables, but the data type has to be the same. You can join or link numbers to numbers, strings to strings, booleans to booleans and dates to dates.

ArcGIS

Within ArcCatalog the wizard based *Database Connections* guide you through the connection process.

Join and Relate (equal to Link) are similar to ArcView 3.

ANNEX 3 : DATA INVENTORY DETAILS

The following is the GIS data currently available in CAS and considered useful for the system objectives.

Administrative areas

Source : DAG
Filename : Mouhafazat.shp
Content : **Mohafaza**
Format : ESRI shapefiles
Structure : Lines
Extent : All Lebanon
Attributes : None
File size : 3.80 MB
Projection : Stereographic
Utility : This line format is not useful for representing statistics. Polygon files should be obtained from DAG, or alternatively the files converted to need converting to polygons using ArcInfo.

Source : Arcleb
Filename : Mohafaza.shp
Content : **Mohafaza**
Format : ESRI shapefiles
Structure : Polygons
Extent : All Lebanon
Attributes : Names, e.g. *Mount Lebanon*
File size : 180 KB
Projection : Lambert
Utility : Can be used to join to statistics until stereographic polygons available, but cannot map together with CF.

Source : DAG
Filename : Caza.shp
Content : **Caza**
Format : ESRI shapefiles
Structure : Lines
Extent : All Lebanon
Attributes : None
File size : 6.57 MB
Projection : Stereographic
Utility : This line format is not useful for representing statistics. Polygon files should be obtained from DAG, or alternatively the files converted to need converting to polygons using ArcInfo.

Source : Arcleb
Filename : Kada
Content : **Caza**

Format : ESRI coverage
Structure : Polygons
Extent : All Lebanon
Attributes : Names, require checking, e.g. *Bcharre*
File size : 250 KB
Projection : Lambert
Utility : Can be used to join to statistics until stereographic polygons available, but cannot map together with CF.

Source : Lebanese Army DAG
Filename : libcad.shp
Content : **Circonscription foncière**
Format : ESRI shapefiles
Structure : Polygons
Extent : All Lebanon
Attributes : Mohafaza code, e.g. *3*
Mohafaza name, e.g. *North*
Caza code, e.g. *35*
Caza name, e.g. *Akkar*
CF code, e.g. *35049*
File size : 21.2 mb
Projection : Stereographic
Utility : Presenting statistics by CF. Field location for enumerators.

Survey areas

Source : DAG
Filename : sector.shp
Content : **Sector (= Petite Zone)**
Format : ESRI shapefiles
Structure : Polygons
Extent : Beirut
Attributes : Sector name, e.g. *BCD*
Sector number, e.g. *13*
File size : 204 kb, 60 records.
Projection : Stereographic
Utility : Presenting statistics by Petite Zone. Field location for enumerators.

Source : DAG
Filename : based on libcad.shp
Content : **Grande Zone** based on CF source, by editing lines or by query
Format : ESRI shapefiles
Structure : Polygons
Extent : Beirut
Attributes : Mohafaza code, e.g. *35*
Mohafaza name, e.g. *North*
Caza code, e.g. *3*
Caza name, e.g. *Akkar*
CF code, e.g. *35*
Create zone code
File size : < 20 MB

Projection : Stereographic
Utility : Presenting statistics by Grande Zone. Field location for enumerators.

Settlements

Source : Lebanese Army
Filename : villages_center_1007.shp
Content : **Settlements - towns and villages**
Format : ESRI shapefiles
Structure : Point
Extent : All Lebanon outside Beirut
Attributes : Name, e.g. *Marj Ketermaya*
Caza code, e.g. *23*
File size : 466 KB
Projection : Stereographic
Utility : Context for maps. Field location for enumerators. Potential to show statistics per settlement.

Buildings

Source : DAG
Filename : building.shp
Content : **Buildings in Beirut**
Format : ESRI shapefiles
Structure : Polygons
Extent : Beirut
Attributes : None
File size : 5.43 mb, 21 531 records.
Projection : Stereographic
Utility : Location of buildings in Beirut. Field location for enumerators.

Source : Lebanese Army
Filename : Building_2010.shp (Beirut)
Cfname_bldg.shp (outside Beirut, e.g. baabda_bldg.shp)
Content : **Buildings in major urban centres**
Format : ESRI shapefiles
Structure : Points
Extent : Beirut
Major towns outside of Beirut
Attributes : Building ID, not related to CAS codes.
File size : 3.21 MB, 17105 records for Beirut
various for 49 other CF, eg 7124 records outside Beirut
Projection : Stereographic
Utility : Location of buildings. Field location for enumerators.

NB: There is no data available for buildings in villages.

Streets

Source : DAG
Filename : streets.shp, centreline_2010.shp (Beirut)

Cfname_st.shp (outside Beirut, e.g. baabda_st.shp)

Content : Streets
Format : ESRI shapefiles
Structure : Lines
Extent : Beirut. Major towns outside of Beirut
Attributes : Streetnames (St_name), e.g. *Khodr Sajhane*
File size : 1.19 MB, 6865 records: 471 KB, 1188 records for Beirut.
Various (e.g. 622 KB, 2559 records) for 49 other CF.
Projection : Stereographic
Utility : Location of streets. Field location for enumerators.

Roads

Source : DAG
Filename : roads.shp
Content : **Major roads**
Format : ESRI shapefiles
Structure : Lines
Extent : All Lebanon
Attributes : None
File size : 7.70 MB, 2889 records
Projection : Stereographic
Utility : Field location for enumerators. Context for maps.

Aerial photos

Source : DAG
Filename : ?
Content : **Digital orthophotos – not evaluated**
Format : ?
Structure : Raster
Extent : Assumed to be the major towns
Attributes : None
File size : ?
Projection : Stereographic
Utility : Field location for enumerators.
Context for maps.
Locating buildings in geographic database

City map

Source : Lebanese Army DAG
Filename : beymap5000.jpg
Content : **Raster street map of Beirut**
Format : JPEG
Structure : Image
Extent : Beirut
Attributes : None
File size : 130 MB
Projection : Stereographic
Utility : Field location for enumerators
Context for maps

Topographic maps (1:20 000)

Source	: NCRS
Filename	: map_sheet_name.tif
Content	: **Scanned map series**
Format	: geotiff, black and white
Structure	: Image
Extent	: Lebanon
Attributes	: None
File size	: 615 MB in total
Projection	: Lambert, require reprojection to Stereographic
Utility	: Digitising ilots. Field location for enumerators

ANNEX 4 : METHODOLOGY FOR DIGITISING ILOTS AND BUILDINGS

Methodology for digitising ilots in ArcView 3.x

Source of data

Mapping of Ilots is contained in paper photocopy maps. Ilots are mainly based on roads and CF boundaries, which are available in digital files – roads cover part of the country, CF boundaries are complete. Other lines can be traced on the digital topographic map (1:20 000) once these have been reprojected to Stereographic.

As the capture of these areas is urgent to enable enumerators to use field maps printed from the CAS map, this has started immediately using ArcView 3 for Beirut, where all required digital data is available. Ilots outside Beirut cannot be digitised until the topographic maps are available. ArcInfo Workstation is currently unavailable and requires more processing steps and lacks an easy interface.

As complex editing is not available in ArcView 3, Ilots should be traced as polygons as accurately as possible over a backdrop of roads, CF boundaries and buildings – using the paper topographic maps as reference material. Digitising should be carried out systematically by CF, and saved as shapefiles using a standard naming system – eg *cfnumber_cfname_ilots.shp* or *10156_Hamra_ilot.shp*. One shapefile should equal all the ilots in one CF, with the following attributes:

i. 2 digit ilot code

ii. 5 digit CF code

iii. concatenated complete 7 digit ilot serial number.

Ilot boundaries and coding should be checked, preferably independently.

They should be stored under 1 directory – *ilots*, and backed up regularly. Any subsequent moving, copying or renaming of the shapefiles should be done using the ArcView data management function and not Windows Explorer.

Amendments to ilot boundaries for the new census can be directly edited using ArcView 3.

When ArcGIS is available, its superior editing tools can be used to trace and copy lines, such as roads and CF boundaries, that exist in other files and ensure uniformity.

Digitising procedure using ArcView 3.x

1. Create new View
2. Set Map and Distance units to metres in View/Properties
3. Load background data as appropriate:
   - CF boundaries – *libcad.shp*
   - Beirut street image - *beymap*
   - sector boundaries in Beirut – *sector.shp*
   - Streets –
     - *Streets.shp* – Beirut
     - *Centreline_2010.shp* – Beirut

- *Cfname_st.shp* – outside Beirut

- Roads – *roads.shp*
- buildings as points
  - *building_2010.shp* – Beirut
  - *Cfname_bldg.shp* – outside Beirut
- buildings as polygons in Beirut only – *building.shp*
- Settlements – *villages_center_1007.shp*

4. Create new theme for ilot – View/New Theme/feature type polygon.
5. Open Table
6. Edit/Add Field
   - Name: *CF_code*, Type: Number, Width: 10, Decimal: 0
   - Name: *Ilot2_code*, Type: Number, Width: 5, Decimal: 0
   - Name: *Ilot_code*, Type: Number, Width: 10, Decimal: 0
7. Select polygon tool
8. An appropriate scale should be selected for the digitising, approximately 1:5 000.
9. Draw Ilot Number 1.
10. Enter 2 digit code in *Ilot2_code*
11. Continue drawing ilots in order of their code number, using the Append Polygon tool.
12. Use the Vertex Edit tool if the edges of the polygons need adjusting, however this is time consuming and it is preferable to avoid this.
13. Note any queries on the definition of the ilots, e.g. differences between maps and which ilot buildings should be in, in a spreadsheet (*remarques.xls*) or database.
14. When all ilots complete for sector/CF
    - Use Field Calculator to enter *CF_code* – e.g. 31121
    - Create full *Ilot_code* by using Field Calculator to concatenate *CF_code* and *Ilot_code*, (CF_code * 100) + Ilot2_code.
15. Test print the ilot and appropriate reference layer and check that the location and coding are correct.
16. Solve location queries by defining general criteria to be followed.

Methodology for digitising buildings in ArcView 3.x

1. Create new point shape files for a CF.
2. Add fields:
   - Name: *CF_code*, Type: Number, Width: 10, Decimal: 0

- Name: *Ilot_code*, Type: Number, Width: 10, Decimal: 0
- Name: *Bldg2_code*, Type: Number, Width: 5, Decimal: 0
- Name: *Bldg_SN*, Type: Number, Width: 16, Decimal: 0

3. Add relevant backdrop themes – topographic maps, street maps, aerial/space photography, building polygon map for Beirut.
4. Add points over each building in the required order, i.e. clockwise within block.
5. Finish this for an ilot.
6. Number the buildings sequentially in the order of the rows using the *Bldg2_code* field, either in ArcView or using the auto-number facility in Excel on the shapefile .dbf file. Great care should be used in editing tables outside ArcView and the results checked. It is preferable to create an Avenue script to do this automatically within ArcView.
7. Continue for the other ilots.
8. When complete, use a Spatial Join on the shape field to join the ilot codes automatically to the building entries in the row.
9. The joined table field can then be converted to a new shapefile with building and ilot codes.
10. The Building Serial Number can then be calculated from the ilot and building codes.
11. The CF code can be entered using the field calculator.
12. Building and ilot shapefiles can be merged at the caza level to create a more manageable number of files.

ANNEX 5 : GIS EQUIPMENT

GIS PROCUREMENT excluding PCs

ITEM/SPECIFICATION	Quantity	Unit price ($)	Proc. phase	Cost Phase 1	Estimate Phase 2
GI HARDWARE					
DESKTOP PRINTER Min. specs.: A3 colour inkjet printer.	2	250	1	500	
SCANNER – increase to IT requirement min. spec to A3, 400 dpi, 8 bit colour flatbed scanner if possible.					
GPS RECEIVERS					
Basic Handheld Min. specs.: Weatherproof, capable of downloading waypoints to PC, using LatLong and UTM coordinates, supporting NMEA and TSIP protocols, 12 parallel channel receiver, multiple map datums, data transfer cable for connection to PC.	1	200	2		200
Field GIS Model Min. specs.: Weatherproof, capable of downloading waypoints to PC, using LatLong and UTM coordinates, supporting NMEA and TSIP protocols, 12 parallel channel receiver, multiple map datums, data transfer cable for connection to PC, supporting post processing differential correction, autonomous accuracy approximately 10 metres, accuracy after differential correction 2-5 metres,	1	700	2		700
POCKET/PALMTOP PC Min. specs.: Windows for Pocket PC 2002, 206 MHz, 64 MB RAM, 32 MB ROM, 64k colour display, USB/serial data transfer cable for PC connection. Ruggedized case, auto adaptor.	1	1200	2		1200
GI Hardware Total		2350		500	2100

ITEM/SPECIFICATION	Quantity	Unit price ($)	Proc. phase	Cost Phase 1	Estimate Phase 2
GI SOFTWARE					
ARCINFO UPGRADE Upgrade ArcInfo 7 to ArcInfo 8 (ArcGIS) concurrent/floating licence, to include 1 year support/maintenance.	1	< 18,000?	1	<18,000?	
ARCVIEW LICENCE ArcView 8 (ArcGIS), to include 1 year support/maintenance.	1	1,800	1	1,800	
ARCVIEW UPGRADES 2 upgrades from ArcView 3.x to ArcView 8 (ArcGIS), single use licences, to include 1 year support/maintenance. BUT 1 upgrade only to be implemented when Image Analyst extension available for ArcGIS.	2	720	1	1,440	
IMAGE ANALYST Image Analyst extension to ArcView 3.x, to be upgraded to Image Analyst for ArcGIS when available, to include 1 year support/maintenance.	1	2500?	2		2500?
ARCPAD FIELD GIS ArcPad version 6, to include 1 year support/maintenance.	1	1000?	2		1000?
MRSID ENCODER FOR GIS MrSID Encoder For GIS, extension to ArcView 8, to include 1 year support/maintenance.	1	2000?	2		2000?

ITEM/SPECIFICATION	Quantity	Unit price ($)	Proc. phase	Cost Phase 1	Estimate Phase 2
SOFTWARE LOCALISATION FOR ARCMAP					
ArabView or similar Arabic language support for ArcMap component of ArcGIS, to enable use of Arabic script in map output.	1		1	?	
GI Software Total					

ANNEX 6 : GIS TRAINING

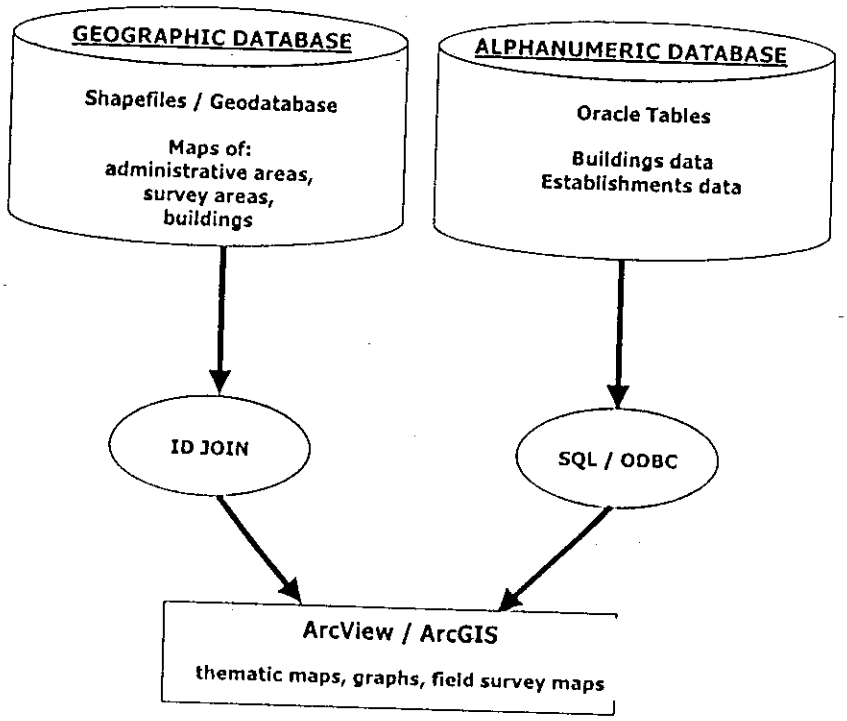
SPECIFICATION	Days	Trainees	Trainee days
BASIC GIS TRAINING			
Introduction to ArcGIS 1. 2 days / 16 hours. To be provided by certified ESRI trainers. For all current GIS staff: manager, analysts, geographer, programmers.	2	7	14
ADVANCED GIS TRAINING			
Introduction to ArcGIS 2. 3 days / 24 hours. To be provided by certified ESRI trainers. To include practical exercises with Lebanese data. For all current GIS staff: manager, analysts, geographer, programmers.	3	7	21
GIS PROGRAMMING TRAINING			
2 day training in ArcGIS development – Programming ArcObjects with Visual Basic for Application. To be provided by certified ESRI trainers. For GIS Programmers.	2	3	6
GPS TRAINING (Phase 2)			
1 day training in use of GPS and Field GIS. For all current GIS staff: manager, analysts, geographer, programmers.	1	7	7
IMAGE ANALYST TRAINING (Phase 2)			
2 day training in Image Analyst extension to ArcView and use of remote sensing data. To be provided by certified ESRI trainers. For GIS Programmers.	2	3	6
Total training	10		54

ANNEX 7 : OUTLINE DESIGN OF CAS GEODATABASE

1 Logical design

Statistical data will all be held in Oracle database tables. Maps will be kept in ArcView / ArcGIS, with common numeric IDs/serial numbers used to join tables in the 2 databases.

Connection between the two is by ODBC connections, SQL in ArcGIS is used to select the appropriate part of the Oracle tables. ArcView or ArcMap (within ArcGIS) is used to display the statistics as thematic maps.

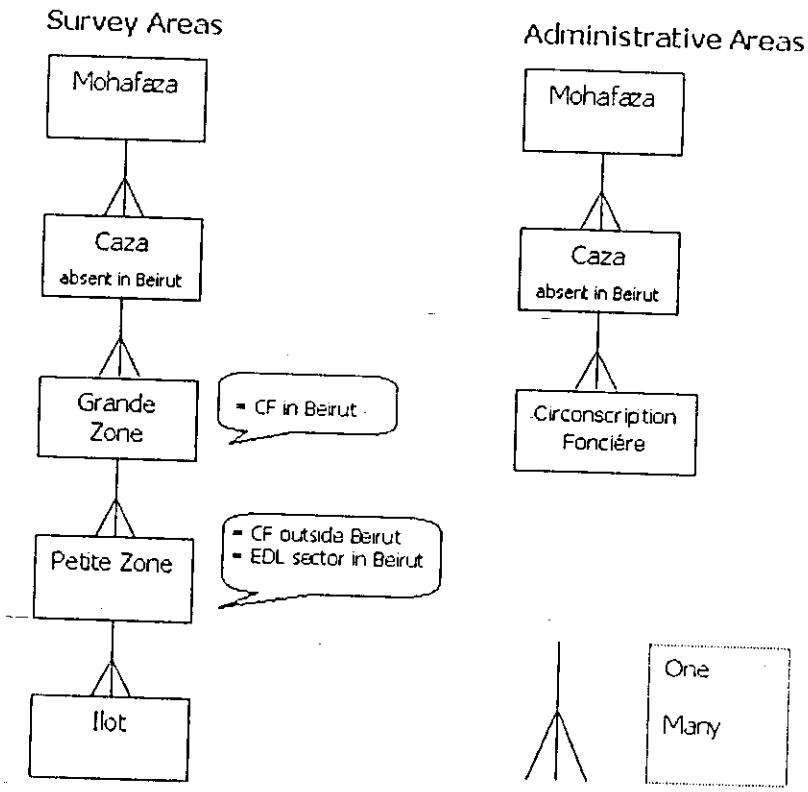


Logical design of GEOCAS – the CAS GIS

The following entities or objects have been identified within the buildings and establishments surveys. To clarify the entities covering geographic areas, which are administrative areas and survey areas overlap, the following diagram attempts to clarify their relationship and separate the 2 concepts.

ENTITIES FOR GEOCAS	RELATED TO	FEATURE CLASS	ATTRIB-UTES	JOIN TO ORACLE TABLE	FORMAT	NOTE
Administrative Units						
Mohafaza	Caza	Polygon	Numeric id	Numeric id	Shapefile	
Caza	Mohafaza/CF	Polygon	Numeric id	Numeric id	Shapefile	
Circonscriptions Foncières (CF)	Caza/Ilot	Polygon	Numeric id	Numeric id	Shapefile	
Survey Areas						
Ilots	CF	Polygon	Numeric id	Numeric id	Shapefile	
Grande Zones	Aggregation of Petite Zone	Polygon	Numeric id	Numeric id	Shapefile	Based on other data, may not be required.
Petites Zones	Aggregation of ilot	Polygon	Numeric id	Numeric id	Shapefile	Based on other data, may not be required.
Statistical units						
Building	Ilot/Building unit/Establishment	Point	Numeric id	Numeric id	Shapefile	
Building unit	Building/ Establishment	No geographic representation	-	Oracle only	-	Not required in GIS
Establishment	Building/ Building unit	No geographic representation	-	Oracle only	-	Join to building shapefile with numeric id
Other entities						
Streets	None	Lines	Name	None	Shapefile	
Roads	None	Lines	Name	None	Shapefile	
Settlements	CF	Points	Name, CF code	None	Shapefile	Possible future inclusion in Oracle
Other data						
Aerial photo	None	Raster	None	None	GeoTiff/ Imagine/BIL	
Satellite photo	None	Raster	None	None	GeoTiff/ Imagine/BIL	
Topographic map	None	Raster	None	None	GeoTiff/ Imagine/BIL	

To clarify the entities covering geographic areas, which are a mixture of administrative areas and survey areas, the following diagram attempts to clarify their relationship and separate the 2 concepts.

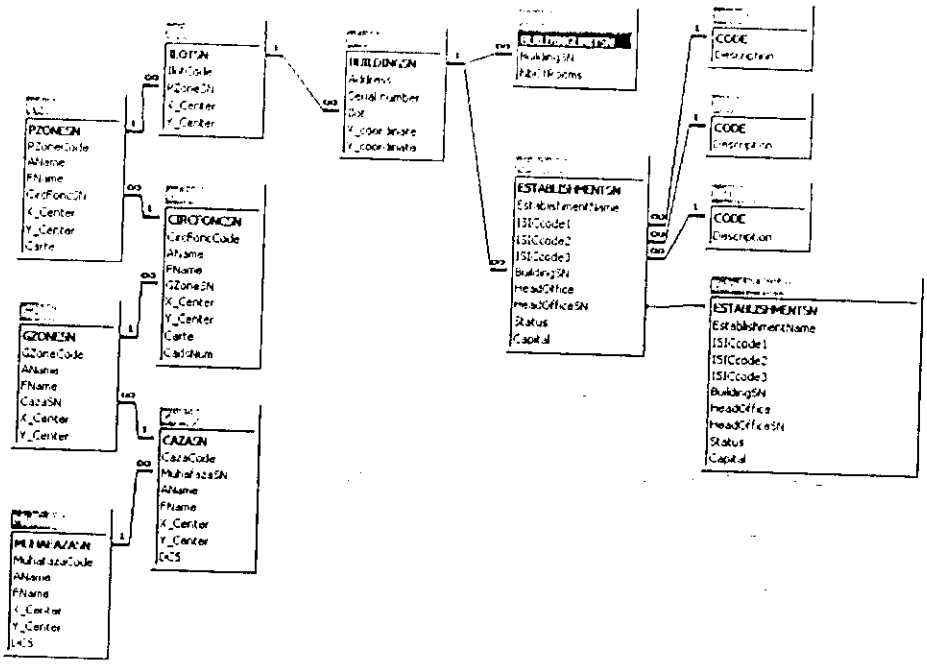


Area entities

2 PHYSICAL DESIGN

ALPHANUMERIC DATABASE

The proposed Oracle design is proposed as follows by the Database Expert. Care should be taken over the relationship between Zones and Administrative Areas, which have different manifestations within and outside of Beirut.



GEOGRAPHIC DATABASE

Data is currently stored as shapefiles for vector files, and as raster images (GeoTiff/Imagine/BIL). The data should be stored once on a shared disk, in line with standard database practice, and regularly backed up.

All data should be stored in Stereographic projection.

Current data files are listed in Annex 3. They should be stored in a standard Windows directory/file structure, suggested as:

Geocas

- *National files*
  - Roads
  - Villages
  - CF
  - Rasters – topographic maps, aerial/space photos
- *Beirut files*
  - Raster map
  - Buildings
  - Streets
- *Rest of country*
  - Caza
    - CF
      - Buildings
      - Ilots
      - Streets

2.2 Coding scheme

The following numeric identification fields should be used to identify these geographic units, and to ensure correct joining/linking with the corresponding Oracle tables. It is recommended that all CAS codes be entered in new columns to avoid confusion with obsolete codes/attributes that have come from DAG.

FILES	Numeric codes
Administrative Units	
Mohafaza	1 digit code
Caza	2 digit code
Circonscriptions Foncières	5 digit code
Survey Areas	
Ilots	7 digit code
Grande Zones	?
Petites Zones	?
Statistical units	
Building	10 digit serial number
Building unit	No geographic representation
Establishment	No geographic representation

3 Migration to Geodatabase

ArcGIS has a native format called a Geodatabase. This is a relational database in which all digital maps and geographic objects can be stored. Other formats such as shapefiles can however be left as they are without importing into the database.

Once the GIS Section is competent with ArcGIS, and is not in the middle of a major survey, migration of data using wizard tools in the ArcCatalog is recommended. In the long term is better to organise data in a relational database model in line with the other working practices of CAS. The data model can also be used to enforce relationships (e.g. an ilot must be in only one CF, a CF must be in a caza, an establishment must be in a building etc.) and data domains (e.g. a building serial number must contain 10 digits).

Images can take up large volumes of disk space. Therefore it is recommended to convert to MrSID format to compress imagery by approximately 10 times. This will be essential for using images in ArcPad.

ArcGIS can display data from different projections, which is potentially useful when Lambert projected data is acquired, or GPS points in Latitude/Longitude are imported. However without the correct parameters for the Stereographic coordinate system it is unlikely that this will work correctly.

4 Metadata

Whilst using ArcView 3 metadata on all data acquired or created should be written in a simple text file, using the same file name as the shapefile. For example the file *sector.shp* requires a metadata file *sector.txt*, stored in the same folder.

In ArcGIS all metadata is stored in ArcCatalog for all files in XML format, metadata creation is semi-automated, and is stored with the data and moved/copied with the data. The ESRI stylesheet is the default stylesheet for metadata and is recommended.

ANNEX 8 : PROJECTION PARAMETERS

Stereographic Coordinate System:

In official use by the national mapping agency, DAG:

In ArcView this requires a Custom projection.

Unit	: Meter
Ellipsoid	: Clarke 1880
Datum	: assumed to be Clarke 1880
False Easting	: unknown
False Northing	: unknown
Prime Meridian	: unknown
Base Projection	: Stereographic, origin Lo = 38°, Mo = 43°50
Scale Factor	: unknown

Lambert Coordinate System:

In common use in Lebanon outside DAG.

In ArcView this requires a Custom projection.

Unit	: Meter
Geographic Coordinate System	: Clarke 1880, consisting of -
Projection	: Clarke 1880
Datum	: Clarke 1880
False Easting	: 300000
False Northing	: 300000
Prime Meridian	: Greenwich
Base Projection	: Lambert Conformal Conic
Central_Meridian	: 37.35° / 37° 21' E
Central_Parallel	: 34.65° / 34° 39'
Standard Parallel 1	: 33.07343889 / 33° 04' 24.38" N
Standard Parallel 2	: 36.21644445 / 36° 12' 59.20" N

الجمهورية اللبنانية
مكتب وزير الدولة لشؤون التنمية الإدارية
مركز مشاريع ودراسات القطاع العام

Republic of Lebanon
Office of the Minister of State for Administrative Reform
Center for Public Sector Projects and Studies
(C.P.S.P.S.)