FRAMEWORK DATA MODELING FOR THE PROPOSED NATIONAL SPATIAL DATA INFRASTRUCTURE OF UNITED ARAB EMIRATES

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PREFACE

This technical report is an unedited reproduction of a report submitted in partial fulfillment of the requirements for the degree of Master of Engineering in the Department of Geodesy and Geomatics Engineering, May 2004. The research was supervised by Dr. David Coleman.

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DEDICATION

To my family, for their devoted support and boundless love and encouragement …

ABSTRACT

The report primarily investigates the status of the geospatial data activities of the U.A.E., with a focus on identifying the framework datasets and related technical and institutional issues concerning its generation, maintenance and dissemination. These datasets are defined along with their content, classification, coding, common spatial reference, and exchange and format standards. This is done with the perspective of building the U.A.E. National Spatial Data Standards.

The maintenance of such a framework involves many players and therefore coordination becomes a major criterion. Accordingly, adequate guidelines for the formation and the functioning of a council for such activities are outlined. Moreover, such efforts are expected to raise several institutional issues. Therefore the strategies are required to resolve the custodianship and legal protection of the datasets and related return on investments issues. The entire process would put an extra burden on agencies amidst the already existing constraints on the budget. This demands the mobilization of extra funding at national level. However, cost-benefit analysis of such initiatives is required for convincing the higher management for enough funds. Therefore the guidelines for developing such strategies and business-cases are covered in the report.

Moreover, some easy-to-implement solutions, promoting the feasible way of data sharing and exchange, are explained in the report. The process is to demonstrate the potential benefits of such initiatives and to create awareness among the decision-makers and the users involved in the geospatial data activities of the country. It is anticipated that the strategy would act as a roll mover or a quick starter for the wider implementation process of such initiatives.

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Without any of these people, this stage would be very difficult to achieve. Thank you very much all…

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ABBREVIATIONS

AADC	Al Ain Distribution Company
ABS	Australian Bureau of Statistics
ADDC	Abu Dhabi Distribution Company
ADNOC	Abu DHABI National Oil Company
ADWEA	Abu Dhabi Water & Electricity Authority
AGI	Association for Geographic Information (UK)
ANZLIC	Australian New Zealand Land Information Center
APSMA	Australia Public Sector Mapping Agencies
ASDD	Australia Spatial Data Directory
ASIBA	Australian Spatial Information Business Association
ATPD	Abu Dhabi Town Planning Department
BSI	British Standards Institute
CAP	Cooperative Agreement Program
CCOG	Canadian Council on Geomatics
CEONeT	Canadian Earth Observation Network
CGDI	Canadian Geospatial Data Infrastructure
CGIS	Center for Geographic Information System (Qatar)
CGNDB	Canadian Geographic Names Database
CGSB	Canadian General Standards Board
CoG	Committee on Geomatics
DM	Dubai Municipality
DND	Department of National Defense
DTM	Digital Terrain Model (U.A.E.)
ECSSR	Emirates Center for Strategic Studies and Research
ECV	Electronic Conveyance Victoria
EDC	Etisalat Data Center
EMAN	Environmental Monitoring and Assessment Network
EMAN	Environmental Monitoring and Assessment Network
EPD	Exploration & Production Directorates (Abu Dhabi)
ERWDA	Environmental Research & Wildlife Development Agency
ETISALAT	Emirate Telecommunication Corporation

FLAP	Florida Light & Power
FME	Feature Manipulation Engine
FOIA	Freedom of Information Acts
FTP	Life Transfer Protocol
GINIE	Geographic Information Network in Europe
GIS	Geographic Information System
GPS	Global Positioning Satellite
GSTB	Geospatial Data Transfer Standards
GUI	Geographic User Interface
HMT	Her Majesty Treasury
IACG	Inter - Agency Committee on Geomatics
IAG	International Association of Geodesy
ICSM	Intergovernmental Committee of Surveying & Mapping
ICSM	Intergovernmental Committee of Surveying and Mapping
IERS	International Earth Rotation Service
IGGI	Inter Governmental Group on Geographic Information
IGS	International GPS Service
IGSG	International GPS Service for Geodynamics
ISO	International Standard Organization
ISO	International Standard Organization
ITRF	International Terrestrial Reference Frame
ITRS	International Terrestrial Reference System
LIS	Land Information System
LPI	Land and Property Information
MCT	Ministry of Construction & Technology
MDCF	Metropolitan Dade County
MSC	Mapping Science Committee
MSD	Military Survey Department (U.A.E.)
NGDC	(U.A.E.) National Geospatial Data Council
NGDCH	National Geospatial Data Clearinghouse
NGDF	National Geospatial Data Framework
NGN	National Geodetic Network (U.A.E.)

NGSC	National GIS Steering Committee (Qatar)
NLIS	National Land Information Systems
NLPG	National Land & Property Gazetteer
NPR	National Performance Review
NSDI	National Spatial Data Infrastructure
NSG	National Street Gazetteer
NTDB	National Geographic database (Qatar, U.K)
ODGE	Ontario Geospatial Data Exchange
OGC	Open GIS Consortium
OMB	U.S Office of Management & Budget
ONS	U. K. Office of National Statistics
OSDM	Commonwealth Office of Spatial Data Management
POL	Property On-Line project
SASNZ	Standards Australia &Standards New Zealand
SCC	Standard Council of Canada
SDI	Spatial Data Infrastructure
SDT	Semantic Data Translator
SDTS	Spatial Data Transfer Standards
SINES	Spatial Information Enquiry Service
SPEAR	Streamlined Planning through Electronic Applications and
SSI	Spatial Sciences Institute
TRANSCO	Abu Dhabi Transmission & Dispatch Company
U.S NIST	National Institute of Standards & Technologies (USA)
U.A.E.	United Arab Emirates
UCGIS	University Consortium for Geographic Information Science
UKOS	United Kingdom Ordnance Survey
UPRN	Unique Property Number
USFGDC	U.S. Federal Geographic Data Committee
USGS	U.S. Geological Survey (USA)
USNSGIC	US National States Geographic Information Council
VSCO	Vendor Statement Certificate On-line

Chapter 1 - Introduction to NSDI

1.1 Introduction

Geospatial data activities of the United Arab Emirates (U.A.E.) are investigated in this report with a focus on identifying the framework data sets. These data sets are defined along with their content, classification, coding, common spatial reference, and exchange and format standards. Along with this, technical and institutional issues related to its generation, maintenance, and dissemination are discussed with the perspective of building the U.A.E. National Spatial Data Standards and Specifications. The whole exercise is to promote the creation of an National Spatial Data Infrastructure (NSDI) for the U.A.E.

When we come across the term "infrastructure," quite often it brings up the thought of fundamental services provided by the state to improve the quality of the life of its citizens. In general, transportation networks, water supply systems, electric power distribution systems, schools, hospitals, etc. are some examples of such services provided by the government. The term was originally used in the eighteenth century in relation to network of railway systems [Groot, 1997]. The concept has been used, however, in a wider context to comprise the human resources and operational procedures required to maintain the fundamental services of the state [Masser, 1998].

As more and more infrastructure was made available to improve public services, decision makers were faced with more complex environmental, social and economic problems. This has forced them to change the conventional way of conducting business [Groot, 1997]. Accordingly, the use of information technology has increased in most

government agencies and private sector organizations, giving rise to a growing demand for digital data [Tosta, 1997a]. As a result, governments of many countries have introduced National Information Infrastructure initiatives to provide an efficient mechanism for managing digital data demands. A survey shows that 120 of 192 world nations are involved in the development of this infrastructure [Crompvoets J. and Bregt A., 2002]. Governments of Australia, Canada and the United States, however, are considered as the leaders in the field [Masser, 2002].

In the year 1992, then United States President Clinton introduced the concept of the "electronic information highway" in his political platform [Groot, 1997]. The approach was instrumental in gaining the same status to the information infrastructure as any other fundamental infrastructure of the country. The executive order signed by him defines the NSDI as follows "National Spatial Data Infrastructure (NSDI) means the technology, policies, standards and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data" [Clinton, 1994, Section 1a]. As the geospatial data mostly deals with the physical development of any country, much of the content that flows through the information highway is spatially related. Therefore, what we require is an efficient mechanism for maintaining these rich sources of spatial information just as is provided for any other service. In this context, the word "infrastructure" is used to promote the concept of facilitating access to "geographically related information" using a minimum set of standards and specifications [Nebert, 2001].

Many countries, including Australia, Canada, and the United States (U.S), believe that geographic information is an essential part of their information infrastructure [Morrison, 1993]. The means of promoting efficient and flexible access to this rich source of data, however, has always been a daunting task. With the realization of the importance of National Spatial Data Infrastructure (NSDI) in resolving such hurdles [Morrison, 1993], the concept of establishing NSDI has emerged as an important geospatial data activity within these countries. As a result, the creation of a robust mechanism for geospatial data dissemination has become the main objective of any NSDI. It is expected that the process will ensure the availability of complete and consistent spatial data sets required by various users, even though the data are collected by different jurisdictions [Smith and Thomas, 1996].

For any country, implementing an NSDI or National Geographic Information Strategy would depend on three main components; namely, coordination between the data producers themselves and the users, the framework data set with all its elements, and the related information about the data (metadata) [Masser, 1998]. It is not mandatory, however, to have all the components and their related elements in their optimal form in order to establish an NSDI [U.S. National Research Council (U.S. NRC), 1993]. As Rhind [2000, p. 40] mentions, *"we already have such NGDIs (National Geographic Data Infrastructure) without having had some previous, umbrella and/or, coherent planning to establish them"*. As stated by Rhind [2000], one could see components of an NSDI as they exist in the geospatial data activities of many countries. Nevertheless, the basic problem is that these components are neither coherent nor organized [Morrison, 1993]. As a result, duplication of effort and waste of resources are

quite common in such activities [Tosta, 1997a]. Therefore certain policy initiative from the government is needed to shape the development of an NSDI *and* an institutional context is required for drawing a boundary within which these are developed. In the overall process of its development, the main emphasis should be in resolving such issues rather than focusing on the development of the technology [Masser, 1998].

1.2 Background of Geospatial Data Activities in the United Arab Emirates

Among the developing nations, the United Arab Emirates is considered to be one of the most rapidly growing countries. The discovery of oil and its subsequent export in 1962 and the resultant growth in the economy [Ibrahim and Vine, 1999] opened the door for rapid urban growth with several thousand kilometres of roads, drainage networks, telephone lines, power and water networks, etc., accompanied by a spurt in new real estate developments. In addition to this, the current and the future physical development plan for the country has generated a huge amount of information. As the data mostly pertains to the physical and infrastructure development of the country, the major content is geospatially related.

This huge resource of geospatially related data was produced and maintained independently by the government agencies of the country. As a result, numerous scattered stand-alone systems have emerged. In addition to the rapid urban growth, the autonomous functioning of the U.A.E.'s government agencies is also a factor in the existence of such incoherent geospatial data sets. Consequently, the data development costs are increased many times with the added expense of coping with the inconsistent results from one agency to the next. Even though funding for such exercises came from

a single federal resource, sharing of the data was impossible. The absence of geospatial data standards and coordination for generating and maintaining these data sets was found to be the main reason behind such situations. To resolve such critical issues, implementation of some innovative means, such an NSDI, has become indispensable to the U.A.E.

As a result of the vigorous geospatial data activities in the many government agencies, many components of the NSDI are already available in the U.A.E. Yet, the NSDI concept is not popular in the country. Several reasons can be attributed to this lack of enthusiasm in the U.A.E. Following are those issues that the author feels are the most relevant.

- The NSDI is not one of the priorities in the agenda of development programs [Edward, 1998].
- The idea of an NSDI is not regarded as a service infrastructure [Masser, 1998].
- The concept and benefits of an NSDI are not well promoted or, to some extent, clearly understood by the potential contributors.
- There is a high degree of autonomy in the functioning of spatial data producers [Al-Romaithi, 1994].

Institutional issues that are hampering the promotion and the implementation of the NSDI are commonly seen in many countries [Masser, 1998] and the U.A.E. is no exception. The realization of the NSDI will take several years and, the full implementation may consume more time [Masser, 1998; U.S. FGDC, 1995]. Moreover, there is no single perfect model that helps the easy implementation of the NSDI [Masser,

1998] and hence, the establishment of an ideal model is a long and continuous process of refinement.

As part of the NSDI implementation program, the primary task of the U.A.E. should be the formation of institutional arrangements. To begin with, such institutional arrangements should be developed for those components of the NSDI that already exist in the country. This should consist of a set of rules and regulations governing the following:

- coordinating geospatial data acquisition;
- fixing responsibilities on data updating and maintenance;
- choosing methods of data sharing and distribution.

These institutional contexts, which draw a boundary within which further components are developed, will be used for the full implementation of the proposed NSDI model. For the purpose, the author proposes an incremental approach in which the smallest individual unit of the necessary components could be identified and developed in a sequential fashion. At a later stage, especially when the country has matured enough to realize the real potential of the NSDI, these individually developed components could be integrated to form the complete model.

1.3 Problem Statement

The primary aim of this research is to investigate and propose a common spatial data set which could be shared and used as a common base for the proposed framework of the U.A.E. NSDI. In order to build such a set of data that are easily accessible and

shared among the geospatial data community, several issues need to be resolved. In the author's opinion, such issues are common to all concerned parties that are involved in building an NSDI for their respective countries. The following is a summary of these issues:

- Data Accessibility:

  Most government agencies and their departments practice a high degree of autonomy in their functioning thus making the data an exclusive property that is inaccessible to others.

- Data Incompatibility:

  The lack of common standards make data exchange among the agencies practically impossible thus limiting the success of cross-sector data dissemination and geographic information systems (GIS) application development.

- Lack of Coordination:

  Almost all the GIS agencies in the country are working compartmentally without any coordination. Quite often, this has led to the acquisition of the same data by several agencies that receive the funding from the same federal resource. This has created duplication of both efforts and data thus wasting time and money.

- Legal Protection:

  The prevailing copyright law does not cover the issues concerning spatial data acquisition and dissemination.

- Technical**:**

  A lack of awareness of the current trends in geospatial databases and their technology has led the decision-makers to approve inappropriate systems and methodologies for spatial data handling.

1.4 The Objectives of This Report

This report will primarily address the creation of a common spatial data set that would form common base for the framework data set, a major component of the U.A.E. NSDI. The three main objectives of this report are summarized as below.

1. ***To identify and define a common spatial data set, which could be used as a common base for the potential framework data set of the proposed U.A.E. NSDI***;

   The process will include the definition of its contents, common reference, data exchange and format standard and geospatial data classification and coding. This will be defined within in the context of building the U.A.E. National Spatial Data Standards.

   This objective is narrated in chapter four with complete details. The results of the survey conducted by the author were used to identify the commonly used data sets. Accordingly, framework data sets for the UAE are proposed.

   The contents of these data sets are explained with its classification, coding, data exchange formats, common reference and metadata standard are covered in this chapter. These standards were framed based on the project executed by the UAE Military Survey. The projects were supervised by the author.

2. ***To address the organizational issue, which will determine the terms for***;

   a) incorporating the data, maintained by the various agencies, to serve as a common data set;

   b) database custodianship, among the agencies that are maintaining the different sets of geospatial data covering the cross-sector geographic information systems (GIS) requirements;

   c) legal protection of the data, facilitating authorized access and distribution; and

   d) a coordinating body to oversee the geospatial data are produced, maintained and distributed according to the set norms of the national framework.

3. ***To identify and define the procedures for data discovery, visualization and access with an easy-to-implement solution for the U.A.E.;***

The approach is to promote the most economic and feasible way of data sharing and exchange mechanisms, as a quick start for the proposed NSDI implementation process.

1.5 The Plan and Organization of this Report

The research work will consist of the following tasks and methodology.

1. Review any necessary information related to an NSDI in general and to common data set in particular that would form a base for the proposed framework data set.
2. Study the policies and implementation procedures of framework data and NSDIs of selected countries.
3. Conduct field surveys to assess the geospatial data activities of government and private agencies of the U.A.E.

4. Identify and define the commonly used data components in the U.A.E. based on the survey results.
5. Design the conceptual model of the framework data, based on the identified components of commonly used data.
6. Analyze the data to determine the critical factors that are hampering the smooth implementation process of the NSDI.
7. Frame the institutional agreements to remove those critical factors, thus promoting the implementation of the data framework in the country.
8. Frame the methods and procedures for creating a data sharing and exchange culture in the country through easy to implement solutions.

1.6 The Structure of this Report:

The structure and the content of the report are summarized briefly here.

- **Chapter 1**

Chapter 1 is an introductory chapter defining mainly the problem and research objectives.

- **Chapter 2**

The second chapter reviews the NSDI activities of the developed countries in order to derive the lessons for the NSDI implementation for the U.A.E. Findings from this chapter are used as guidelines for achieving the objectives of the U.A.E NSDI implementation programs.

- **Chapter 3**

  Chapter 3 discusses the GIS activities of the U.A.E based on the results of the survey conducted by the author. The findings of the chapter are used as the background for the NSDI implementation programs for the U.A.E.

- **Chapter 4**

  Chapter 4 identifies and defines the common data set with all its elements, which would form the basis for a for framework data set for the U.A.E. The process is based on the results of the research survey conducted by the author as explained in Chapter 3. The common data are explained with their contents, accuracy and geo-coding scheme from the U.A.E. National Geospatial Data standards perspective.

- **Chapter 5**

  This chapter explains the institutional arrangements needed for the smooth implementation of the geospatial data framework for the country. In particular, it covers the policy issues governing data custodianship and the creation, maintenance and distribution of the framework data. The cost recovery system and the legal protection of the data are also covered with sufficient guidelines for implementing such a system for the U.A.E. As the whole process of development may consume a lot of resources, funding is a critical issue, which needs special consideration. Therefore, the mechanism for funding is also covered in detail with sufficient guidelines for framing a strategy for mobilizing enough resources for the U.A.E.

- **Chapter 6**

  Chapter 6 explains the mechanisms for data discovery, visualization and access. The concept of a clearinghouse to facilitate the smooth discovery of data would be difficult to implement in the absence of a national coordination council and the lack of standards and policies. In order to create a data access culture, certain easy-to-implement solutions are explained as a makeshift arrangement. This would start the process that would lead to the wider initiative for the complete implementation of the U.A.E. NSDI.

- **Chapter 7**

  The final chapter provides a summary of the report and recommendations for the successful implementation of the proposed U.A.E. NSDI.

Chapter 2 - NSDI Initiatives at the International Level

2.1 Introduction

Chapter 2 reviews the concepts, definitions, and components of Spatial Data Infrastructure (SDI) of various countries of the world. After identifying the "ideal" definitions and components of SDI, section 2.5 briefly discusses the National Spatial Data Infrastructure (NSDI) activities of the U.S., Canada, the U.K., and Australia with respect to these components. In section 2.6, special reference is made to the successful nation-wide integrated GIS model of the State of Qatar as an example of the successful implementation of an NSDI working model in the gulf region.

The coordination of geospatial data generation and maintenance based on a common set of standards has become a national initiative in many countries. Such programs and projects are being referred to by different labels. For example, in the United States, the term 'National Spatial Data Infrastructure (NSDI) is used ([McLaughlin, 1991]; [U.S. National Research Council (NRC), 1993]), in Canada it is referred to as the 'Canadian Geospatial Data Infrastructure (CGDI)' [Evangelatos and Labonte, 1998], and in Australia it is the 'Australian Spatial Data Infrastructure (ASDI)' [ASDI, 2003]. In some cases, it is referred to as the 'National Geographic Information Strategy', the 'National Geographic Information Infrastructure' [Masser, 1998, p.4], or the 'National Geospatial Data Framework (NGDF)' [Rhind, 1997, p. 301]. Although there is a variety of terminology, the foremost goal of such initiatives remains the same for all parties. The roles and responsibilities of the participating agencies in the coordinated effort, however, may differ considerably; they depend mainly on the political and administrative arrangements unique to a particular country.

The focus of the NSDI effort is more on harmonizing the standards for data capture and exchange, a shared approach to data collection and maintenance, and promoting the use of common data sets [Tosta, 1995]. The approach not only decreases the cost involved in amalgamating information from different sources but also minimizes the need for redundant development of software tools for spatial data exploitation [Nebert, 2001, p. 6].

2.2 Background

Government and private sector agencies throughout the world require accurate digital geospatial data for the efficient use of public resources. Quite often, the requirement is beyond the data production capacity of individual agencies. Financial constraints on mapping budgets also force agencies to adopt the shared approach in data acquisition and maintenance. As a result, interdependencies have increased among these parties, and quite often, the private sector agencies have become involved.

The absence of clear policies to handle such partnerships -- in terms of pricing, right of use, copyright, quality, confidentiality, and accountability -- has created disorders in the geospatial data environment [Tosta, 1995]. To resolve these issues, many governments throughout the world including governments of Australia, Canada, and the United States (U.S), are involved in the development of more institutional strategies. The efforts of the United States, however, in building a national level coordination of geospatial data activities has gained popularity in all parts of the world because of its remarkable level of political support [Masser, 1998].

2.3 Concepts and Definitions of Spatial Data Infrastructure

Several coordination committees were set-up to supervise the task of NSDI implementation. As a result, various terminologies exist in the literature to explain the scope and related components of such an infrastructure. The basic objectives of such programs, however, remain the same for all [Lucet, 2001]. These terminologies and the related components of the NSDI are explained in the subsequent sections.

Concepts:

The term *infrastructure* is used in the literal sense to convey the idea of dependant and supporting facilities, similar to electric power, telecommunications, railways and road networks. In the context of handling geospatial data, however, the term infrastructure is used to mean the supporting environment that makes the data flexible and easier to access, with a minimum set of standard practices, procedures, and specifications [Nebert, 2001]. The supporting environment that a Spatial Data Infrastructure may provide consists of geographic data and attributes, metadata that presents sufficient documentation on data, catalogues and web-based mapping for discovering the required data that are distributed across the network [Nebert, 2001]. In addition to this, the infrastructure also stipulates the organizational agreements that are required to draw a boundary within which these components are developed [Masser, 1998].

Definitions:

Most of the definitions outlined by the committees established for the task do not differ much from the one given by the U.S. FGDC of the United States. The executive

order, signed by then U.S. President Clinton, defines the NSDI as follows "National Spatial Data Infrastructure (NSDI) means the technology, policies, standards and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data" [Clinton, 1994, Section 1a].

2.4 Components of a Spatial Data Infrastructure

The components of a spatial data infrastructure (SDI) in an ideal case could be deduced from the one outlined in the U.S. National Academy of Public Administration 1998 [Montalvo, 2001] as graphically illustrated in Figure 2.1.

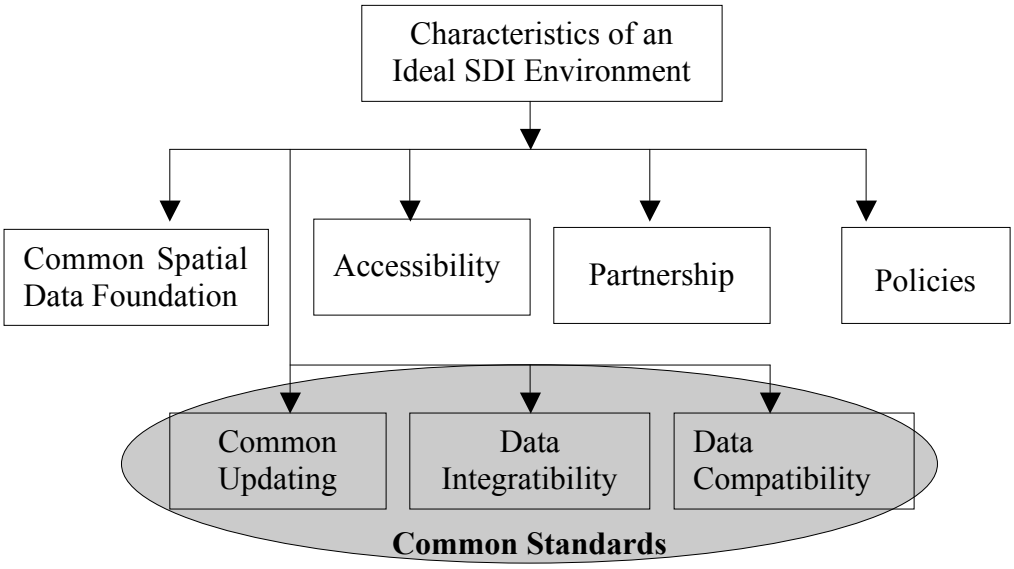

Figure 2.1
Characteristics of an ideal spatial data infrastructure environment.

Through common geospatial data standards, it is possible to make various data sets compatible, thus making most of them integral. As a result, data updating is feasible through common practices and methodology.

The main components of the SDI initiatives in an ideal environment could be as depicted in Figure 2.2. In the forthcoming sections, the NSDI implementation initiatives of the various countries are explained in detail with respect to those SDI components.

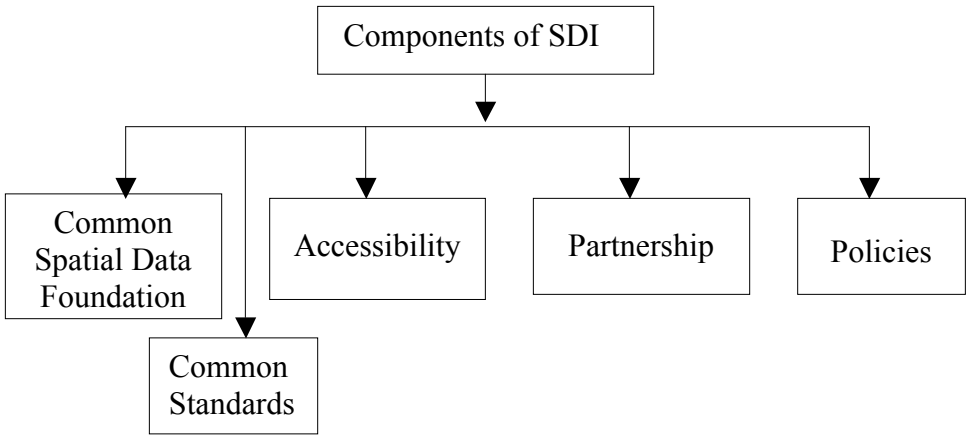

Figure 2.2

Major components of spatial data infrastructure

Masser [1998] states that the coordination, metadata and core data are the three major elements of an NSDI or the 'National Geographic Information Strategy' as graphically illustrated in Figure 2.3. The institutional context, which draws a boundary within which these components are developed, is not included as a major element of the NSDI [Masser, 1998]. Issues such as policies on acquisition, maintenance and the distribution of data and legal issues governing the protection of data are considered here as the institutional context [Masser, 1998].

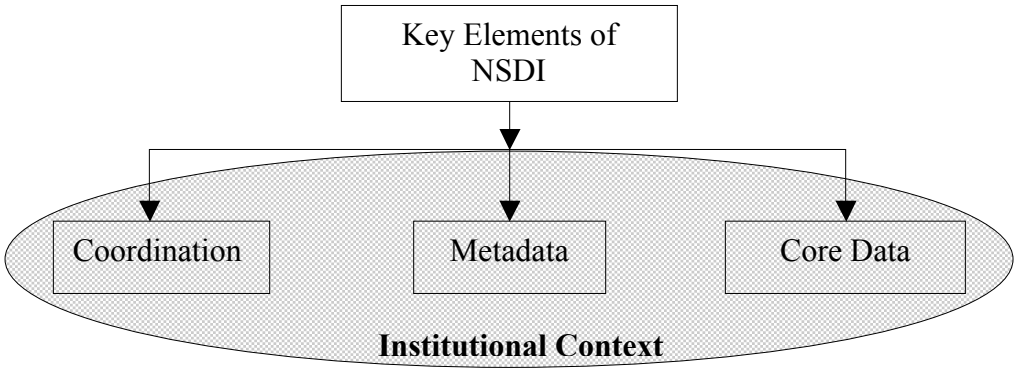

Figure 2.3

Key elements of an NSDI as proposed by Masser [1998]

2.5 International Trends in the Implementation of an NSDI

Advances in computer communications and database technology have made it possible to link all the disparate geospatial databases through the common information highway [O'Donnell and Cyril, 1998]. Most probably, the underlying technology that allows such linkages of the databases for common access and update is also encouraging the creation of NSDI-like initiatives in many countries. The South Korean government recognizes geographic data as the fundamental infrastructure needed for the sustainable development. As a result, in South Korea plans are underway to allocate US$ 360 million for the development of a National Geographic Information System [Korean Ministry of Construction and Technology (KMCT), 1995]. In Japan, Ministry of Land, Infrastructure and Transport collaborating with more than 50 private companies to develop major components of NSDI [Akiyama M, 2001]. In 1995, the Dutch Council for Real Estate Information (Ravi) published the plans for a National Geographic Information Infrastructure to achieve sustainable development through spatial data planning [The Dutch Council for Real Estate Information (Ravi), 1995].

A survey shows that 120 of 192 world nations are involved in the development of this infrastructure [Crompvoets J. and Bregt A., 2002]. Investigating the status of the NSDIs in all these countries goes beyond the scope of the report. Nevertheless, considering the strong progress made by Australia, Canada, and the U.S. in the implementation of NSDIs, the initiatives of these countries are covered in the subsequent sections. In addition to this, the status of the NSDI developments in the U.K. also covered in the section. As an example of such an initiative in the gulf region, special reference is made to on the successful nation-wide integrated GIS model of the State of Qatar. The status of the initiatives in those countries is explained with respect to the "ideal" SDI components mentioned in section 2.4.

2.5.1 American National Spatial Data Infrastructure

In 1989, the United States Office of Management and Budget (U.S. OMB) promoted a much wider coordination for the utilization of geospatial data. Subsequently, in 1990, the U.S. FGDC was formed to 'coordinate the development, use, sharing, and dissemination of surveying, mapping, and related spatial data' [U.S. OMB, 1990, pp 6-7]. Eventually, the Mapping Science Committee (MSC) of the United States National Research Council (U.S. NRC) identified the phrase 'National Spatial Data Infrastructure' (NSDI) for the coordinated atmosphere for the creation, management, distribution, and use of geospatial data [Tosta, 1997a].

In 1993, the MSC published a document entitled *Towards a Coordinated Spatial Data Infrastructure for the Nation*, which clearly defines the actions and responsibilities of various agencies and the U.S. FGDC, that are required for the realization of the U.S.

NSDI [U.S. NRC, 1993]. Consequently, in September 1993, National Performance Review (NPR) listed the NSDI as one of the proposals to 're-invent' the functioning of the federal government [Tosta, 1997a]. This was followed, in 1994, by the then U.S. President Clinton signing Executive Order No. 12906: *Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure*. This order gives clear guidance on executing tasks that are required for the implementation of the U.S. NSDI [Clinton, 1994].

The Executive Order recognized four major access of activity. They are the National Digital Geospatial Data Framework, Geospatial Data Standards, National Geospatial Data Clearinghouse, and partnerships to support the development of the U.S. NSDI [Tosta, 1995]. These activities are further explained in the subsequent sections.

National Digital Geospatial Data Framework

The goal is to create a data set that would offer a unique geospatial-referencing framework to facilitate smooth data integration. For this process, data would come from various sources based on its flexible access and smooth integration capabilities. Such data would have to meet certain nominal set of standards and serve the needs of the majority of its users. The framework will considerably reduce data redundancy and promote collective participation in data acquisition and management, thereby reducing the heavy investments required for such activities [Tosta 1995].

As defined in the U.S. FGDC report, the framework will hold data for the following seven-geospatial layers [U.S. FGDC, 1995]:

- Geodetic control;

- Elevation;
- Administrative boundaries;
- Cadastral or ownership information;
- Transportation;
- Hydrology;
- Digital ortho-imagery.

In 1998, The U.S. National States Geographic Information Council (USNSGIC) and the U.S. FGDC conducted a survey among 5000 data users throughout the U.S. The survey assessed the geospatial data generated and maintained by state, regional, and local governments. Programs were established to build framework of these datasets to make them available nationally [U.S. FGDC Framework Survey, 1999].

In 2000, GeoConnections of Canada and the U.S. FGDC signed an international collaboration to produce framework datasets for the border regions of Canada and the U.S. in the Rocky Mountains. The project was successfully completed with a set of nine vertically integrated data layers. These layers are currently available online for public. Confident gained from this collaboration is pushing them for the development of common spatial data infrastructure for Canada and the United States [Joint Framework Project, 2001].

Data Standards

The U.S. OMB authorizes different federal agencies to chair the sub-committees, under the U.S. FGDC, for such themes as soils, vegetation, cartography, transportation,

cadastre, etc. One of the main responsibilities of these sub-committees is to develop standards for data collection, geospatial data content, feature classifications, geospatial data presentation, data management, and maintenance to ease data sharing [Tosta, 1997a].

One of the best examples is the metadata standard, developed by the Standards Working Group, which was eventually approved for use, through the NSDI executive order, by all federal agencies for any geospatial data collected after January 1995. The standards developed by these sub-committees are subjected to extensive review processes by all related agencies and the public before they are adopted as part of the NSDI [Tosta, 1997a].

At the time of compiling this report, Geospatial data standards endorsed by the U.S. FGDC are as listed below [U.S. Geospatial Data Standards, 2003].

- Content Standard for Digital Geospatial Metadata (version 2.0)
- Content Standard for Digital Geospatial Metadata, Part 1: Biological Data Profile
- Metadata Profile for Shoreline Data
- Spatial Data Transfer Standard (SDTS)
- Spatial Data Transfer Standard (SDTS), Part 5: Raster Profile and Extensions
- Spatial Data Transfer Standard (SDTS), Part 6: Point Profile
- SDTS Part 7: Computer-Aided Design and Drafting (CADD) Profile
- Cadastral Data Content Standard, FGDC-STD-003
- Classification of Wetlands and Deepwater Habitats of the United States
- Vegetation Classification Standard

- Soil Geographic Data Standard
- Geospatial Positioning Accuracy Standard, Part 1, Reporting Methodology
- Geospatial Positioning Accuracy Standard, Part 2, Geodetic Control Networks
- Geospatial Positioning Accuracy Standard, Part 3, National Standard for Spatial Data Accuracy
- Geospatial Positioning Accuracy Standard, Part 4: Architecture, Engineering Construction and Facilities Management
- Content Standard for Digital Orthoimagery
- Content Standard for Remote Sensing Swath Data
- Utilities Data Content Standard
- U.S. National Grid
- Content Standard for Digital Geospatial Metadata: Extensions for Remote Sensing Metadata

Data Access - National Geospatial Data Clearinghouse

As part of the supportive activities in the NSDI development, for smooth access to geospatial data, is the implementation of a unique concept called data clearinghouses. The availability of the data along with the metadata, produced by geospatial data agencies, is advertised on the Internet. The NSDI executive order insists that the federal agencies responsible for geospatial data handling should describe the data using metadata content standards, and publish these metadata on the Web for easy access [Tosta, 1997a] by common users. The users of the data can easily access this information using normal Internet and query tools. Metadata, the Internet, and distributed search and query tools are the three essential components of the national data

clearinghouse [Tosta, 1995]. It has been observed by many of the participating agencies that because of the clearinghouse initiative, access to data has increased tremendously [Tosta, 1997a].

In 2002 the U.S. NSDI Cooperative Agreement Program (CAP) established by the U.S. FGDC, has funded the integration of the clearinghouse with the OpenGIS services [U.S. FGDC, 2002]. Now in the U.S., this clearinghouse is forming the building blocks for the Geospatial One Stop Initiative supervised by the ministry of interior with a leading role for the U.S. FGDC [Moeller, J. 2003]. The One Stop initiative is an electronic government implementation project to bind together e-govt and geospatial information.

Partnerships

American Vice-President Gore highlights in National Performance Review (NPR) report of 1993, the importance of partnership between government and private geospatial data agencies in establishing National Spatial Data Infrastructure [Gore 1993]. This view has promoted an atmosphere of collaboration among different levels of the national geospatial data community. The challenge posed by such an atmosphere, however, is clearly visible in the statement of U.S. FGDC secretary, Bruce Babbit [1994, p. 31]:

> 'finding new ways to communicate more effectively and share resources among levels of government and between the public and private sectors is probably the greatest challenge facing us in the next year. It's my personal goal to see FGDC facilitate more enduring and productive partnerships for collecting, managing and using geospatial data to solve real problems.'

Consequently, the U.S. FGDC formed a Competitive Cooperative Agreement Program giving guideline for establishing partnerships [Masser, 1998]. The goal of the U.S. FGDC is to promote data partnerships to generate geospatial data sets through common data standards. This approach allows smooth integration of disparate data sets [Tosta, 1997a] for easy and flexible access.

A major milestone in the U.S. FGDC partnership initiative was the successful completion of framework datasets across Canada/U.S. national borders [Joint Framework Project, 2001]. Further, the U.S. FGDC is collaborating with many levels of government and the Universities through cooperative projects to enhance the NSDI [State/Tribal Forums, 2001].

The I-Team (Initiative Team) project was created to overcome the institutional and financial difficulties of the NSDI development. At present 39 out of 50 states of the United States are participating in the I-team project [Masser, 2002]. Geo-Data Alliance is another initiative established in the U.S. for public-private partnership facilitating the NSDI development. The Open GIS Consortium (OGC), the University Consortium for Geographic Information Science (UCGIS), and the U.S. National State Geographic Information council (USNSGIC) are some of the organizations participating in the alliance [U.S. NSDI Stakeholders, 2003].

Policies on Pricing and Copyright

In the United States, according to the prevailing law, the public is entitled to receive the information, maintained by the federal agencies, at a reasonable price

covering only the data distribution cost. Accordingly, federal agencies such as the National Mapping Division (NMD) of the United States Geological Survey (USGS) and the Bureau of Census sell the data to the public at a rate just covering the distribution expenses. Many states, however, are considering imposing restrictions on public access to geospatial data and finding provisions to market the geospatial data and its services on a commercial basis. A recent survey has shown that amendments have already been made in the existing 'open record law' in many states. This will allow for the commercialization of the geospatial data. As a result, it is feared that this approach may create irregular practices in marketing the geospatial data and its services [Masser, 1998].

Although the U.S. Copyright Act covers Intellectual Property Rights on digital databases, the scope and practicality of it is being questioned. The law was challenged by a recent verdict of the U.S. Supreme Court in a legal fight between a publishing company and a telephone company regarding the publication of data maintained by the later. Because of inadequate clauses in the copyright law, the verdict was in favor of the publishing company although they copied the data from the telephone company database for their own commercial benefit. Because of this, there is a growing concern about the clauses of the existing copyright law, and how they will protect digital databases. There are demands for amendments in the existing law [Masser, 1998].

Legal context concerning public access to geospatial data are becoming major bottleneck in the implementation of NSDI in the U.S. This is primarily due to prevailing differences in the state laws. Compared to Federal law, state laws generally have

precedence regarding the state and local data. All 50 states of the Unites States have one or more legal provisions on public access to geospatial data called "freedom of information acts" (FOIA). The act is somewhat similar to public records acts of the Federal government. In addition to this, states have some legal provisions to protect privacy and confidentiality of the publicly available data, which in some cases limit access to certain information. To protect the rights of the geospatial information copyrights, patents, and trademarks are normally used. At least eight states of the U.S. set certain limitations to access the geospatial data maintained by the government. The statute allows these agencies to collect "reasonable" charge, quite often higher, for accessing the data [Private Sector Issues, 2001].

The scenario, however, can be different for the geospatial data maintained by the private companies as they may copyright their services. As a result, availability of information is becoming difficult even for emergency dispatch services. This was evident in geospatial data service contractual agreement between the public sector agency Metropolitan Dade County, Florida (MDCF) of Department of Natural Resources and the private agency, Florida Light & Power (FLAP). Though the data was produced for the MDCF, copyright was with the FLAP as per the contract. During a terrible natural calamity in Florida, FLAP declined to provide the same information to Department of Natural Resources without a license agreement despite the emergency. The Company finally delivered the data after three months of negotiations, and even then only with stringent limitations on its use [Private Sector Issues, 2001].

2.5.2 Canadian National Geospatial Data Infrastructure

In 1994, Geomatics Canada initiated the development of Canadian Geospatial Data Infrastructure (CGDI) through a product called GeoExpress. The idea was to create a means to access and explore the geospatial data components maintained by various agencies. Subsequently Canada formed the Mapping 2000 Alliance, a conglomeration of geospatial data professionals from various agencies of government, private and educational institutions. Several collaborative projects were initiated by the Alliance. One project is ChartNet, developed to maintain a national digital hydrographic chart [O'Donnell and Cyril, 1997].

In 1995, the Province of Saskatchewan proposed a full study on the implementation of the CGDI [Evangelatos and Labonte, 1998] in a meeting convened by the Canadian Council on Geomatics (CCOG). A private agency was assigned the task and recommended that the main objectives of the CGDI implementation be easy access to data, promotion of data use, improvement in data integrity, and promotion of data sharing. The CCOG later assigned the task of developing the CGDI framework, involving all levels of government, to the Inter-Agency Committee on Geomatics (IACG),

In 1997, the IACG proposed a model of the CGDI consisting of five fundamental elements illustrated in Figure 2.4. These elements are further explained in the succeeding sections of this chapter. In 1998, the GeoConnection secretariat was established to coordinate all the developmental activities of the CGDI. An interesting outcome of these initiatives was that, in 1999, the federal Cabinet extended its full

support to the national efforts to develop the geospatial data infrastructure [Nichols et al., 1999]. Now in Canada, GeoConnections became the CGDI national initiative steered by Natural Resources Canada, with a mission for bringing Canada's geospatial data available over the Internet for the purpose of collaboration with all levels of government bodies and the private sector [CGDI Workshop, 2001].

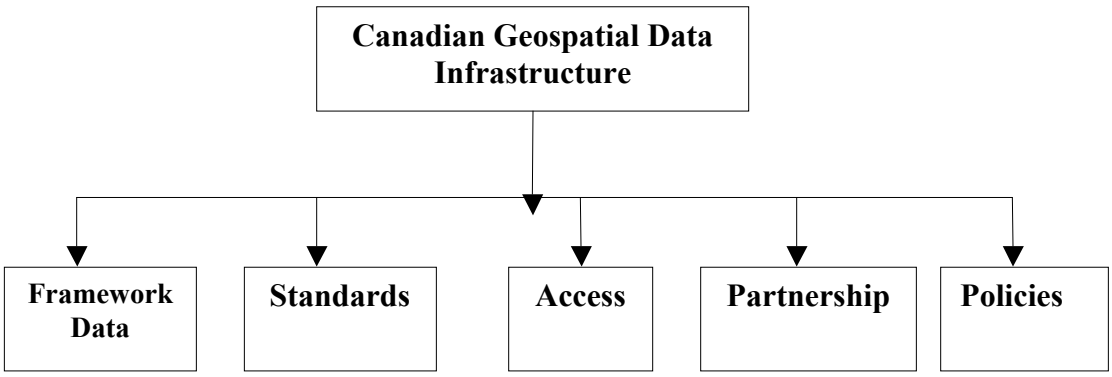

Figure 2.4
Fundamental elements of Canadian Geospatial Data Infrastructure as proposed by IACG in 1997 [Nichols, et al., 1999]

Framework Data

In Canada, the core of the CGDI is the Framework Data that provides a geo-referencing framework for the country [CGDI Working Group, 2001, p 5]. It is collection of seamless and fully integrated sets of geospatial data facilitating most geospatial data applications. Framework data contains features with graphical and the related attributes. Although most datasets satisfying the criterion are not ready, Canada, however, is steadily progressing with well-defined implementation plans for a operational CGDI 'not later than March 2005' [CGDI Working Group, 2001, p. 8]. Framework data consists of three primary components as listed below [GeoConnections Framework Data Node, 2001]:

- Alignment layers

- Land Feature/Form layers
- Conceptual layers.

Alignment layers

These are required to geo-reference other geospatial data sets and its contents, ensuring the consistency and the reliability of all other data sets. The components of these data sets are illustrated below:

- Canadian Spatial Reference System: These are set of geodetic control points with a high degree of accuracy and are the basis for entire framework data sets.

- Data Alignment Layer: These are set of points with lesser degree of accuracy and are easily locatable on the imageries and maps.

Land Feature/Form

These are well-defined topographic features contained in the most NTDB's such as infrastructures, natural features like rivers and elevation. The data sets identified under this category are illustrated below:

- Roads
- Railroads
- Transmission Systems
- Structures
- Hydrography
- Elevation
- Imagery

Conceptual Layers (Defined boundaries)

These are the data sets generated for demarcating the boundaries of administrative jurisdictions and responsibilities. The data sets identified under the category are as follows:

- International Boundaries
- Provincial Boundaries
- Electoral Districts
- Municipality boundaries
- Department of National Defense (DND) Properties
- Indian Reserves (First Nations)
- Crown Subdivisions
- National and Provincial Parks
- Ecological Units (ecozones, ecoprovinces, ecoregions, ecodistricts and soil landscapes)
- Watersheds
- Toponymy - Canadian Geographic Names Database (CGNDB)

Data Standards

Canada has legacy in the deployment of Geomatics solutions and framing standards for reading geospatial data from different sources. In developing standards that support interoperability and re-usability of geospatial data, its solutions were not

satisfactory and, as a result, are not competent in the international market [Evangelatos and Labonte, 1998]. To overcome the shortcoming, Canada now focuses its resources on building standards that are competent enough to all sectors. As a result, it started supporting such works at national and international levels through many government and private agencies [McKellar, 1998]. In order to ensure the compatibility of the Canadian geospatial standards at the global level, consensus are reached among the stakeholders to develop them based on the international geospatial data standards. Many of these standards need approval of Canadian General Standards Board - Committee on Geomatics (CGSB CoG). Standard Council of Canada (SCC), however, has to endorse these standards before it becomes the nationally adopted one [IDON, 2000].

The CGDI Architecture Working Group (CAWG) of GeoConnections participate with the international standard organizations in the development of geospatial data standards supporting the CGDI. Notable among them are ISO and the Open GIS Consortium. As part of Canada's continuous efforts in the process of developing geospatial data standards, GeoConnections sponsored a project for the development of 'Plan and Process Model' for the Geospatial Data Standards. The project resulted with several recommendations to ensure the integration of geospatial data standard development of various agencies and stakeholders in Canada [Plan and Process Model, 2000].

Now in Canada, development of the CGDI is based on broad spectrum of standards such as GML for geospatial data exchange services, Web Map Service for Internet based services, and Framework data standards for defining the geospatial data

contents. At present following are the standards and specification endorsed by the authorities as part of the CGDI initiative [CGDI Presentation, 2003]:

- Geodata Discovery Service
- ISO Metadata Standard
- Web Map ServiceWeb Feature Service
- Style layer descriptorsGeographic Markup Language
- Filter encoding

Data Access

GeoConnections mission is to provide online access and sharing of geospatial databases and services that are distributed across Canada. Funded programs are launched to achieve the target through partnership with stakeholders. Now, discovery services are used to make this mission possible. As a result, around 29% geospatial data clients in Canada use Internet for data access. This figure is high compared to the geospatial data access rate of the U.S. and Australian clients [KPMG Report, 2001, p. 17].

Discovery services are provided either through a geospatial search engine such as CEONet or through thematic specific searchable directory such as Environmental Monitoring and Assessment Network (EMAN) [Technical Manual, 2001, pp. 12-18]. In Canada, the CEOnet has been operational since 1997 and is now emerged as the GeoConnections Discovery Portal of the CGDI initiative. As a result, the portal is becoming a prime component of the CGDI. All levels of government agencies, non-government organizations and private sectors are encouraged to use the services. In addition to this, GeoConnections collaborate with international organization in data sharing. It receives geospatial data from clearinghouses distributed across the globe. The

success of the discovery service is evident from its exponential growth since its inception. Now, it enables the search of over 100 heterogeneous distributed geo-databases containing millions of products [Technical Manual, 2001, pp. 30-34].

Discovery services are succeeding in a number of provinces for geospatial data maintained under their jurisdictions. Ontario Geospatial Data Exchange (ODGE) is one of such initiative in progress [Geospatial Data Policy Action Plan, 2001, p. 4].

Partnerships

Canada would be the first country to pioneer such a broad joint initiative in the development of spatial data infrastructure. This is evident in the CGDI initiative itself, as it is driven by the partnerships among the federal, provincial, and territorial governments; the private sector; and academia [Evangelatos and Labonte, 1998]. The GeoConnections collaborate with those agencies to satisfy Canada's geospatial demands by making it available online through discovery services [KPMG Report, 2001, p. 1]. As a result, Canada is in an advantageous position in harnessing the support even from local governments compared to its U.S. FGDC counterpart. In the latter case, the authority is very much limited to the federal government agencies only [Masser, 1998].

Certain principles were adopted between federal and provincial governments on partnership issues. As per the agreement, all the partners involved in the development and maintenance of most commonly used geospatial data sets should share the costs. Such parties are allowed to use these data sets to integrate with existing databases residing with the respective organizations and are free to distribute these derived data

sets to their stakeholders [Evangelatos and Labonte, 1998]. At the federal level, however, data partnership arrangements are not as common. Consequently, government agencies are not able to share data among themselves for decision-makings [KPMG Report, 2001, p. 1].

A major milestone in the partnership component of the CGDI initiative is the joint project between the GeoConnections and the U.S. FGDC, for producing framework datasets across the US/Canada national borders in the Rocky Mountains. Confidence gained from this cross-border collaboration is further pushing the partners for development of a common spatial data infrastructure [Joint Framework Project, 2001].

Policies

Canada has much advanced in developing many components of the CGDI and expected to have operational CGDI 'not later than March 2005' [CGDI Working Group, 2001, p. 8]. Inconsistent policies for data licensing and related issues, however, pose a big challenge in using the geospatial data across the different sectors. Many government agencies have their own independent policies and pricing mechanisms. The situation demands multi-dimensional agreements from various agencies that are participating in the CGDI initiatives [Evangelatos and Labonte, 1998].

Initiatives are underway in Canada, however, to have consistent data licensing policies and terms and conditions for geospatial data distribution. To modify the existing policies and practices on geospatial data distribution, a study was sponsored by GeoConnections in 2001. KPMG consulting Inc. carried out the study under the

leadership of GeoConnections Policy Node [Geospatial Data Policy Action Plan, 2001, p. 1].

The Study found that the major impediment in the growth of geospatial data use, -- especially in the federal government agencies and their departments -- is the prevailing inconsistencies in data cost recovery practices. This varies from agencies which recover a certain percentage of the investment to agencies which supply data free of charge without receiving any benefits. The benefit accruing from cost recovery, however, is very marginal (about 13%) compared to the annual budget for data creation, maintenance and dissemination. Because of this practice, even federal agencies depend quite often on cheaply available data for decision-making process. This is happening in spite of the availability of best quality data sets that would have helped them in better decision-makings. [Geospatial Data Policy Action Plan, 2001, pp. 5-19]

In Canada, Crown copyright and complex licensing agreements exist for the base map data. This prevents the redistribution even within or between organizations limiting the wider use of geospatial data across the country. At the national level, this is the basic difference between the digital data policies and practices between Canada and the U.S. The approach contradicts the goal for increasing the growth of geospatial data use and the resultant benefits [Geospatial Data Policy Action Plan, 2001, pp. 24].

The KPMG study recommends increasing the growth of the geospatial data use by making it available at the price levels affordable to the majority of data users. It

recommends further, wherever feasible, to supply the data free of cost [Geospatial Data Policy Action Plan, 2001, pp. 5-19].

2.5.3 Australian Spatial Data Infrastructure.

The Australia New Zealand Land Information Council (ANZLIC) is formed to coordinate the geospatial data activities of government of Australia, New Zealand and the States and Territories of Australia. Since its inception in 1986, the council has produced five versions of national strategic plan for the management of geospatial data. Most recent version of the report is National Strategic Plan for 2000-2005 [Masser, 2002]. The vision for geospatial data activity for Australia is expressed in the report that states [Australian New Zealand Land Information Center (ANZLIC), 2000]:

> 'Australia's and New Zealand's economic growth, and social and environmental interests are underpinned by *quality spatially referenced information* (Quality spatially referenced data means spatially referenced information that is current, complete, accurate, affordable, accessible and integratable)'.

ANZLIC is actively involved in developing policies and framework for the geospatial data management agreeable to both Australia and New Zealand. Facilitating the improved access to geospatial data within Australia, however, is achieved through the Australian Spatial Data Infrastructure (ASDI) [Australian Spatial Data Infrastructure (ASDI), 2003]. As part of the ASDI implementation, ANZLIC's focus is to build distributed sets of geospatial databases that are individually created and managed by 'custodians' from the public and the private geospatial data agencies of Australia [Geoscience Australia, 2003]. The fundamental components of the ASDI structure are

as illustrated in Figure 2.5 [Masser, 2002, p. 18]. These components are discussed in detail in the following sections.

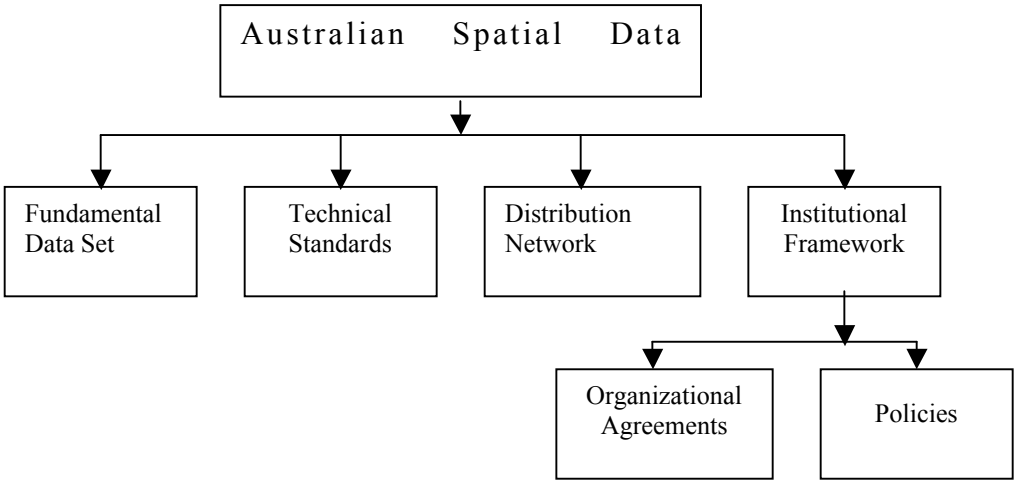

Figure 2.5
Components of Australian Spatial Data Infrastructure

Fundamental Data Sets

In Australia and New Zealand, the availability of complete and consistent data sets will impact the municipal, state, and national services. In Australia and New Zealand, it was envisaged that the availability of complete and consistent data sets would impact the municipal, state, and national services with increased productivity and efficiency of operations. The services identified under this were electricity, gas and water utilities and the national-level project for the management of agriculture, mining and the environment [Mooney and Grant, 1997].

Considering the apparent multi-faceted benefits to Australia and New Zealand, ANZLIC is developed a strategy for identifying the numerous geospatial information products. The identification of the data set is based on the corporate government requirements and their priorities. Data sets that are identified for the purpose are [Baker, 1995]:

- Aerial and satellite imagery,
- Cadastral information,
- Census results,
- Land use and land cover,
- Place names,
- Elevation,
- Soil,
- Vegetation,
- Geology,
- Climate,
- Pollution and hazardous sites,
- And the area of environmental significance.

Australia has already made a significant progress in the creation of core databases [Masser, 1998]. The best examples are the cadastral and topography digital databases of the eight states and territory governments of Australia. In 1993, ANZLIC formed Australian Public Sector Mapping Agencies (APSMA) to create Australian National Digital Base Map for 1996 census. Successful completion of the project motivated the ANZLIC to expand the roles of APSMA and eventually made it as a public owned company in 2001. It has developed number of geospatial products of national interests. One of the important achievements of APSMA was the development of seamless cadastral database called *CadLite*, containing the land parcel boundaries of whole Australia. The project was successfully completed and launched for services in October 2001 [Masser, 2002].

Technical Standards

The ANZLIC promotes the use of common standards to achieve flexible and economic access to the rich source of geospatial data and services available in the country for the decision makers [Australian Spatial Data Infrastructure, 2003]. The approach is clear from the continuous support given by ANZLIC to Standards Australia and Standards New Zealand (SASNZ). On the international front, the council is an active participant in the activities of international organizations, such as International Standard Organization (ISO), for geomatic standards. In addition, Australia adopted the U.S. SDTS to the Australian geospatial data transfer standards. ANZLIC is also sponsoring various projects for defining the technical standards for data models, geographic referencing, data dictionaries, data quality, data transfer and metadata [Masser, 1998].

In spite of having an ongoing initiative to develop a common geospatial data standard that has enjoyed a great deal of government support, many national geospatial data collection projects have had to be suspended because of the absence of commonly accepted geospatial data standards [Mooney and Grant, 1997]. However, state-level geospatial data infrastructure initiatives based on common standards are emerging with encouraging results in Australia. The project Land Victoria is the one of the best examples of such initiatives [Masser, 2002].

The project was initiated in 1996, to establish a common geospatial infrastructure based on cadastral map, between local and state government. The information required by the state on the proposed property developments was managed by the 78 local government agencies. It was found that very little commonality, however, existed between the data maintained by local agencies and cadastral base map maintained by the

state. Consequently, central funding was obtained for the project to match the databases maintained by the local agencies and the state. The project could save good amount of resources for the state and the local agencies, by controlling the duplication efforts.

Distribution Network - Access

ANZLIC is maximizing the geospatial data access through the implementation of directory services similar to the concept of clearinghouse. The Australia Spatial Data Directory (ASDD) services are in consistent with the U.S. FGDC metadata contents standards. The ASDD currently maintains over 30,000 metadata records containing detailed explanation of the national land and geographic data. Through this window, geospatial data community is now able to access good quality data sets that are spread over Australia [Australian Spatial Data Integration, 2003]. Many national level data sets such as National topographic, bathymetric, digital elevation, and resources and environmental data, national geological and geophysical data are currently online that manages the gateway to the ASDD [AUSGEO, 2003].

Further to ensure the compliancy with the national standards for the metadata development process, ANZLIC has produced following metadata resources [Geoscience Australia, 2003] and [ANZLIC, 2003].

- ANZLIC metadata guidelines for assisting the geospatial agencies in developing the ASDD (http://www.anzlic.org.au/asdi/metaelem.htm).
- ANZLIC Metadata Entry Tool: Contains the guidelines for documenting and maintaining the metadata services of the geospatial data agencies and is freely distributed (http://www.anzlic.org.au/asdi/metatool.html).

- ANZLIC Geographic Extent Name Register: Contains the geographic extents of many objects developed as part of metadata implementing guidelines. (http://www.anzlic.org.au/asdi/genreg.html).
- Other metadata tools: Commercially and freely available metadata collection and management tools (http://www.auslig.gov.au/asdd/tech/tools.html).

Institutional framework

In the context of geospatial data activities in Australia and New Zealand, the institutional framework means the policies and administrative arrangements required for the creation and maintenance of and access to data sets and for applying the geospatial data standards [Baker, 1995]. At one end, it deals with organizational arrangements required for the development of the spatial data infrastructure, and at the other end, it deals with the responsibilities and rights ('policies') of agencies that are involved in the creation, maintenance and the managements of the various data sets. In the case of the former aspect, organizational arrangements that are required for the creation of the data infrastructure already exist in Australia and New Zealand. ANZLIC is the responsible body for this purpose [Masser, 1998]. Apart from this, with the new functional changes, Australia Public Sector Mapping Agency (APSMA), that was created for producing Australian National Digital Base Map for 1996 census became the public owned company in 2001. With this new role, APSMA produced many geospatial products of national interests [Masser 2002]. ANZLIC promoted the growth of geospatial data industry in Australia and New Zealand. The release of the 'Spatial Information Industry Action Agenda Positioning for Growth' in September 2001 was considered as the major achievement in the history of ANZLIC in this field [ASDI, 2003].

ANZLIC believes that partnership is very important for a strong geospatial data industry foundation. To achieve this, ANZLIC associates with following partners from government, private, public and academic sectors (http://www.anzlic.org.au/about/about_partners.html):

- Intergovernmental Committee of Surveying and Mapping (ICSM)
- Public Sector Mapping Agency Australia Limited
- National Land and Water Resources Audit
- Australian Spatial Information Business Association (ASIBA)
- Spatial Sciences Institute (SSI)

Commonwealth Office of Spatial Data Management (OSDM) is the operational component of the three tired structure formed to coordinate the spatial information activities relating to the policy and access part of the of ASDI implementation within the Commonwealth of Australia [ASDI 2003]. Geoscience Australia managed the ASDI partnership Grants that was completed in 2001 [Geoscience Australia, 2003].

In November 2000, certain guiding principles were published to promote the flexible and equitable access to basic geospatial data sets. The report clearly emphasizes making the data available to all spectrums of the users without any constraints, including price. To improve such access, it recommends the use of online services and ensures the confidentiality, privacy, security and intellectual property rights of the geospatial data sets [Masser 2002].

Property On-Line project (POL) is the good example of the state level initiation for making the data available on-line for public access satisfying the above-mentioned

conditions. The goal of the project is to make all relevant land information at the fingertips of the online users. To make it work, Land Victoria brought together number of stakeholders such as Vendor Statement Certificate On-line (VSCO) project, Streamlined Planning through Electronic Applications and Referrals (SPEAR) and the Electronic Conveyance Victoria (ECV) project [Masser, 2002].

Commonwealth Government Policy on Spatial Data Access and Pricing, release September 2001, ensures the free availability of certain sets of fundamental geospatial data over the Internet. In some cases, it could be procured as a packaged product for a nominal cost just covering the transfer charges. Geoscience Australia claims that demand for its spatial products has increased 50 – 100 times because of the new policy. The director of the Southern Geoscience Consultants, a geophysical consulting group based in Perth, Australia comments about the policy that '*Southern Geoscience Consultants is very happy with the new arrangements. The data are being used far more extensively than under the old policy*' [AUSGEO, 2002].

2.5.4 National Geospatial Data Framework of the U.K.

A Framework document published by the United Kingdom (U.K.) Ordnance Survey (U.K. OS), in 1995, summarizes the strategies required for the implementation of a geospatial data framework. Rather than creating new spatial data sets, the concept is to spatially associate different spatial data sets, maintained by the various government agencies, with the already existing U.K. National Topographic Database (U.K. NTDB) [U.K.OS, 1995]. In the U.K., however, there is no national level coordination body that enjoys the same political support and power that are comparable to the U.S. FGDC or similar bodies in other countries involved in such initiatives. Moreover, some argue that

the American NSDI model may not be applicable to Britain because of the prevailing autonomy in the governmental setup and the lack of support for this purpose, which the U.S. FGDS enjoys [Nansen et al., 1996]. To overcome the situation, U.K. OS proposes a strategy for a virtual database with no single authority but 'the totality of many individual data sets collected and held separately by many different organizations' [Nansen, et al., 1996, p 4.]. Nevertheless, to realize such a fluid structure, a common geospatial data standard is required and a strict adherence of such standards by the data producers must be assured [Masser, 1998].

In the absence of a coordinating body with enough statutory powers, the realization of a British NGDF seems to be far away. The importance of such a body was made known to the authorities by the Lord Chorley report [U.K. Department of Environment (U.K. DOE), 1987]. The government, however, refused the proposal by arguing that the range of activities of the existing organizations could be expanded rather than creating a new body [Masser, 1998].

Perhaps to overcome the crisis, in 1996 a national level dialogue was held between U.K. OS and other geospatial data communities. The result was the creation of management structure. Consequently, three major operational bodies have formed with definite mandates. They are the U.K. NGDF board, chaired by U.K. OS with statutory powers to make policies and commit resources; the U.K. NGDF Advisory Council, headed by the Association for the Geographic Information (AGI) to liaise with the geospatial community and the U.K. NGDF task force as a functional element of the board [Davey and Murray, 1996]. Despite such initiatives, 'there is no formal NSDI in

the UK, nor a single organization with responsibility for its establishment and coordination.' As a result, 'until recently the UK has lacked a coordinating structure to implement its SDI but there are signs that this is changing' [Craglia, M. et al, 2002, p. 39].

Framework Data/Core Data

Many elements of the core database are already available in Britain. They are the U.K. NTDB (OS MasterMap) maintained by the U.K. OS and, horizontal and vertical coordinate systems and transformations, national geo-referenced postal address database, transport network, administrative, electoral and postal boundaries, national digital elevation model, the Land and Property Information (LPI) run by the Land Registry (LR) and the socio-economic data gathered by Office of the National Statistics (ONS) [Craglia, M. et al, 2002]. The NTDB of the U.K. OS is supposed to serve as a base layer for the proposed framework [Masser, 1998].

The basic strategy is to integrate various geospatial data sets maintained by the different agencies with these core databases. For the purpose, the U.K. OS has created a seamless database called OS MasterMap. The database contains more than 400 million features with a unique identifier for every topographic features [Craglia, M. et al, 2002]. In addition to this, a project was commissioned to build a National Land Information System (NLIS) by correlating many data sets with the U.K. NTDB. Data sets are linked through a unique property number (UPRN) contained in the Land and Property Gazetteer [Smith and Goodwin, 1996]. The linkage of geo-referenced UPRNs, with the unique feature identifier of the seamless topographic database is expected to emerge as a

major step for the implementation of NSDI in U.K. [Craglia, M. et al, 2002]. NLIS provide online services for acquiring property details.

Geospatial Data Standards

The Chorley report [U.K. DOE, 1987] highlights the importance of common geospatial data standards. It also recommends the standard geospatial units and the development of data exchange standards for both cartographic and non-cartographic elements [U.K. DOE, 1987]. Probably, an important outcome of the report is the project initiated by the AGI for the development of geospatial data standards for the U.K. and Europe [Masser, 1998]. The document also states the needs for defining the common characteristics and standard access media for the data set [Nansen et al., 1996]. Subsequently AGI supported the development of the U.K. national standard, BS 7666, for street address through the British Standards Institute (BSI). Similarly, the BSI was involved in the development of many geospatial standards with the support of AGI. The BSI coordinates with ISO for developing national standards in consonance with the international initiatives. Apart from this, geospatial data available through the clearinghouse *AskGiraffe* are documented based on the U.S. FGDC standards [Craglia, M. et al, 2002].

The U.K. Coordinate Reference Framework is now acting as a base for the national geo-referencing framework. The U.K. NTDB is geo-referenced based on this standard. Joint programs are initiated among the U.K. OS, Ireland OS and Northern Ireland OS to harmonize the standards across these organizations [Craglia, M. et al, 2002].

Data Access

The Chorley report [U.K. DOE, 1987] recommends the maximum utilization of the geospatial data maintained by various agencies. Towards achieving this, one of the proposed activities was the development of a national policy on geospatial data availability, operational procedures for the data registers, and storage facilities for permanent data.

Because of the prevailing non-uniform distribution policies, however, there is no consistent approach to dissemination of data. As a result, the public gets different results, when requesting the same information from the responsible different agencies [U.K. DOE, 1987].

In the U.K., though extensive sets of geospatial data are available, most of them are not accessible online [Craglia, M. et al, 2002]. This is in spite of the availability of the Spatial Information Enquiry Service (SINES), a metadata service under the administration of the U.K. OS. SINES maintains a database of 600 geospatial data sets that are owned by more than 40 government and other related agencies [Garnsworthy and, Hadley, 1994]. The concept of SINES is very similar to the yellow pages services provided by the telecommunication companies.

SINES has been withdrawn, however, due to difficulties in maintaining the system with up-to-date information. Instead, the U.K. OS AskGiraffe is operational with central government funding. This also under major modifications and will be eventually managed by the AGI with the support of the U.K. OS [Craglia, M. et al, 2002].

Partnership

Though the Chorley report [U.K. DOE, 1987] recommended a central body to coordinate the activities, the government has refused to accept the proposal [Masser, 1998]. In 1989, however, the AGI was formed by pooling people from government, the private sector, the utilities, and the educational institutes [Leslie, 1994]. Subsequently in 1995, the National Geospatial Data Framework (NGDF) was initiated to liaison with the industry sector to solve common issues impeding the infrastructure development. This was also not successful and has to be abolished eventually. As a result, 'there is no formal NSDI in the UK, nor a single organization with responsibility for its establishment and coordination [Craglia, M. et al, 2002].

Many collaborative projects, in association with different levels of government and private agencies, however, are taking place under the leadership of the U.K. OS. Conversion of large-scale maps of the U.K. with private party participation, National Land & Property Gazetteer (NLPG) project with local government and private party, National Street Gazetteer (NSG) with the U.K. OS and the local government are some of the good examples of joint venture programs in the U.K. Another such initiative is the Pilot Pan Government development for giving access to government geospatial data sets for over 560 federal agencies [Rhind, 1997] and [Craglia, M. et al, 2002].

Policies on Pricing and Copyright

In the U.K., there was a major shift in the geospatial data service charging policies, because of government instructions to public sector agencies to operate more on a commercial basis. This resulted in inconsistent pricing practices among the data providers. A minimum level of cost recovery is expected from the agencies, such as the Office of National Statistics, that are involved in the collection of data required for

policy-making by the government authorities. A maximum cost recovery is expected from the agencies, such as HM Land Registry, that are responsible for the collection of data for regulatory use. In the case of the U.K. OS, however, that is responsible for public as well as government data services, the policy is not lucid and cost recovery is in between the above-mentioned agencies [Masser, 1998].

Outside commentators have observed that: '*the pricing policy in the U.K. is arbitrary. It is unclear whether the government wants to recover the costs, make a profit or stimulate the private sector*' [Policy Studies Institute, 1995, p. 66].

A 1995 study on the issue revealed that: '*the availability of digital information, at an affordable price, was the biggest single barrier to public sector use of GIS*' [Hookham, 1995, p. 20]. It is interesting to note that when the U.K. OS reached Service Level Agreements with its potential customers with regard to the terms of data availability, a tremendous increase, from 20% in 1993 to 80% in 1995, in the use of digital data by British local authorities was achieved [Rhind, 1995]. Britain's stand on copyright is much tougher compared to most other countries. Quite often, it is criticized as a one-sided approach that mostly benefits the data providers than the users [Masser, 1998].

In 2000, however, Her Majesty Treasury (HMT) has simplified government pricing policy and licensing systems. Copyright is waived and access is made free, for information such as legislation, forms, etc. Though free of cost, user license is required for accessing the basic information through Internet. Information, however, is charged at minimum cost with full right on reuse. Individual organizations has the right to issue the

license and fix prizes for the information required for value added use and sale [Craglia, M. et al, 2002]. As a result, terms and condition for data access and reuse is getting much clearer for the geospatial data community in the U.K

The resultant outcome of the approach was the creation of the most comprehensive national geospatial databases in the world with the participation of geospatial data users. It is been widely criticized, however, that '*such commercially lead policy is hampering informed governance and the further development of value-added services in the private sector*' [Craglia, M. et al, 2002].

2.6 Nationwide Integrated GIS Model of the State of Qatar

2.6.1 Background

In Qatar, the discovery of oil in 1970s financed physical developments with many kilometres of new roads and other infrastructure. Government agencies responsible for building and maintaining such national assets depended on paper maps at various map scales to keep track of such developments. As a result, large amounts of various resources were wasted due to duplication of effort and to the resultant inconsistencies in the data. This scenario prompted the government to switch to digital spatial data management system to maintain the vast amounts of information that are required for the effective planning and management of national properties. As a result, in 1989, a nationwide user need study was conducted to assess the benefit of deploying such a system throughout the government.

As per the recommendations of the study, as a first priority, Qatar established the Qatar National GIS Steering Committee (QNGSC) and The Qatar Center for Geographic Information Systems (QCGIS). The major responsibility of the QNGSC is to coordinate and monitor the development of a GIS in 19 government agencies in an integrated fashion based on common standards and practices [Al-Ghanem, 1999].

2.6.2 Qatar National Spatial Data Infrastructure

The Qatar NGSC has the statutory power of framing and implementing the policies ensuring the coordination among the member agencies and applying common national standards on data and application developments. The QCGIS, being the technical advisory body, supports the QNGSC in framing the policies, strategies and

objectives that are required for the organized implementation of a nation-wide GIS system [Al-Ghanem, 1999].

Being the nodal mapping agency, the QCGIS maintains a high-speed fiber optic information highway interconnecting the data sets of various agencies and the fully functional QNTDB for secure data transfer. This rich source of information is made available online, thus allowing 24-hour access to the data. The QCGIS also maintains precise horizontal and vertical control datum networks and makes them available digitally over this highway [Al-Ghanem, 1999].

Tosta [1997b, p. 4] argues that

> '*Qatar, to its credit, identified the data needed for decision-making at all levels, including where most decisions are made - locally - and developed the highest resolution data to support these types of applications. Their small size allowed them to consider this a National Spatial Data Infrastructure'*.

Fundamental Data Sets

One of the objectives of a nation-wide GIS implementation is to ensure that everybody uses a common geospatial framework. The QCGIS maintains a nation-wide high resolution QNTDB, which is available, digitally on-line around the clock over a high-speed information highway. Around 16 QNGSC member agencies that are interconnected over the information highway, could easily access the NTDB for integrating the data sets maintained by the member agencies. The public could also

access the data based on certain access rights. The information content of the QNTDB that are part of the infrastructure is listed as follows [Tosta, 1977b]:

- 6,000 horizontal control survey monuments,
- 4,500 vertical control stations,
- Digital orthoimage [10 centimetre pixels in urban areas, 1 metre elsewhere),
- Digital elevation models [10 centimetres vertical accuracy in urban areas and 1 metre elsewhere), and
- A collection of vector layers (for example, streets, buildings, zoning, land use, etc.) at 1:1000 scale in urban areas and 1:10,000 for the rest of the country.

Technical Standards

The document entitled "National GIS Database Specifications and Data Dictionary – Topographic" [www.gisqatar.org.qa] contains the digital mapping specifications and standards for the production of Qatar's NTDB. This was published by the QCGIS. Subsequently, the CGIS coordinated all the member agencies to develop specifications and data dictionaries for their data themes [Tosta, 1997b]. The coordinated endeavor has resulted in the development of 16 volumes of data dictionaries, one for each agency, giving detailed specifications and guidelines for a national GIS database. The specifications and data dictionary standards became the common national data standards after the endorsement of QNGSC. This ensures the compatibility and consistency in data development thus allowing for the integration of the various data sets at the national level [Tosta, 1997b].

In Qatar the common data standards and shared approach among the member agencies of the QNGSC ensures that there is only one source agency for any given type

of information. This saves a huge amount of investments that otherwise would have been wasted through duplicated efforts.

Data Access

The data sets maintained by the QNGSC member agencies are distributed across the country and are interlinked electronically over the information highway, using common national standards and communications protocols. These data sets are made available to all these agencies for their easy access and use. Under certain access rights, the public can also access the data over the network [Al-Ghanem, 1999].

Several map server-based products are being developed by the QCGIS that are maintained on the public server. Thus member agencies and the public alike can explore the huge resources of data available on the information highway.

Partnership

The nodal mapping agency, the QCGIS, has the additional responsibility as the advisory body to the national GIS programs. The QCGIS cooperate with all the agencies and ensures that the GIS infrastructure is maintained according to the geospatial data standards endorsed by the QNGSC. The role of the Center at the national level is multifaceted. At one end, it supports the QNGSC on framing and implementing GIS policies among government agencies. At the other, it coordinates among the several agencies for the creation of the national GIS data sets in compliance with the standards. Moreover, it imparts training and exchanges technical support throughout the nation for the overall development and use of GIS in the country [Tosta, 1997b].

QCGIS organizes the funds required for the overall development of GIS at the national level and makes sure that the funds are properly allocated among the member agencies according to the priorities set [Al-Ghanem, 1999]. In addition to this, it collaborates with international GIS bodies for exchanging technical support in terms of GIS solutions, innovative data developments, training and education [Al-Ghanem, 1999].

Policies

The QNGSC is empowered to implement GIS policies among government agencies in the country. It promotes cooperation among them and ensures the overall development of the system and data sets according to the endorsed national standards. It has the statutory authority to include an agency in the national GIS programs as well as to regulate the functioning of the existing member agencies that are violating any standards, practices, and procedures in implementing the GIS [Al-Ghanem, 1999].

As far as pricing policy is concerned, the QNGSC ensures that consistent policies exist in the country for any type of data distribution. Therefore, a nominal charge, just to cover the expenses, is collected for the public data distribution. The QNGSC member agencies, however, are allowed to use the data free of cost. For these agencies, no particular restriction is imposed on the day-to-day use of the data [Al-Ghanem, 1999].

Extra care has been taken to protect the security of the strategically important pieces of information that are stored in the national GIS database. Mostly security is achieved through masking such piece of information from the general database through

database security tools. In addition to this, certain access control is also set for the normal users, thus restricting access [Al-Ghanem, 1999].

There is no special law existing in the country for the protection of data, other than general copyright law for the state. This law is concerned with dealing with the digital data that are introduced recently to curtail digital data duplication for commercial purposes [Al-Ghanem, 1999].

2.6.3 Conclusion

The Qatar GIS is expected to recover a substantial portion of its investments, funded by the Ministerial Cabinet, made in the past for building up the geospatial data infrastructure. This is mostly achieved through savings from the elimination of duplication of efforts, making consistent data sets, efficient planning, and management of resources, and reduced manpower requirements due to process automation.

Now in Qatar, almost 16 government agencies are extensively using the technology and its infrastructure for day-to-day functioning and decision-making. Managers, decision makers, and the public alike are more versatile with digital geospatial data for their day-to-day life. One of the greatest achievements is that the educational institutes are using the technology to study more about the geography of their own region. By all accounts and from the international recognitions it has received, perhaps Qatar could be considered as the first country having the first integrated system enjoying the international status as the finest GIS implementation.

'*In the United States, several states and various metropolitan regions are on their way to accomplishing something similar to Qatar's NSDI*' [Tosta, 1997b, p. 4]. She attributes the following factors that enabled Qatar to achieve this status [Tosta, 1997b]:

- Highest-level political support;
- Political will and authority to mandate and enforce standards;
- Outstanding technical leadership;
- Small and relatively uncomplicated geography;
- A relatively small group of institutions involved in geospatial data management;
- Adequate funding; and
- Little existing GIS activity.

2.7 Conclusion and Major Findings from the Case Studies

The concepts, definitions, and the components of Spatial Data Infrastructure (SDI) is discussed in this chapter. This is done mainly with respect to the best practices in the NSDI developments at the international level. Although such initiatives are known by different names, the foremost goal remains the same for all parties. It is found, however, that roles and responsibilities of the participating agencies in the coordinated effort, differs considerably as they depend mainly on the political and other administrative set up of the countries.

The "ideal" definitions and components of SDI were identified from the experiences of the international community involved in the NSDI development. Consequently, this was used to briefly explain the NSDI activities of four developed countries; namely, ASDI of Australia, CGDI of Canada, NGDF of the U.K, and the

NSDI of the U.S. Apart from this special reference is made to the State of Qatar NSDI initiatives, as an example of such programs in the region.

All the above mentioned five countries have achieved a tremendous progress in the development of SDI components such as 'Fundamental Data Set', 'Geospatial Data Standards', and, 'Geospatial Data Access'. This progress is mainly achieved because of the fact that all those three components are related to the technology development. It is also observed that trends in the geospatial data standard development in Australia, Canada, and the U.S. are going in harmony with the international standard organization such as ISO and OGS. In many cases, these countries adapt the standards developed by these organizations and use it as the national standards.

Among the NSDI initiative of five countries discussed in the chapter, the NSDI initiatives of Australia, Canada, and the U.S., however, are found to be progressing rapidly with all five "ideal" SDI components. This is primarily because of the excellent national level coordination achieved by them. Among them GeoConnections of Canada, however, deserves better reference, as it covers all spectrum of geospatial data community including government, private and academia. ANZLIC of Australia covers different levels of government, while the U.S. FGDC comprises only the federal agencies [Masser, 2003]. Despite having well-established geospatial data activities, however, the U.K. lacks similar organization for coordination. As a result, there is no formal NSDI in the U.K. [Craglia, M. et al, 2002]. In Qatar, geospatial data activities are coordinated by federally supported QNGSC.

A major shift is noticed in the strategy adopted by the U.S. FGDC in developing NSDI at the federal level. The current strategy of Australia, Canada, and even the U.S. is

now to develop it in a structured way starting from sub national government level with the participation of private industry and academia [Masser, 2003].

Another important factor is the increased role of private sector in the implementation of the NSDI. Canada is closely involved with this sector for the development of the CGDI through the Geomatic Industry Association of Canada, closely followed by Australia with the formation of Australian Spatial Industry Business Association. The U.S. has now realized the commercial potential of the NSDI and started partnership with the private sector for their NSDI development [Masser, 2003].

Chapter 3 - Status of Geospatial Data Activities in the U.A.E.

3.1 Introduction

The U.A.E. is making rapid progress in the development of its infrastructure, thus facilitating more advanced civil services. The discovery of oil, in the early 1960s, opened the door to rapid urban growth accompanied by a spurt in new real estate developments. As an example, the rapid physical developments happening in the coastal areas of Abu Dhabi are shown in Figure 3.1.

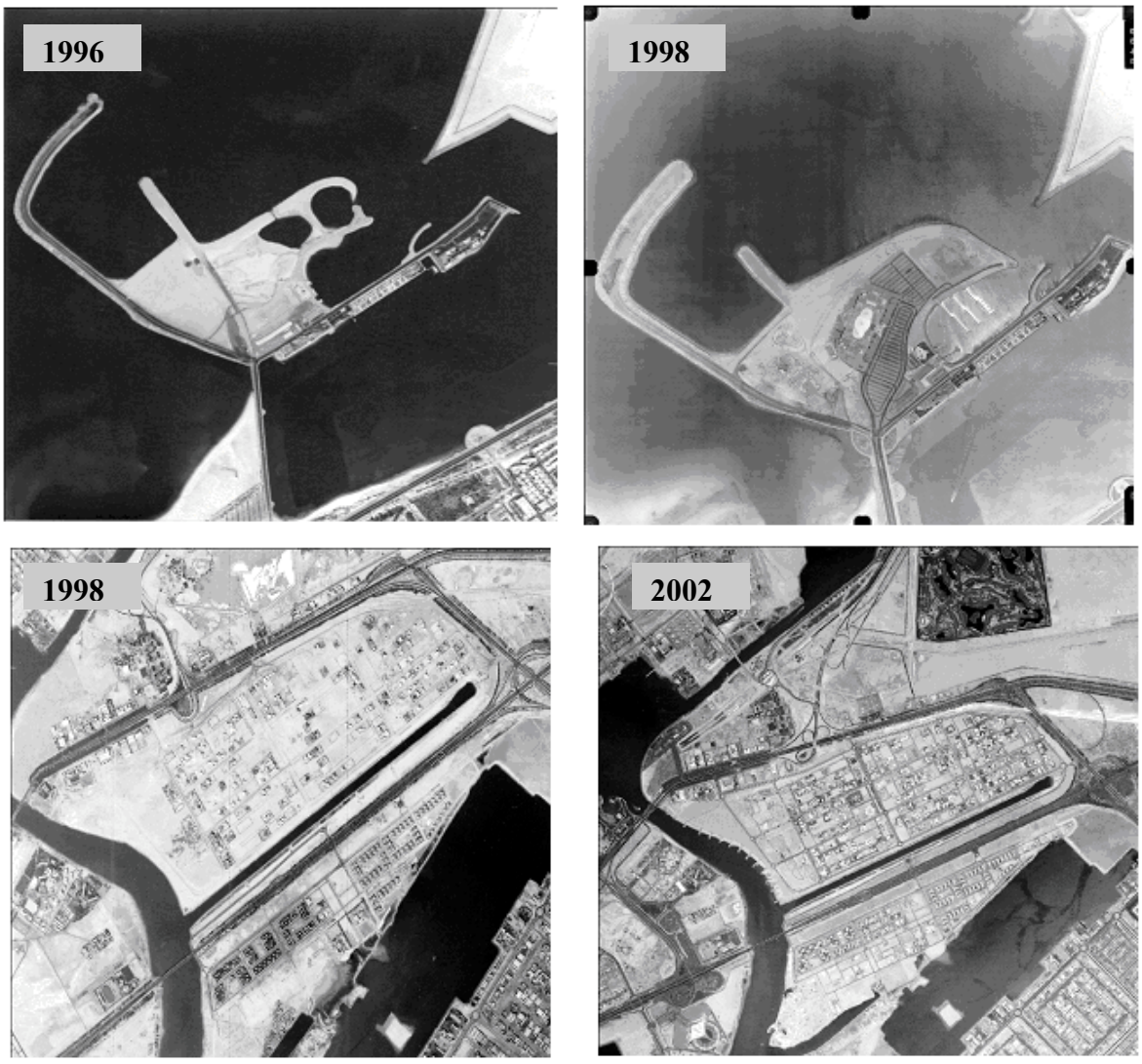

Figure 3.1
Aerial photo showing rapid physical developments in certain areas of the U.A.E
[United Arab Emirates Armed Forces (2002a)].

As part of its strategy to make the country self reliant, the U.A.E. has now shifted its focus towards the development of the industrial sector. This process has further increased economic activities. Most agencies depend on computer-based system for managing the information generated from such developmental activities. As this information mostly deals with the physical development of the country, the major data content is spatially related.

Agencies responsible for maintaining these data sets -- such as local municipalities, utilities departments, and oil companies -- have developed them independently without any inter-agency cooperation. As a result, several stand-alone systems with huge amounts of information have been generated without any possibility of sharing. This has caused a heavy strain on government budgets due to data duplication efforts. Another characteristic of these organizations is that most of them have a great deal of autonomy in their functioning. In fact, this principle was adopted to speed up the data production activity so that it could cope with the increased demand for the data required for the developmental activities. Several factors encouraged management to opt for autonomy in their organization. The important factors, as mentioned by Al-Romaithi [1994], influencing the adoption of such practices include [Al–Romaithi, 1994]:

- The sufficient availability of resources for spatial data development, without any outside agency support.
- Inconsistencies in the available data sets due to the absence of common data standards.
- Absence of metadata services informing potential users of the availability of data, its models, its formats, the point of contact, and the accessibility.

- Absence of a geospatial data-coordinating agency at the national level, to monitor the systematic development of the geospatial systems conforming to the common national standards and practices.

In recent years, however, there has been a definite change in the attitude of the geospatial data agencies in the country. Most of them realize the potential of coordinated efforts in building-up the data sets. As a result, certain initiatives are underway to explore the means of sharing and exchanging of the data that are already available. Moreover, due to advancements in the spatial data management systems, many software packages are currently available in the market that makes data format transformation more flexible. Availability of such easy-to-use data translators is also an encouraging factor

This chapter is dedicated to analyzing the current status of the geospatial data activities of the most important data producers in the country. This analysis is based on a field survey conducted by the author. The author has distributed a questionnaire (see Appendix A) to all the agencies in the United Arab Emirates involved in collecting and/or using geospatial data. The main purpose of distributing the questionnaire was to identify the organizations that are responsible of the production and the utilization of geospatial data in the United Arab Emirates.

As part of the survey, geospatial data agencies are grouped into three categories; namely government agencies (municipalities, public works departments, planning departments, transportation departments, communication departments, etc.), oil

companies, and the private companies involved in the geospatial data services. The amount of geospatial data maintained by these agencies was the basis of this grouping.

The important purpose of the survey was to define the common geospatial data sets used by the geospatial agencies in the U.A.E. The percentage of data utilization by the agencies is the main criteria in identifying the commonly used geospatial data sets. The survey concentrated mainly on the available spatial data sets and not on the attribute data.

The structure of the questionnaire is divided into two parts. The first sets of questions are framed to collect the information pertaining to the institutional, management and policy issues adopted by the agencies for geospatial data creation, maintenance, and the dissemination. The second set of questions are framed to collect the information pertaining to the technical specifications and standards adopted by these agencies in maintaining the geospatial data sets in their organization.

The author has received the information from almost 21 departments and organizations, both local and government, that are devotedly involved in geospatial data activity. The study shows that out of 21 such organization and departments, only 6 are the major data producers that are catering to the needs of the whole GIS community in the country. The names and the areas of mapping and surveying jurisdiction of the major data producing agencies are shown in Table 3.1. The remaining 15 parties are only the data users.

An explanation of the activities of the 6 data producers is divided into three sections of this chapter. Section 3.1 will examine the function and the policies related to the geospatial data activities of these six major data producers. Section 3.2 will explore the existing inter-agency coordination activities among these agencies. Section 3.3 will highlight the technical components of the geospatial data sets that are maintained by these six agencies.

Table 3.1

Data producing agencies in the country and their area of mapping and surveying jurisdictions

SN	Name	Area of Jurisdiction
1	Military Survey Department (MSD)	All of U.A.E.
2	Abu Dhabi Town Planning Department (ADTPD)	Middle and western region of Abu Dhabi emirate (About 65% of Abu Dhabi)
3	Abu Dhabi National Oil Company (ADNOC)	Abu Dhabi Emirate
4	Emirate Telecommunication Corp. (ETISALAT)	All of U.A.E.
5	Abu Dhabi Water and Electricity Authority (ADWEA)	Abu Dhabi Emirate
6	Dubai Municipality (DM)	Dubai Emirate

3.2 The Functions and policies of the Major Government Sector Data Producers

The policies framed by the major data producers for handling the geospatial data are very much localized. This is mainly due to the prevailing autonomy in their functioning. As a result, the contents, model, and structure of the data were rigidly

designed to meet the local requirements of the organization. Whenever there is any requirement for any special set of data, these are produced within in the organization to satisfy the specific needs. The geospatial data activities and the overall functioning of these agencies are explained in detail in sections 3.2.1 to 3.2.6.

3.2.1 The U.A.E. Military Survey Department

The Military Survey Department (MSD) is considered to be the largest federal mapping agency in the U.A.E. It is responsible for collecting, processing, and disseminating up-to-date topographic, aeronautical, and nautical information over all of the U.A.E. territory. It was established mainly to serve different military departments in their geospatial data activities. The U.A.E. MSD also has a wider responsibility as a mapping agency of the country and it supports various government agencies, oil companies, and other organizations. It caters to the needs of these organizations in terms of supplying them with maps, aerial photographs, geodetic control data, and technical advice.

Considering the current trends in geospatial data activities happening elsewhere in the world, the U.A.E. MSD is also shifting its focus from conventional mapping practices. As a result, several step have been taken to promote the U.A.E. NSDI activities in the country. One of the major such initiatives is the creation of a National Geodetic Network (NGN) for the U.A.E. Another important step towards the same goal is the production of countrywide digital maps and Digital Terrain Models (DTM) at various scales. Further, the U.A.E. MSD has expanded its activities to establish topographic databases for multi-purpose use, catering to the needs of the wide spectrum

of geospatial data users in the country. These databases are expected to a hold variety of data sets including ortho-photos and DTMs. The project was completed in 2003.

As a long-term objective of the U.A.E. MSD, these data will be available online for public access using Internet tools. The department would work in close cooperation with other agencies to formulate the institutional framework facilitating clear legislation and policies for such data dissemination. The U.A.E. MSD believes that data sharing and exchange, among various agencies, could be accomplished very easily within in its jurisdictions. The U.A.E. MSD proposes an incremental approach by which such processes are established at the local government levels first and then gradually established at the federal level. It is expected that this approach would minimize the cost and time of implementation.

Sources of Geospatial Data for the U.A.E. MSD

As with other mapping organizations in the country, the data source is mainly in-house. In some special cases it is obtained from the private sector. There exists cooperation between the various government agencies and the U.A.E. MSD for database updating. The U.A.E. MSD acquires certain sets of data from these agencies mainly for updating the topographic databases. Inter-agency cooperation, however, is limited to such practices only but needs to be encouraged in a wider context of common mapping projects. The geospatial data sets that are maintained by the U.A.E. MSD are listed here.

Geospatial Data sets Maintained by the U.A.E. MSD

The following data sets have been created and are maintained by the U.A.E. MSD:

- Digital topographic maps covering the entire U.A.E..
- Satellite imageries with 5 m, 10 m, and 30 m resolution for all of the U.A.E..
- Digital ortho-images for the complete U.A.E. at various scales.
- DTM with 1 m to 5 m vertical accuracy (depends on purpose) for the entire country.
- Hydrographic charts (in both digital and manual forms).
- Aeronautical charts (in both digital and manual forms).
- Geodetic control points.

3.2.2 Abu Dhabi Town Planning Department

The Abu Dhabi Town Planning Department (ADTPD) is mainly responsible for maintaining the geospatial data as well related attribute data for the Abu Dhabi area. The jurisdiction of this department covers the middle and western regions of Abu Dhabi emirate, which is about 65% of the U.A.E. [ADTPD, 2001]. The ADTPD oversees the physical development of Abu Dhabi as a capital city. It also caters to the developmental activities of the nearby cities falling under its jurisdiction. The department carries out this task within the framework of government policies and regulations. The main functions of the ADTPD could be summarized as follows:

- Determines the optimum size of the cities considering the projected growth of population and other related services.
- Prepares the preliminary studies covering economic, social, and demographic issues.
- Setup land use plans.
- Monitors the overall execution and related issues of the master plan of the city.

To execute these tasks in an organized fashion, the ADTPD is divided into seven sections; namely, Planning, Research and Study, Utility, Land Use, Buildings, Design, and Execution. The ADTPD GIS Center supports the acquisition and management of the spatial data. The Center has developed many GIS systems to handle various spatial analysis tasks. One of the systems developed by the Center makes available the spatial data online, for more than 60 users within the department. It also provides data services to various other departments and users. The data are accessed, analyzed, and managed through customized applications using MapInfo® GIS software packages.

Sources of Geospatial Data for the ADTPD

Most of the data required for the department activities are produced in-house. The spatial data pertaining to various sections that are handling different tasks are verified by the GIS Center before updating the database with these sets of data. Quite often, private parties are also involved in generating the data sets. This is mainly for preparing large scale digital topographic maps and orthoimages that are prepared from the aerial photographs collected through aerial surveys. Most of the information, spatial as well attribute, on utility networks, such as water, electricity, telecommunication, drainage and sewage, are received from the respective departments either in digitally or on physical forms. The U.A.E. MSD also supports the ADTPD with small-scale topographic data, both digitally and on physical forms, for the regional planning activities.

Such a combination of various data sets makes for a very comprehensive information base, both spatial and non-spatial, for the physical developmental activities for Abu Dhabi and its related environment. The database is regularly maintained with periodic updating.

Geospatial Data sets Maintained by the ADTPD

The ADTPD has the following data sets.

- Digital orthophoto covering the entire area of Abu Dhabi with 0.5 m resolution. These images are available in such formats such as JPEG, GEO-TIFF, etc.
- DTM data covering about 30% of the jurisdiction area of the ADTDP with 0.5 m vertical accuracy. Work is in progress for the rest of the areas.
- Digital vector planning data at 1:500, 1:1000, etc., map scales.
- Road centerline network data that are mostly captured using the aerial survey method.
- Drainage and sewerage network data, spatial and attribute. Those are available for most parts of the urban areas.
- Cadastral data, spatial as well as attribute, produced in cooperation with Abu Dhabi Municipality.
- Topographic data set. This data set is available at 1:5000 and 1:10,000 map scales. It is prepared through the photogrammetric restitution method.

3.2.3 The Abu Dhabi National Oil Company

Abu Dhabi National Oil Company (ADNOC) is a state-owned company that operates the oil and gas industries in all Abu Dhabi areas. Since its establishment, ADNOC has steadily broadened its activities through different subsidiaries. It is comprised of three oil and gas exploration and production companies; five support services companies to the petroleum industry; four joint venture companies for oil and gas processing; two chemical and petrochemical companies; two maritime transport

units for crude oil, refined products and natural gas; and a company that is responsible for the distribution of refined products in the local and regional markets [ADNOC, 2000].

As far as spatial data are concerned, the main unit responsible for its acquisition and management is the Exploration and Production Directorates (EPD) of ADNOC. Among several spatial data handling systems implemented at EPD, a computerized geological mapping system is used to store digital maps and drawings. The rest of the ADNOC Group acquires and manages spatial information through its local survey and mapping units.

Geospatial Data Sources for the ADNOC

The ADNOC maintains a huge amount of data generated from seismic surveys and related detailed information on oil fields and oil wells. Satellite imageries and aerial photographs are generated through private party contacts. The ADNOC receives digital topographic maps and geodetic control points from the U.A.E. MSD. Data sets related to settlements, new construction, and other related activities, are received from the ADTPD. Utilities information pertaining to the water and electricity networks is collected from the Abu Dhabi Water and Electricity Distribution Authority (ADWEA), while the telecommunication network data are received from the Emirates Telecommunications Corporation (ETISALAT).

Geospatial Data sets Maintained by the ADNOC

The main spatial data sets available at the ADNOC include the following:

- Digital topographic and hydrographic maps for all concession areas including the boundary lines for each subsidiary jurisdiction area. This information is available in medium and small scales.
- Digital spatial data for all oil/gas pipelines and oil/gas well positions with related attribute data. This information includes inshore and offshore concession areas.
- Digital geological maps of all concession areas with related attribute data.
- DTM data that covers different areas, of interest to ADNOC, with 1 to 5 metre accuracy.
- Large-scale digital maps, as well as detailed drawings, for the facilities in the oil fields or in the industrial complexes.

3.2.4 Emirates Telecommunications Corporation

The Emirates Telecommunications Corporation (ETISALAT) is the official telecommunications service provider for the U.A.E. with the responsibilities to operate, maintain, and develop the entire telecom network for the country. The corporation is equipped with state-of-the-art telecom technology and is considered to be one of the leading service providers in the region [Emirates Center for Strategic Studies and Research (ECSSR), 1998]

The ETISALAT maintains a huge amount of higher resolution spatial information on the entire telecom network of the country. The data set is generated and maintained by the ETISALAT Data Center (EDC). It is considered to be the first GIS user in the country. It implemented GIS technology back in the mid 1980s. Now, the EDC GIS is fully equipped with state-of-the-art GIS tools, based on ESRI© suite of products and databases [www.etisalat.co.ae].

Geospatial Data Sources for the ETISALAT

In addition to in-house spatial data productions, ETISALAT receives data from town planning departments and municipalities. All maps and as-build drawings received from these organizations are either digitized or translated into the required formats to update the database maintained by the EDC. The surveys section at the EDC is responsible for collecting information related to new installations using GPS or total stations. ETISALAT receives topographic maps from the U.A.E. MSD.

Geospatial Data sets Maintained by the ETISALAT

Most of the data produced by the ETISALAT is related to the communication services networks only. Following are the available data sets:

- All telecommunication lines and corridors with related attributes.
- The positional information of all communications towers with related attributes.
- Large-scale digital maps, as well as detailed drawings, of telecom facility installation sites.

3.2.5 Abu Dhabi Water and Electricity Authority

The government has a strategy to privatize its energy sector to meet the ever-growing demand for electricity and water. The ambitious plan is already launched with the formation of 11 companies under the Abu Dhabi Water and Electricity Authority (ADWEA) and the whole process of privatization is estimated to be completed within 10 years. The companies involved in power generation are Al Mirfa Power Company, Umm Al-Nar Power Company, Bainounah Power Company, and Al Taweelah Power Company. The distribution companies, Abu Dhabi Distribution Company (ADDC), and Al Ain Distribution Company (AADC) are responsible for the sale and distribution of water and electricity, including operations, maintenance, meter reading, and customer billing throughout the Emirate of Abu Dhabi. ADDC provides services to 200,000 customers throughout the Emirate of Abu Dhabi (excluding Al Ain), while AADC provides services to 100,000 customers throughout the eastern portion of the Emirate of Abu Dhabi (excluding Abu Dhabi City). The Abu Dhabi Company for Servicing Remote Areas, Abu Dhabi Transmission and Dispatch Company (TRANSCO), Abu Dhabi Water and Electricity Corporation, Al Wathba Central Services and Emirates CMS Power Company are the other new companies operating under the ADWEA. The transmission company TRANSCO provides the highways (by pipeline or wire) for the producers to distribute the energy. All the companies will be subsidiaries of ADWEA and will be supervised by the regulation and supervision of the Bureau for Water and Electricity [Ibrahim and Vine, 1999].

The ADWEA Enterprise GIS Project was completed in June 2002 with the primary objective of modernizing ADWEA by integrating AM/FM/GIS within the transmission and distribution companies.

Geospatial Data Sources for the ADWEA

The ADWEA maintains huge amounts of data mostly generated from large-scale maps. The data are captured from the physical drawings through private contracts. It also receives data from town planning departments and municipalities. All maps and as-built drawings received from these organizations are either digitized or translated into the required formats to update the database. The telecommunication network data are received from the ETISALAT.

Geospatial Data sets Maintained by the ADWEA

The geospatial data set pertaining to the complete network of electricity and water is generated and maintained by the ADWEA. Details of the available spatial data components are listed below.

- Electricity transmission encompasses all elements including power stations, overhead and underground transmission lines, transformers, switches, circuit breakers, etc.
- The water transmission network consists of pump stations, pipes, valves, fittings, hydrants, tanks, wells, etc.
- The electricity distribution network includes substations, underground and overhead distribution lines (primary and secondary), transformers, bus bars, switches, fuses, generators, meters, joints, service connections, etc.

- The water distribution network includes pumps, tanks, wells, reservoirs, valves, fittings, distribution lines, service points, etc.

3.2.6. Dubai Municipality

The Dubai municipality is considered to be one of the largest government organizations in the Dubai emirate. It is responsible for providing geospatial data services to the various users for mapping and surveying areas coming under its jurisdiction. The scope has further increased from a mere data provider to a GIS service provider, in the advent of e-governance activities initiated by the Dubai government. In the past the Planning and Surveying Department of the Dubai municipality took the initiative to automate its functions, and as a result a Land Information System (LIS) has been developed.

At the beginning of 2001, a GIS center was established with a wide scope and broad objectives. One of the main objectives of the center is to generate and maintain geospatial data for all the Dubai emirates, in addition to its traditional members belonging to the Dubai municipality. Other responsibilities are to provide various GIS services, digital base maps, data integrity, data availability, and technical support to all users. It also ensures that the common data standards are enforced in the development and use of geospatial data in the emirate [www.dubai-municipality.org.ae].

Geospatial Data Sources for the Dubai Municipality

Most of the spatial data are received through three main sources: private contracts, different departments in the Dubai municipality, and several utility agencies in the emirate. These various data sets are maintained and managed by the GIS center according to derived data standards and formats.

Geospatial Data sets Maintained by the Dubai Municipality

Following are the available data sets of the Dubai Municipality:

- Digital ortho-images for the entire Dubai Emirate maintained at various map scales.
- DTM data that cover most of the emirate including the urban areas.
- Topographic base map for the entire emirate maintained at 1:20,000 map scale.
- Cadastral data, both spatial and attribute.
- Transportation network, this includes road centerline.
- Planning data,
- Address data that covers most of the urban areas in the emirate.
- Utility data that includes drainage and sewerage networks.

3.3 The Functions of Non-Government Sector Data Producers.

Non-government sector, especially the commercial establishments, involvement in the geospatial data activities is very significant in the country. Public sector depends heavily on the private companies for the production of geospatial data. The trend is increasing as a result of the increased data needs that are beyond the production capacity of the respective government organizations. The companies, however, do not possess any right on data produced for the government.

Private agencies are playing another important role in the geospatial data activities; to meet the demand for detailed street maps, location services and other geo-referenced land use information. The requirement for such services is growing with the expanding importance of business developments in the country. DubaiEZguide (www.dubaiEZguide.com) maintained by Transport Hi-Tech Consultants, and UAElocator (www.uaelocator.com) by Spatial Data Integrators, are some of the examples of online geospatial data services in the U.A.E.

Moreover, private companies are the sole source of satellite imageries in the country. Government agencies fully depend on this sector to fulfill the organizational requirements for raster data.

In the U.A.E., non-government establishments, however, has no role in policymaking. The commercial licensing policy of the country does not give such provisions to these sectors. Nevertheless, the increased demand for the geo-referenced vector as well as raster data, and the value added data sets on the Internet, making the participation of private industry very vital in the over all development of the U.A.E. NSDI.

3.4 Limitations of the Current Geospatial Data Activities

Misinterpretation of autonomy and the resultant independence in functioning have led most geospatial data agencies to consider the data to be their private property, thus making it inaccessible to others. Moreover, since there is no information cost recovery system in the country, there is no substantial benefit for sharing the resources with others [Al-Romaithi, 1994]. Because of these factors, the contents, structure, and formats of the data generated by the major data producers of the U.A.E. have become inconsistent, and thus incompatible.

Regrettably, coordination among the geospatial data producers that is vital for initiating data sharing and exchange is missing even at the national level. This situation is dramatically increasing the cost of data development, as several agencies collect and maintain the same information. Similar situations are normally seen in the mapping practices of many countries. As observed by Montalvo [2001], the absence of institutional coordination with overlapping jurisdictions and poor management of resources are substantially increasing data sharing costs and delaying spatial data infrastructure implementations.

In addition to this many inadequacies exist in the practices of geospatial data producers in the country. This lack of cohesion is obstructing the smooth flow of spatial data sets. Among these shortcomings, however, the author feels that three very important factors are generally preventing the optimum use of available information.

3.4.1 Coordination

The lack of coordination is an expected outcome of the prevailing autonomy in the functioning of the major spatial data producers. As a result, no initiatives so far have been undertaken to develop common spatial data standards. In addition to this, the government is overspending its budget due to duplicate efforts in spatial data acquisition and maintenance. As a consequence of duplication, management becomes more complex because of the resultant inconsistency in the data sets [Tosta, 1995]. Moreover, as several local and federal authorities are involved in maintaining the land information, quite often, duplication in effort causes many overlapping responsibilities. Because of the absence of coordination such responsibilities are creating chaos in the geospatial data activity in the country. As noted by Al-Romaithi [1994, p. 24] '*the major problem to be faced in the U.A.E. is that, as land information development extends beyond the departmental activity into the area of federal government, the rationalization of these sectors is going to be a huge task*'.

Based on the results of the survey (see Appendix E) conducted, the author feels that the absence of coordination on geospatial activities at the national level has influenced the optimum use of the data sets as follows:

- The concept of data custodianship is not addressed properly in the country. This is required to establish an authority for the generation and maintenance of the geospatial data sets. In the absence of such a mechanism, frequently more than one agency acquires the same piece of information. The best example is the generation and maintenance of DTM data being carried out in the country. At one end, oil companies are collecting these DTM data sets through a costly exercise. On the end,

the U.A.E MSD (as the national mapping agency of the country) maintains a rich collection of DTM data for almost all areas of the country. If proper coordination existed, among the data producers at the national level, with clearly defined roles and responsibilities, such duplication of efforts would have been contained.

- The author found from the survey that 86% of the departments indicate that, though the data are available with many government agencies, they are not in a position to release the data to others due to the absence of a policy stating the right of distribution and other related issues. If proper coordination had existed, data dissemination would have been more flexible and benefited the vast majority of the geospatial data users in the country.

- The survey shows that 71% of the agencies were of the opinion that, though a huge amount of geospatial data exists in the country, it is very difficult to find the details and the availability of the data sets. This had happened because there is no proper documentation on the data sets. Creation of a national metadata content standard and the maintenance of the details of the datasets in a publicly accessible media would solve this problem. Such coordination could have lead to the creation of 'metadata content standards' similar to those produced by the American FGDC.

3.4.2 Legislation

No proper regulations exist in the country for covering issues such as copyright, licensing for distribution or reuse, data rights, legal responsibility for data quality, and access to sensitive data. The existing general copyright law (Act 40,1992), however, addresses only the issues related to the production of copies and therefore is inadequate to cover the relationship between owners and users of spatial information. There is no law suitable to tackle the versatility of data dissemination as made possible by the advent of the Internet and related technologies.

As a result, the survey shows that 90% of the data producers prevent access to their data sets, even to government agencies. The few who do allow access to their data sets prevent the acquiring party from re-distributing the data. In general, most of the data producers do not consider the data sets to be the national property. Rather they treat it as an exclusive organizational asset [Al-Romaithi, 1994].

Private parties are not even allowed to use the rich source of spatial information that is generated and maintained by government agencies. Even though there is very good commercial value for such information, in the absence of proper legislation, the government is losing a tremendous amount of revenue from this source. Moreover, as no pricing policy exists in the country, it is not possible for those government agencies that are willing to share the information to distribute the data on a commercial basis in spite of a great demand.

Therefore, because of nonexistent legislation depicting the terms and conditions for the dissemination of geospatial data, it will be difficult for the government to

implement the NSDI initiatives. Though some emirate may be making an outstanding effort to implement e-governance by making a great deal of data available on the Net for public access, the absence of proper legislation will make their initiatives chaotic.

3.4.3 Common Data Standards

With the increased number of government organizations involved in the development of geospatial data handling systems, common standards are becoming an essential tool for sharing these data sets among the agencies [Charlene and Allam, 1990]. However, no common geospatial data standards exist for the country, probably due to the absence of a coordinating body to oversee such an implementation. As a result, the survey shows that 90% of the spatial data producers have structured and modeled the data independently, without any consideration to common standards that are available for free from the mapping agencies elsewhere in the country. The situation has impeded the progress of data sharing, thus preventing cross-sector data integration for decision-making through spatial analysis.

Therefore, to resolve these issues, a strategy for developing the U.A.E. national geospatial data standard is urgently required. This standard should cover the data model, data transfer formats, data classification, data coding, accuracy, and reference system.

To some extent, it is easy to develop software suitable for translating formats, thus facilitating the cross-platform data transfers. However, the mechanism is not always wholly successful and much work needs to be done after data are transferred. Today many organizations want to exchange the definitions behind the graphic data and it cannot be resolved without a common standard [Clarke, 1995].

Despite these shortcomings, however, there are some initiatives towards this is happening at federal and local level organizations in the country. In 1982, the federal U.A.E. MSD took the first initiative and established the National Geodetic Network (NGN) as a reference system for the whole country. The U.A.E. MSD also took a lead role in standardizing the feature classification and coding system for the proposed U.A.E. NTDB.

At the local level, the Dubai Municipality is enforcing common standards for its geospatial data production. The GIS Center of the Emirate, entrusted with the authority and statutory power ensures that the data are developed according to set standards and policies. In addition, in 2000, the Environmental Research and Wildlife Development Agency (ERWDA) published a draft proposal for establishing a distributed environmental database for Abu Dhabi emirate, emphasizing the need for creating a common standard for the environmental data for public use [ERWDA, 2000].

3.5 Conclusion

The functions, geospatial data sources, and various data sets of the major geospatial data producers in the country are explained in the first half of this chapter. It was generally found that the existing autonomy in the organization is a major reason for viewing the data as an exclusive property of the agencies. As a result a lot of duplication effort is seen in geospatial data production and maintenance. The prevailing practice has been discussed in the chapter with a practical case of DTM data production, in which two federal agencies are involved. However there are certain advantages in practicing autonomy as it makes the agency self reliant in data production, thus making it more effective for organizational local needs.

The second part of the chapter highlighted the limitations that currently exist in the geospatial data activities of the country. The author feels there are three critical factors that are hampering the smooth flow of geospatial data in the country. Lack of coordination, legislations, and standards are these factors. However, some exceptions exist as in the case of Dubai emirate. It has resolved some of these issues, thus allowing more flexible data sharing and exchange between the government departments than before. The prevailing situation was analyzed based on the data collected through a survey conducted by the author, covering twenty-one organizations involved in the geospatial data activity in the country.

Chapter 4 - Conceptualization of Framework Data sets for the U.A.E.

4.1 Introduction

One of the desirable elements of the spatial data infrastructure is the information represented on the conventional base-maps or contents of most geospatial databases. In order to be qualified as an essential component of the NSDI, these data sets should be consistent, re-usable, current, complete, accurate, and provide a sufficient base for geo-referenced data sets [Lucet, 2001]. Such data sets are generally referred to as either framework, fundamental, foundation, core, or base data sets [Nichols et al., 1999].

No consistent terminology and concepts that are internationally acceptable exist to address the data sets, despite the numerous efforts at standardization. As a result, various expressions and notions prevail. In the United States, the MSC classifies these data sets as 'framework' data sets [Tosta, 1997a]. The Canadian geospatial community prefers the term 'framework data' to depict such data sets [CGDI Working Group, 2001, p 5]. In Australia, the data sets are 'fundamental' data sets and the 'core data' are considered the NTDB and cadastral database of ANZLIC [Baker, 1995]. As in Canada, the 'core data' is considered a subset of the fundamental data set. In the U.K., the NTDB, Land and Property Information, and the Socio-economic data are considered to be 'core data' and framework data are created by spatially linking these core databases [Nansen et al., 1996].

Even though there exists a variance in this issue, framework data remains as the most important component of the NSDI initiatives around the world. Therefore, the process of establishing framework data is the crucial issue in any such initiative. For this

purpose, identification of the most commonly used data sets becomes significant. In the U.A.E., this was achieved through an analysis of the results of the survey conducted by the author (see Chapter 3 and Appendix E). The procedures adopted for the purpose will be the subject of discussion in the first few sections of this Chapter. Moreover, the terminologies and concepts of framework data that are most suitable to the U.A.E. environment will be discussed here.

To qualify for the national framework, however, the most commonly used data sets should be generated using the common geo-referenced system and be in compliance with common national standards. Therefore, the remaining sections of this Chapter will be focus on these two issues.

4.2 Concepts and Definitions of Framework Data sets

Framework data sets are very specific geospatial data themes that are linked through a common geo-referencing system. Various thematic data sets, maintained by several agencies, could easily be spatially related to these data sets [Nichols, et al., 1999, p. 15]. Generally, framework data set provides a common base for representing thematic information [Lucet, 2001, p. 15, www.gsdi.org]. As a result; '*at any rate, framework data sets provide the thematic geographic framework of the country'* [Groot, 1997]. The themes that are normally used for the purpose are transportation networks, utility networks, settlements, terrain elevation, hydrography, administrative boundaries, parcel boundaries, geographic names, postal addresses, etc. [Lucet, 2001]. The features found in these data sets are key to associating external data to the real world.

Data Framework

The framework is to facilitate the availability and accessibility of the framework data sets and to provide an environment that is conducive to the creation and use of these data sets. The Framework provides content specifications, technology, procedures, and strategies for the creation of such specific data sets. Moreover, framework also provides organizational arrangements and the business practices that promote the use and the maintenance of these data sets at the national level [Lucet, 2001].

The advantage of a framework is that the existing data sets that are for local use exclusively could be made to fit into the framework by modifying its contents according to framework specifications. The process facilitates the sharing and exchange of such data sets. Therefore, the framework becomes '*a common means of information exchange and value adding*' [Lucet, 2001].

4.3 Commonly Used Geospatial Data sets in the U.A.E.

One pre-requisite of any NSDI implementation is the identification and consolidation of geospatial data themes that are commonly used by the various agencies in the country. To achieve this in the U.A.E., an extensive survey was conducted as explained in the Chapter 3. Using the survey results, most commonly used data sets were identified. The geospatial data sets along with the percentage of use are illustrated in Figure 4.1. The maximum utilization of the data sets was the selection criterion. Accordingly, the data sets with more than 50 percent of utilization were chosen as the most commonly used ones.

Providing these data sets with common spatial reference would facilitate the vertical and horizontal integration of various agency-specific thematic data sets. These data sets could further then become an essential component of the proposed NSDI model of the U.A.E. These data sets are listed with their contents in the succeeding section.

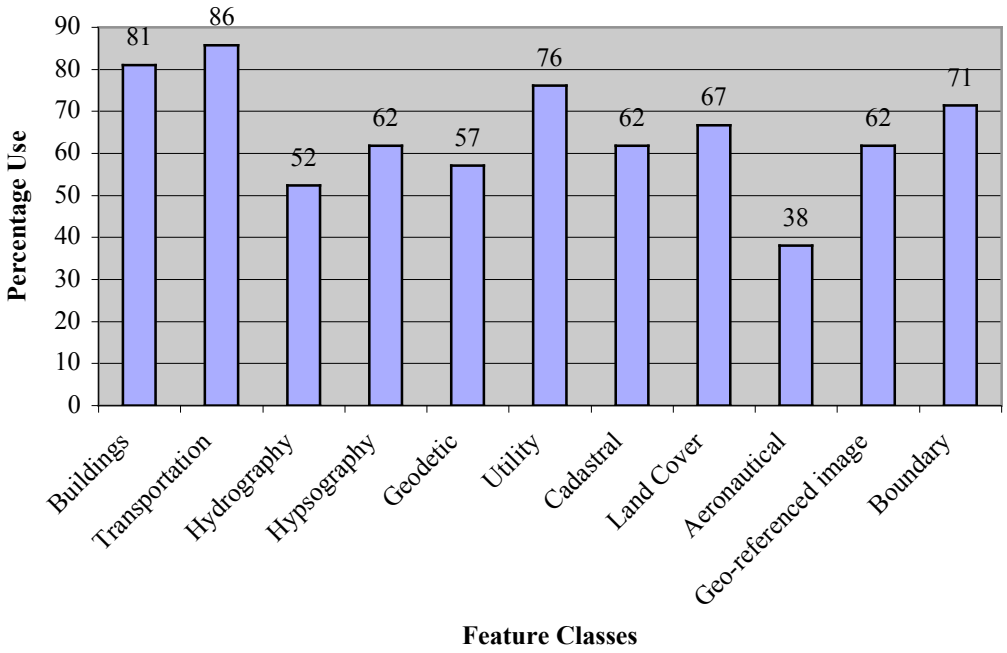

Figure 4.1

Commonly used geospatial data in the U.A.E. with its percentage of use
[Prepared by the author based on information received from the survey]

The contents of the commonly used geospatial data sets in the U.A.E. are illustrated as follows:

- Transportation: the transportation theme will include roads center lines, bridges, tunnels, culverts, and parking areas;
- Physical features includes all buildings and built up areas;

- Hydrography: the hydrographic data sets include sounding points, bottom features, coastlines, shallow water areas, water wells, streams, lakes, dams, and canals;
- Hypsography: the hypsography theme includes DTM data, spot height, contour lines, ridgelines, cliffs, faults, and valley lines;
- Geodetic: the geodetic theme includes horizontal and vertical survey control points in second and third order, benchmarks points;
- Utility: the utility theme includes electrical power lines, electric poles, telephone lines, pipelines, tanks, manholes, and service corridors;
- Cadastral: the cadastral theme includes parcels and associated boundary lines and survey corner points;
- Land cover: the land cover theme includes bare land areas, agriculture areas, natural vegetation areas, and parks;
- Boundary: the boundary theme includes international boundary lines, national boundary lines, administrative areas, and boundary points;
- Geo-referenced images: the geo-referenced images include ortho-images and satellite photos.

4.4 Framework Data sets for the U.A.E.

To qualify as framework data, the geospatial data sets that are identified as the most commonly used should be acquired and maintained within the organizational arrangements and should conform to the technical standards [Baker, 1995]. Therefore the geospatial data sets that are identified and listed in section 4.3 would form framework data set for the U.A.E, provided it is generated and maintained within the

organizational arrangements and are complies with geospatial data standards for the U.A.E.

The institutional context, within which these data sets are created and maintained, will be discussed in Chapter 5 of the report. The technical standards that are required to make these data suitable for the framework are discussed in the section 4.5.

4.5 Geospatial Data Standards for the U.A.E.

Geospatial data standards are a pre-requisite for achieving a collaborative build-up of common data sets [Masser, 1998]. Moreover, if applied effectively, the standards will smooth the efficient utilization and maintenance of the NSDI [Croswell, 2000]. Therefore, the creation and implementation of the geospatial data standards is an essential constituent of the NSDI program. The standards for metadata and the framework data content of the U.S. FGDC are widely used in such initiatives. However, to have a global reach for such standards, many international standards organizations are in the process of defining standards. Most notable among them are the ISO (International Standards Organization), for geographic information standard TC 211, and the European Committee of Standards technical committee for geographic information specifications, CEN TC 287, on GIS data in Europe [Tom, 1998].

As the national mapping agency, the U.A.E. MSD is involved in the creation of geospatial data standards that are acceptable at the national level. Towards achieving this, the U.A.E. MSD has already developed a national catalogue for geospatial data features with geo-coding and classification schemes. The features that are listed in the

catalogue will be the content of the U.A.E. national topographic database, which is under construction and expected to be completed by the end of 2003. The creation of the U.A.E. NGN is the other project the U.A.E MSD has projected to complete by the end of 2003.

It is anticipated that the standards adopted by the U.A.E. MSD for the execution of these projects, in harmony with international practices, will emerge as national geospatial standards.

Many computing standards, such as Hardware and Physical Connection Standards, Network Communication and Management Standards, Operating System Software Standards, User Interface Standards, Data Format Standards, Programming and Application Development Standards, User Define Standards, impact the implementation of the U.A.E. NSDI [Croswell, 2000]. Addressing all the above-mentioned standards is beyond the scope of this report. Only the standards that have a direct effect on the design and implementation of the U.A.E. framework data set will be addressed here.

4.5.1 The Common Geo-Reference System for the U.A.E.

The common reference system is one of the fundamental elements for the consistent and easy integration process of different geospatial data sets [Hofman, et al., 2000]. In the U.A.E., however, because of the absence of the coordinated activities, different systems are used to geo-reference the spatial data, as illustrated in Table 4.1.

The Clarke 1880 based datum is used as a common geo-reference for the spatial data of the jurisdictional area of Abu Dhabi emirate, covering 80 % of the whole of the U.A.E. The U.A.E. National Geodetic Network was also established based on the same reference. The Dubai emirate uses the WGS 84 based geo-reference system. Though this emirate is the other major geospatial data activity center of the U.A.E., it covers only 20% of the country.

Table 4.1

Most commonly used geospatial data reference systems in the U.A.E.

The Emirate	Reference Ellipsoid	Projection System	Zone	Horizontal Datum	Vertical Datum
Abu Dhabi (West and Mid Region)	Clarke 1880	UTM	39-40	Nahrwan	Ras Ghumays
Abu Dhabi (East Region)	Clarke 1880	UTM	40	Nahrwan	Ras Ghumays
Dubai	WGS 84	DLTM	40	ITRF 95	Rashid Port
Sharjah	WGS 84	UTM	40	Bp5-ITRF 93	Sharjah – TDP
Ajman	Clarke 1880	UTM	40	Nahrwan	Ras Ghumays
Al Fujairah	WGS 84	UTM	40	WGS 84	Fujairah Port
Ras Al Khaimah	Clarke 1880	UTM	40	Nahrwan	Ras Ghumays
Umm Al Quwain	NA	NA	NA	NA	NA

Since the geospatial data pertaining to 80% of the U.A.E. area is geo-referenced based on the Clarke 1880 reference ellipsoid, it could be concluded that most of the geospatial data contents listed in section 4.3, are generated and maintained based on this reference system only.

A study conducted by the survey section of Dubai municipality of the U.A.E., however, shows that the existing geodetic network based on Clarke 1880 ellipsoid is not

suitable for geo-referencing the geospatial data that requires better accuracy satisfying the needs of the majority of data users in the country [Al-Zaffin, 1997]. The study finds that the existing reference system based on Clarke 1880 gives a maximum distortion of about 9 meters, a value inappropriate for most of geospatial data applications. In search of an accurate referencing system as part of the study, Dubai municipality concluded that the International Terrestrial Reference Frame (ITRF) is best suited for establishing the geodetic framework for the U.A.E.

The ITRF is based on International Terrestrial Reference System (ITRS), established jointly by the International Earth Rotation Service (IERS) and the International Association of Geodesy (IAG), using 1980 Geodetic Reference System ellipsoid (GRS80) as the reference ellipsoid. For providing the better coverage for coordinate measurements for the ITRS, the International GPS Service for Geodynamics (IGS) maintains a network of permanent Global Positioning Satellite (GPS) tracking stations across the world. These stations can be used as reference sites for the individual countries geo-referencing framework. The ITRF is a geocentric system with accuracy of +- 5cm and ideally suited for the geospatial data accuracy requirements of wide variety of spatial data users in the U.A.E [Al-Zaffin, 1997].

Most data producers in the country, including the nodal mapping agency MSD, is planning for new control network that provides better accuracy and reliability satisfying the requirements of geographic information projects. For the purpose, the better option for the U.A.E. is the ITRF based reference system as it assures the required accuracy and reliability. Moreover, best results are already available in the country from the

experiences of establishing the ITRF based reference system for Dubai emirate. These reasons are compelling the author in recommending the ITRF based common geo-reference system for the U.A.E. The required parameters for the proposed system is as listed in the Table 4.2.

Table 4.2

Reference Ellipsoid	Projection System	Zone	Horizontal Datum	Vertical Datum
WGS 84	UTM	39-40	ITRF	Ras Ghumays

Moving to the proposed reference system, obviously, involve overheads to the agencies that are already under the mapping budget constraints. MSD, as the nodal mapping agency responsible for maintaining the national geodetic network, have to go for a challenging task of reestablishing the entire network based on the ITRF, similar to the exercise done by the Dubai emirate. The task requires field exercises that demand more resource mobilization. Subsequently existing data needs to be transformed into proposed reference systems. The transformation process, however, could be carried out using the automated procedures.

Individual agencies may have the option of preserving data for internal use, in the old reference system. They, however, have to ensure the availability of data identified from them as the framework data, in the proposed reference system.

After establishing the network, a mandate should be fixed to create all the new data based on the projected reference system. This will facilitate the availability of the complete data sets in the new reference within a given time frame. Appropriate policies need to be created to ensure the implementation of these strategies, so that all the concerned parties generate and maintain the data based on the ITRF.

4.5.2 Geospatial Data Coding and Classification

Geospatial data classification and subsequent geo-coding would facilitate an easy exchange of data across the platforms. Therefore, for promoting smooth access to huge amount of geospatial data that are already available, the '*designers and users of geospatial data should adhere to accepted coding and classification standards within their own organization, as well as standards established by government and professional groups at national and international level*' [Croswell, 2000, p. 75]. Regrettably, in the U.A.E., there is no formal geo-coding and classification system to help the users, at national level, to identify the geospatial features uniformly.

The U.A.E. MSD has initiated a project for classifying and encoding the topographic features that are identified to be included in the U.A.E. NTDB. As a result, a detailed features catalogue has been created for the country. These features, along with their codes and geometric representations, are listed in Appendix-B. A very comprehensive data dictionary, entitled 'the U.A.E. National Topographic Database – Data Dictionary', has also been developed explaining all these features with proper codes, geometric representations, and data models showing the entity relationships. Part

of the data dictionary showing the detail of a feature, as an example, is shown in Appendix – C. The author supervised the overall development of the project.

4.5.3 Geospatial Metadata

Since the framework data are gathered from different sources, maintaining the proper information about the geospatial contents, quality, models, formats, source and lineage are extremely important [Croswell, 2000]. Internationally, many organizations are involved in the implementation of metadata content, storage and maintenance standards. In the U.A.E., however, because of the absence of such data documentation, as per the survey the author conducted found that 71% of the agencies have difficulty in acquiring the details and availability of the huge amount of geospatial data sets that are maintained by the various agencies in the country. As observed by Al-Romaithi [1994], the absence of metadata is one of the factors that encouraged management to go for autonomy in the organizational functioning, thus impeding the flexible information flow in the country.

The U.A.E. MSD has taken a lead in the process, however, by developing metadata content standard for the country based on the 'Content Standard for Geospatial Metadata' developed by the U.S. FGDC. The popularity and the wide acceptance of the U.S. FGDC standards [Croswell, 2000] was the rationale behind this approach. Probably, this is the same reason many other countries also have adopted this standard for their own use.

4.5.4 Geospatial Data Format Standards for the U.A.E.

In the U.A.E., quite often geospatial data producers maintain their data in very rigid vendor-specific formats making these data unavailable to others. The potential benefit of making these data accessible to others and the availability of easy-to-use data translators is changing this attitude. Though limited at the time of writing, certain initiatives are taking place in the country to exchange data among the agencies.

There is a need for common standards for all levels of geospatial data activity. The standards need a common foundation at the local, national and international level to ensure its compatibility between different geospatial data products, services and applications. This necessitates the development of common geospatial data standards in harmony with the international best practices. The Internal Standard Organization (ISO) Technical Committee on Geographic Information/Geomatics (ISO/TC211) suite of standards is accepted by many countries, including Canada and the U.S., for defining rules and standardized schemata for the definition and description of geospatial data and its management. ISO/TC211 focus on every aspect of geomatics that defines rules for application schema, cataloguing, encoding, portrayal, etc. However, for any specific application, only a portion of the TC211 standard will be required, and it is applied through set of profiles [http://www.iso.ch/iso/en/ISOOnline.openerpage].

In Canada, CGDI Architecture Working Group (CAWG) develops national geospatial data profiles and product specifications based on ISO/TC211 suites of standards through set of profiles [http://www.geoconnections.org/english/geospatial/geospatial_standards_links.html]. Therefore, adopting such international practices for

the U.A.E. would definitely save time and effort especially in the absence of any strong initiatives for developing or implementing such standards at the national level.

By the time this approach has been initiated and has matured, the data producers should be maintaining the data sets in commonly accepted generic data formats. In the absence of national standards for the data transfer, more meaningful data translators that process spatial data independent of source and destination formats would facilitate meaningful data access and exchange. One such product available in the market is the 'Feature Manipulation Engine (FME) produced by Safe Software Inc [2001]. The conversions into the desired formats using the spatial data translators will be discussed in the chapter 6. The process would help in creating a data exchange and access culture in the country. The data exchange standards that could be encouraged for use among the data producing agencies and that are supported by many GIS software vendors are listed in Table 4.3.

Table 4.3

Vector data standards that are encouraged for use in the country data

Format	Description
IGES	Interactive Graphic Exchange Standard
ISIF	Vector graphic data exchange format developed by Intergraph Corp.
DXF	Developed by Auto Desk
DLG	Exchange of Topographic data developed by United States Geological Survey (USGS)
SHP	Shape file format of ArcView® Desktop GIS package from ESRI
GEN	Generated ASCII file of ArcInfo® GIS software of ESRI

In the case of images in raster formats, many industry standard formats are available. TIFF, JPEG, and GIF are the most popular among such standards. JPEG in particular is most commonly used to exchange and access raster images on the Internet.

4.6 Conclusion

The concept of a framework data set based on international practices and suitable to the U.A.E. environment has been addressed in the Chapter. As a requirement of the U.A.E. NSDI implementation, very commonly used geo-data sets were identified among U.A.E. users based on the maximum utilization of the data sets. In order to fit these data sets into the framework, compliance with common data standards and the geo-reference is essential.

Accordingly, a reference system was identified to act as a common geo-reference system for the country. Analysis shows that it could be achieved very easily as most of the geo-spatial data have a common base.

To smooth the process and further maintain these data sets, the framework should conform to the envisaged geospatial data standards for the U.A.E. It is expected that the entire process of framework creation that has been explained here, will put a strong foundation for the U.A.E. NSDI initiative. The institutional contexts within which the framework data sets are created and maintained, is the topic of the next Chapter.

Chapter 5 - Institutional Arrangements

5.1 Introduction

Policies on data acquisition, maintenance and distribution and the legal protection of data are paradigms within which sets of data are developed [Masser, 1998]. Intellectual property rights and the privacy of the geospatial data sets are some of the aspects covered under the legal framework. Many such policies and legal frameworks are developed by the agencies that are actively involved in the process. There is a great deal of variation in these developments [Masser, 1998], mainly because these are implemented for serving only the local needs.

To resolve this, many countries have already set up coordinating bodies at the national level. These bodies are expected to formulate the strategies for uniform policies and a legal framework to facilitate the implementation of an NSDI. One of the main objectives of such a body is to oversee the geospatial data that are produced, maintained and distributed according to the set of norms of the national framework [Baker, 1995]. ANZLIC of Australia and New Zealand [Mooney and Grant, 1997], Geoconnections of Canada [CGDI Workshop, 2001], the U.S. FGDC [Tosta, 1995], the Qatar NGSC [Al-Ghanim, 1999], etc., are some of the examples of such national level bodies set up for the purpose. Among these, the U.S. FGDC enjoys a much higher political profile [Masser, 1998, p. 37].

The absence of such a body in the U.A.E, as Al-Romaithi [1994] points out, is one of the reasons behind the prevailing autonomy in the functioning of the government organizations, thus causing the duplication of effort in the geospatial data activities. The

resultant increase in the data acquisition cost and the non-accessibility is now prompting the geospatial data community in the U.A.E, to look for coordinated efforts in such processes. Some initiatives are happening in the country for the formation of similar bodies. Therefore the main focus of this chapter is to describe the guidelines for the formation and functioning of such bodies. The coordinated efforts are expected to raise such issues as custodianship, copyright, privacy, and pricing, as many players are involved in the generation of data that are required by themselves and a wide variety of other users in the country. The issues are explained in detail in the forthcoming sections of this chapter.

The mobilization of the resources required to implement these activities remains the one crucial issue that is impeding NSDI development in many parts of the world. Compiling and enforcing uniform policies and a legal framework will put an extra burden on these agencies whose budgets are already under constraints. Therefore, the mechanisms for funding the initiative are discussed in detail in the remaining sections of the chapter.

5.2 The U.A.E National Geospatial Data Council

For any nation, an important objective of governments is to be efficient in the utilization of public assets [Tosta, 1997a]. This is achieved only through sharing all the available resources in a coordinated fashion [Al-Romaithi, 1994]. In the context of geospatial data handling, since such data are a national asset [Masser, 1998], budgetary efficiency should also be utilized. Moreover, the creation and maintenance of geospatial data is beyond the capacity of an individual organization [Tosta, 1997a]. Therefore, the

process should be a joint effort so as to satisfy the needs of the users for more accurate geospatial data sets. This necessitates the role of a coordinating body at the national level so that these data sets are generated and maintained consistently in compliance with a set of standards and on institutional framework. Therefore author propose National Geospatial Data Council for U.A.E. for the purpose. The role of the proposed U.A.E National Geospatial Data Council (U.A.E. NGDC) should be to persuade rather than command, the member agencies and related people to work as a team in a coordinated fashion [Rhind, 2000] to achieve the goal.

5.2.1 The U.A.E NGDC Structure

The main task of the coordinating body will be to promote better inter-agency relationships and to ensure that set standards and procedures are strictly followed by the participating agencies. In order to exercise these responsibilities, the committee should be entrusted with enough statutory power and freedom to function effectively. This demands a group of people, from the geospatial data producing organizations, with a decision-making capacity and with sufficient knowledge of geospatial information technologies and practices. A high-ranking official at the level of Under-Secretary with enough authority and adequate awareness of geospatial science should lead the committee. The Chairman of the proposed council being the under secretary of the government, naturally have direct access to the one of the ministers in the cabinet of the country, as per structure of the cabinet in the U.A.E. This facilitates quick and prompt approval for the committee decisions and regulations. The organization structure of the proposed geospatial data council is illustrated in Figure 5.1.

The members of the proposed council should be decision makers and leaders of geospatial data activity of their respective agencies. Some of the key data users and the private agencies involved in geospatial data activities should also be included in the committee.

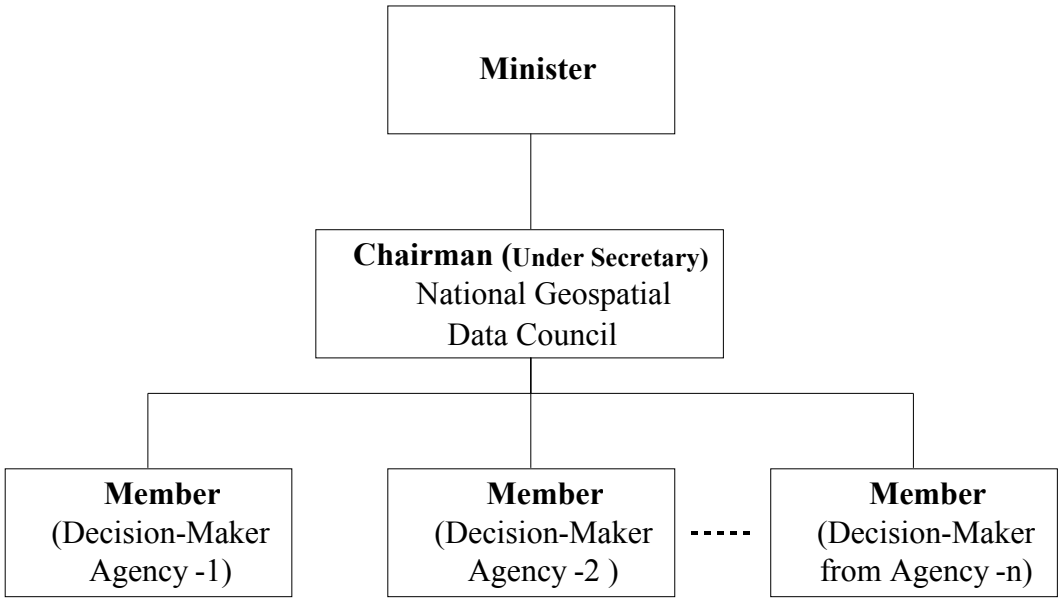

Figure 5.1
The Organizational structure of the U.A.E National Geospatial Data Council [Proposed by the author].

The U.A.E. NGDC Working Groups

The responsibilities of the proposed working group will cover the common issues of all the data categories and their respective agencies. Mainly the group will deal with policies of data dissemination, development of geospatial data standards, data accessing and availability through clearinghouses, and data archival issues. The specifications and policies regarding these issues are to be developed in concert with all the participating agencies. The working group will function under the guidelines of the council and will

provide the necessary technical support to the council. The organization structure of the proposed geospatial data working group is illustrated in Figure 5.2.

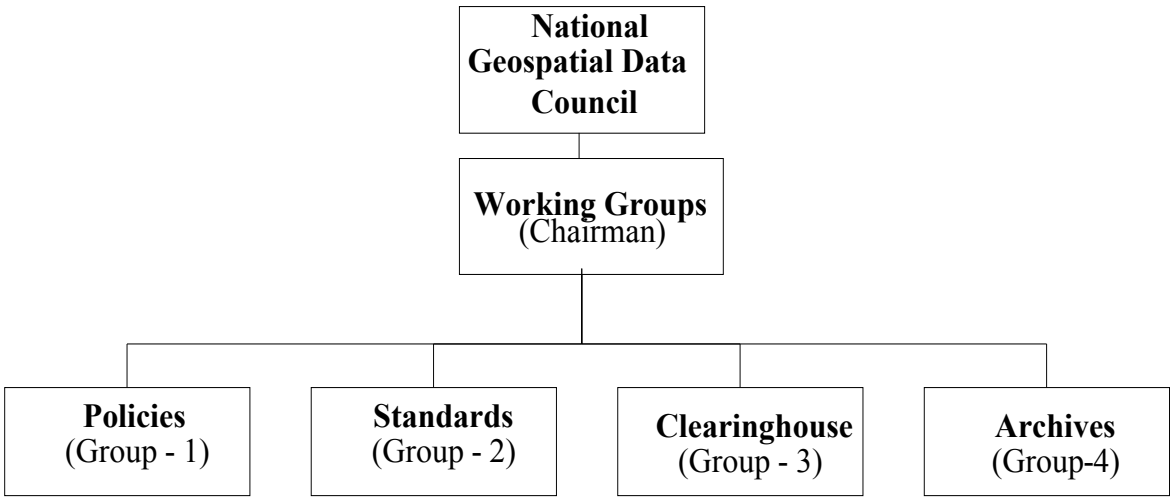

Figure 5.2
Organizational structure of Geospatial Data Working Group
(Adapted from U.S. FGDC structure [Masser, 1999]).

5.2.2 The U.A.E. NGDC Objectives

The goal of the proposed U.A.E. NGDC is to create a data framework for integrating geospatial data from a multitude of sources through a coordinated effort, to make available geographic information needed for good governance of the country. This necessitates the harmonious functioning of several agencies aimed at one goal. Therefore the objective of the council should be wider in scope in order to accommodate both the interests of the nation and the participating agencies. The objectives of the council are listed below:

- Foster the inter-agency relationships;
- Promote the development, maintenance and management of framework data sets;

- Encourage the development and the deployment of the geospatial data standards;
- Promote the development and sharing of related technology, practices and expertise;
- Encourage the development and the enforcement of polices on geospatial data dissemination.

5.2.3 Functioning of the proposed U.A.E. NGDC

The proposed geospatial data council is to be invested with both the authority and the statutory power to assume the leadership role in formulating the policies, strategies and objectives that are required to implement a geospatial data framework for the country. The council will review the Geospatial data technology, standards, guidelines, specifications, and practices developed by the working group.

Subsequently, the Council will forward the technical reports to the member agencies through the respective members of the council. The suggestions and the recommendation of the agencies are further reviewed by the council through the working group to ensure its conformity with the set goals and standards. Subsequently the chairman of the council will approach the cabinet for their approval. Since the chairman will have direct access to the cabinet, approval becomes easier and subsequently it becomes national geospatial data policies.

5.3 Data Custodians and their Roles

Most of the geospatial data producing agencies collect and maintain data to serve their specific operational needs. The quality requirements of such agencies are greater

than the needs of other users throughout all levels of government [U.S. National Research Council (NRC), 1994]. Moreover, these data sets are very effectively and efficiently managed by these organizations at their respective sites [Tosta, 1997a, p. 183].

5.3.1 The Concept of Data Custodians

The agency that collects the data serves as the best custodian of data. It is relatively easy for these agencies to expand their responsibilities to incorporate the data needs of all participating organizations [U.S. National Research Council (NRC), 1994], as the quality requirements of the latter are much less than the former.

The high quality spatial data sets that are generated and maintained by these custodians could be easily integrated to offer national coverage, provided these sets are produced in conformity with commonly accepted standards and within in the institutional framework. Therefore, the primary goal of the U.A.E. NSDI initiative will be to promote such custodianships [Tosta, 1997a].

5.3.2 Roles of Data Custodians

As custodians of the data sets, with the additional responsibility of making them available to the whole nation as a part of the framework, they should ensure following:

- The Data sets are created and maintained within the organizational context and are in compliance with geospatial data standards [Baker, 1995].

- The data sets are openly available with attributes for authorized users with complete documentation covering the accuracy, currency, quality, and definition [Al-Romaithi, 1994].
- The mechanism is provided for converting the required sets of geospatial data into standard or user specified formats [Bishr and Radwan, 2000].
- The formatted data sets should be provided online to the user using commonly accepted file transfer protocols [Bishr and Radwan, 2000].
- The protection of the data should be guaranteed as they may contain socially and politically sensitive information [Kabel, 2000].

To protect the data from misuse, regulations are required as part of the institutional framework. The custodians could benefit from delivering such services to the geospatial data community in the country. Deriving the terms of benefits for data delivery services, however, should be based on the norms of institutional contexts [Al-Romaithi, 1994], to ensure the uniformity in such practices.

5.4 Institutional Issues Governing Framework Data set Creation and Maintenance

Those geospatial data sets that have been identified as the most commonly used data sets in the country should be acquired and maintained within an organizational arrangement and should conform to technical standards [Baker, 1995]. This would qualify these sets, framework data. The process involved in such an arrangement is laid out in following 4 sections.

5.4.1 Preparing Existing Geospatial Data sets to Fit into Framework

The survey shows that there is a huge amount of geospatial data available that are currently being used by various agencies for their day-to-day operations. These data sets are generated and maintained based on standards that satisfy only the needs of each agency. Therefore, a tremendous amount of effort is required to make these data sets suitable for the framework. The process involves coordinate transformations, feature re-classifications, re-definitions, geo-code conversions, metadata creations, etc. Consequently, an enormous amount of resources is required to develop the necessary tools to facilitate such a process and the subsequent conversion of the data to meet the established specifications and standards. The initial expenditure required for converting these data sets, according to the set norms of the framework, is very substantial. As the conversion responsibility belongs to agencies, it may put a heavy financial burden on them amidst the budget constraints and related pressures from the government. Consequently, the entire process of development may be jeopardized, if agencies are made responsible for finding the resources required for the purpose.

Therefore, in order to hasten the process, the U.A.E. NGDC council will have to exercise its power to mobilize the funds required from the federal resource. Subsequently, this could be distributed among these agencies on a priority basis. Since the shortage of funds remains as the one crucial issue that is impeding the NSDI development process, the issue will be separately discussed in section 5.7.

5.4.2 Creation of New Data sets to fit into the U.A.E NGDF

The assumption here is that of a post-implementation scenario of the NSDI, wherein most of the commonly used data sets are already on the framework facilitating smooth data sharing and exchange. Under this ideal scenario, the inclusion of newly identified spatial themes into the framework does not pose much of a problem. These data sets must be compiled, archived and maintained in the digital form that permits the data to be adapted to the framework according to the set standards and procedures.

5.4.3 Updating the Framework Data

The geospatial data agency responsible for the creation of a data set may not possess enough resources for regular updates [Palmer, 1984]. Many member agencies of the U.A.E. NGDC may require that those data sets be regularly updated by this custodian. This situation may jeopardize the whole concept of making available the most current and accurate data for the use of a wider range of users. Therefore, to alleviate such a problem, as a part of the organizational context, the U.A.E. NGDC should identify those data sets that require frequent updates. Thus, the council should find ways to allocate sufficient resources for such custodians.

5.4.4 Dynamic Updating Mechanism

The process of updating the framework data requires constant monitoring backed by enough resources, to ensure the availability of the most current data. Therefore, the council should deploy a mechanism for dynamically updating the most frequently changing data sets, such as man made features containing “buildings” and other installations. In the framework context, technically it is feasible to implement such

mechanisms. For example features like “building” and other man made installations are frequently constructed in the urban area of the U.A.E as illustrated in Figure 3.1. No such construction can be are carried out in the country without the prior approval of the concerned authority, which in this case, is the public work departments of the respective municipalities.

There should be a system in the concerned departments to instruct the users or contractors to submit digital copies, in a specified format, of the design and as-built drawings of the proposed construction. Through a strictly controlled and enforced regulation, the submission of the digital copies of the drawings becomes the pre-requisite for the approval.

The digital data received from the contractors should meet the set standards and specifications after an on-site verification for accuracy. These data sets could then be used to update the respective framework data sets. Since 80% of all updates normally happen on these types of features, the author feels that the implementation of such a system will save a tremendous amount of resources.

5.5 Criteria for Geospatial Data sets to be Part of Framework

There are no restrictions on bringing any useful geospatial data sets into the framework. In order to qualify, however, these data sets and the custodians should abide by certain criteria as listed below:

- The custodians responsible for the creation and maintenance of these data sets should become members of the U.A.E. NGDC. This is to ensure uniformity in the geospatial data activity in the country.
- Any geospatial data agencies that are responsible for potentially useful geospatial data creation and maintenance should become the members of the U.A.E NGDC.
- The data sets must be acquired, stored, and maintained in digital format according to set standards and specifications.
- Metadata descriptions should accompany the data sets with proper details of accuracy, consistency, completeness, and correctness.
- Data sets should be available in the standard formats defined by the framework.
- Data sets should be easily accessible through commonly available tools such as the Internet.

The process of inclusion of geospatial data set as part of the framework is illustrated in Figure 5.3. The whole strategy is to facilitate the widespread use of the data sets and the integration of the various thematic data sets by providing a common spatial reference [Nichols et al., 1999]. The agencies participating in the process, however, are free to keep the data in the formats that satisfy their internal needs.

5.6 Institutional Contexts for Geospatial Data Dissemination

The availability of sophisticated geospatial information technology has increased the demand for high-quality spatial data [Masser, 1998]. The creation of such geospatial data sets, however, is beyond the capacity of most of the data users [Tosta, 1997a]. As a result, these organizations depend on outside sources for their data. In some cases,

because of budgetary constraints, the data producing agencies are forced to function in a profit-making way [Masser, 1998], rather than as a government-funded service provider. The interdependencies and the partnerships among the various agencies, can lead to several issues such as data custodianship, pricing and cost recovery, and regulations and legalities covering copyright and the protection of individual privacy. In many countries, such issues have created chaos in the geospatial data dissemination environment with conflicting policies and regulations [Tosta, 1995].

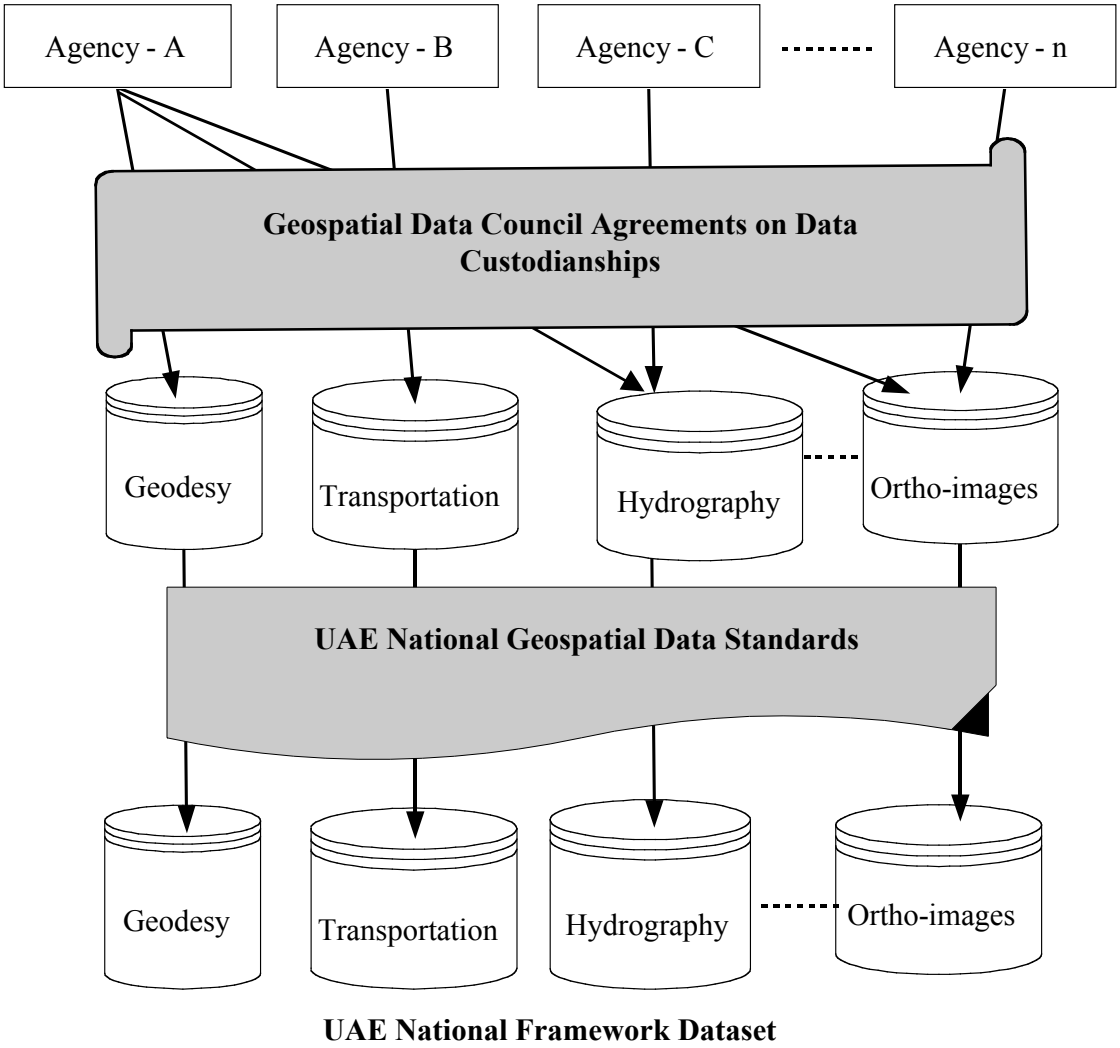

Figure 5.3
Qualifying criteria for geospatial data sets to be part of the U.A.E. NGDF.

In the U.A.E, so far there are no regulations to cover these issues except the general copyright law [Al-Romaithi, 1994], which only prevents the duplication of digital information. The absence of any policies that could have resulted in conflicts has made things easier for U.A.E. Thus time and effort has been saved that otherwise would have been wasted on resolving such clashes. As a result of the strong e-governance initiatives in some of the emirates, however, such laws are being framed to deal with data dissemination to the public. It is anticipated that the localized approach may put the U.A.E in a similar situation. Therefore, there is an urgent need to fill the legislation gap [Al-Romaithi, 1994] that exists in the country.

5.6.1 Pricing and Cost Recovery

Since the early 1990s, the U.A.E. government has been trying to reduce expenditures in all sectors of development [Al-Romaithi, 1994] including geospatial data, thus forcing the geospatial data agencies, like many other agencies, to operate on a commercial basis [Masser, 1998]. Thus, the data acquired and maintained by government agencies are treated as saleable commodities [Al-Romaithi, 1994] and the agencies therefore, are expected to recover their costs. In the absence of any cost recovery system available in the country, however, it would be better to adopt the best practice available elsewhere in the world for this purpose, and thus save an enormous amount in time, money, and effort.

There is still a problem, however, because there is no standard practice available for marketing geospatial data and its services [Masser, 1998] in any country. In the United States, according to the prevailing law, the public is entitled to receive

information, maintained by federal agencies, at a reasonable price that covers only the data distribution costs [Tosta, 1995]. On the other hand, a recent survey in the US, has shown that many states are amending the existing "open record law" to provide for the commercialization of geospatial data services [Masser, 1998], with total cost recovery. In the U.K., for certain sets of data, maximum cost recovery is expected [Masser, 1998]. Up until the CHEST Agreement was introduced in the UK, many spatial datasets were too expensive for educational use. Therefore, in these countries affordability remains a major impediment for public access to geospatial data sets [Hookham, 1995].

For the U.A.E, because of the absence of any pricing policy and the need for one as a result of a forced shift towards commercialization of mapping practices '*it is the right environment to promote an information pricing policy*' [Al-Romaithi, 1994, p. 84]. In some emirates, however, as a result of the vigorous e-governance initiatives for delivering and marketing geospatial data services, policies are being created to serve the local needs. This may encourage other agencies also to go for such independent policies. Therefore, it is felt that the absence of any national initiatives for a common pricing policy, may create irregular practices in marketing the geospatial data and its services.

5.6.2 Cost Recovery Guidelines for the U.A.E

The geospatial data that are maintained by the custodians, for the purpose of fixing a cost strategy, could be classified as follows:

- Politically and socially sensitive data, which should not be made available to any agencies.

- Data that are exclusively used by the government agencies, members of the proposed geospatial data council, for their day-to-day functioning.
- Data used by the general public.
- Data required by the private agencies for value adding and re-selling.
- Data required for research and academic activities concerning the country.

Developing a generic model for a market-oriented approach for all those categories of data is beyond the scope of this report. Therefore, a general guideline only will be addressed here. The U.S. OMB [1993] circular is taken as the base framing a general guideline. It states that the charges for data should be fixed at a cost recovery level and no higher. However, as per the data categorization listed above, this may not sufficient for the commercial use of the data by private companies. Therefore a maximum cost recovery system, based on fixed charges, is required to cover these classes of users. The guidelines for fixing the charges for the data services for all those category of data users are listed below:

- Data that are classified as sensitive should be treated as the exclusive property of the concerned government departments and, in general will not be made available to any other agency, even if they belong to the geospatial data council. Therefore no cost recovery system will be applicable here.
- The member agencies of the council who are responsible for maintaining various data sets are to be allowed to use the data sets maintained by other member agencies free of charge. This is an acceptable proposition because the part of data sets maintained by those member agencies were previously have been maintained by a number of agencies through duplicate efforts. The proposed concepts has

made only one agency responsible for acquiring and maintaining a given set of data, and share the required data sets from the respective council members. The process would considerably reduce the cost of data generation, thus justify the free delivery of the data sets among the member agencies.

- The public who access the data to receive public services are entitled to do so, at a minimum cost that covers only the expenses of the process. The data accessed by this class of users is controlled through password-protected entry. Moreover, not all data are made visible to these users. Access is controlled through the display of only a subschema of the whole database.
- Data that are accessed for any commercial purpose by any class of users should be available on a maximum cost recovery basis. In addition, a minimum percentage of royalty fees should be levied on these users, for the reproduction of any data to be used for a commercial purpose.
- The educational and the research institutions involved in the development of the nation should be encouraged to use the data free of charge. The only condition would be that not all data would be available to these classes of users. Again only a subschema of all the data would be displayed to this group. Groups involved in critical research pertaining to the country, however, should get access to all the sets of data without any restrictions. Each such case should be treated separately.

The objective of any such initiatives should be economy based to provide a return on investment through the preparation and exploitation of geospatial data. The U.A.E. NGDC is entrusted with the power and authority to periodically review the cost recovery system and to make any necessary amendments.

5.6.3 Legal Protection for Geospatial Data

Geospatial data that carry a fiscal value and vital information on national assets and their beneficiaries need to be protected from unauthorized access and secondary use by others. Without a protective framework, deployment of such data sets could lead to dangerous situations, including the loss of investment, as the data are exploited or misused [Kabel, 2000]. Different countries have adopted various mechanisms to address the issue of the protection of data. Such mechanisms, however, do not adequately protect data dissemination made possible by the advent of the Internet and related technologies.

In Britain, the Copyright, Designs and Patents Act of 1988 fundamentally determines the protection of geographic information by law [Data Protection Registrar, 1993]. Britain's stand on copyright, however, is much tougher than most of the other countries [Masser, 1998].

In the U.S., although the Copyright Act [1980] covers intellectual property rights on digital databases, the scope and practically of it is being questioned. The law came under scrutiny by a verdict of the Supreme Court in a legal fight benefiting a private user. As a result of this, there is a growing reservation about the existing copyright law concerning the protection of digital databases. This law requires a number of amendments before it provides adequate protection [Masser, 1998].

5.6.4 Copyright

Prevailing copyright laws, in general, protect only the intellectual accomplishments and not the fiscal investments made by the organizations. Legally,

copyright is not applicable to facts and therefore geospatial databases are not covered under copyright as the data sets containing mostly facts [Kabel, 2000]. Consequently, in many countries duplication of entire geospatial data sets, without organizing features, is not considered as an illegal practice. It becomes an intellectual activity, and hence comes under copyright protection, only when these facts are organized in the database [Kabel, 2000].

Despite these inadequacies, copyright is still used in many countries to protect the intellectual rights of digital geospatial information owners [Masser, 1998]. This is the case in the U.A.E also where no proper regulations exist except the general copyright law [Act 40, 1992]. This law addresses only the issues related to data duplication. As a result, the survey shows that 90% of the data producers prevent access to their data sets, even by the government agencies. In addition to this, despite the commercial benefits, private parties are not allowed to use the rich source of available spatial information.

A shift in approach is therefore required from conventional to more sophisticated procedures, for controlling the flow of geospatial data. This is especially so with the easy and flexible availability of data [Branscomb, 1995] on public domain Internet servers.

5.6.5 Guidelines for Amending Existing Copyright Law in the U.A.E

Geospatial data producing agencies possess certain rights in the “facts” contained in their database and in their efforts invested in collecting these “facts” [Kabel, 2000]. The existing law is not adequate to cover these rights. Therefore, the law needs to be

amended with sufficient clauses to cover the proper definitions for the database and its contents, the rights of the data producers, access rights for the users for different types of uses including commercial.

A database has been better defined by the European Commission through a Directive on the protection of databases that is sufficient to bring databases under the protection of the copyright law. According to the directive a database is '*a collection of independent works, data or other materials arranged in a systematic or methodical way and individually accessible by electronic or other means'* [European Commission (EC) Directive, 1996]. Though it is framed for generic databases, it is applicable to geospatial databases as both have the same constituents. The current day database technology stores the geospatial data contents, including the reference information and its geographic shape, as an item in a field of the database. In effect, the database content is organized and accessed in a similar way in both databases. Therefore, as per the definitions of the Directive, the creation and maintenance of geospatial databases becomes an intellectual activity as the facts are well organized in it and hence comes under copyright protection.

The European Commission covers the right of the database producer as follows:

> '*a right for the maker of a database which shows that there has been qualitatively and/or quantitatively a substantial interest in either the obtaining, verification or presentation of the contents to prevent extraction and/or re-utilization of the whole or of a substantial part, evaluated qualitatively and/or quantitatively, of the contents of the database*' [EC Directive, 1996].

One of the drawbacks of the clause is that the information flow will no longer remain open and there is no provision to prevent the geospatial data producer from claiming the extraction right [Kabel, 2000].

5.6.6 Data Privacy

Protection of geospatial data related to individuals is another crucial issue that needs to be tackled as part of the institutional arrangements. This is especially important in the case of cadastral data and its related ownership information. The data set is identified as part of the framework data set and it is proposed that it be made available for easy access. The issues covering data privacy refer to transparency and security of data processing, limitations on data collections, utilization and leakage of personal data, rights to data content, informing the individual about the process, and the right to make corrections [Kabel, 2000].

5.6.7 Guideline for Data Privacy Policy for the U.A.E

To address the data privacy issue, different countries have taken various approaches. Under the British Data Protection Act, individual users are required to register their purpose and be faithful to the law of data providers to guarantee that the data are purchased and used for only the declared purpose [Data Protection Registrar, 1993]. This is to guarantee that personal data are accessed, treated and utilized in a legal way by specifying the purpose in advance. Similarly, the Dutch Personal Record Act spells out how data related to individuals can be accessed and used to protect it from abuse. In the U.S. the Privacy Act prevents the use of personal records for an unspecified purpose without the prior consent of the individuals [Masser, 1998].

Moreover, in the E.U., any countries that exchange personal data with any of its members are instructed to abide by the European standards for the protection of personal data [Kabel, 2000]. The effectiveness of such legislations, however, is widely questioned [Masser, 1998].

In general, if personal data are collected without the prior consent of the individuals, the data producing agencies must inform the individuals about the proposed use with full details of the people involved in the data collection [Kabel, 2000].

In framing geospatial data policy for U.A.E., best practices in the field around the world would be taken as additional guidelines. The Canadian exercises on such issues would be particularly interesting. In Canada, a study was constituted for modifying the existing data policies and practices. The study was lead by GeoConnections with fieldwork conducted by KPMG Consulting Inc. and a group of professional associates [Geospatial Data Policy Action Plan, 2001].

5.7 Funding the Development and Maintenance of the Data Framework

Implementing an NSDI involves overhead costs and expenditures that have yet to be analyzed and quantified. As Rhind [2000, p. 41] has commented, "we have no real idea how much value related activities currently cost, how much more funding might be needed or what improvements are desirable – at least in any form of business case".

5.7.1 Funding Overheads

An analysis of the overall process involved in the development of the NSDI shows that the following are activities for which funding needs to be assessed and sources identified [Rhind, 2000]:

- Data development and maintenance cost of the framework.
- Physical infrastructure development cost including related hardware and software.
- Human resources development cost.
- Central coordination maintenance cost.

In order to frame a better proposition for the U.A.E with regards to the resource estimates that are required for the overall development, maintenance and availability of the framework data set, the following categories of activities are identified by the author, for which funding needs to be mobilized at the federal level:

- Establishment and maintenance of Framework Data Service Center:

  A centralized data service center responsible for maintaining the access mechanism for the identified components of the framework data sets are required for the U.A.E. This is similar to a clearinghouse node of the U.S. FGDC. Funds are required to develop the technology, the related infrastructure, and their maintenance.

- Establishment and maintenance of proposed geospatial data council and working groups:

  The cost involved in the development and maintaining of the Geospatial Data Policies, Standards and Specifications of the proposed framework are the major

over-head incurred here. In addition to this, the costs required for the maintenance of the administrative procedures are the other overhead, which is minimal compared to other expenses.

- Geospatial Data Transformation and maintenance:

  In order to make fundamental data set available to the geospatial data community it has to undergo transformation, to make it comply with national standards and specifications. Amount required for the process is going to be significant compare to other overheads. It is assumed here that, the new data will be captured based on the set procedures, standards and specifications.

- Human resources development cost;

  Training new staff and continuous professional development of existing staff through professional trainings, seminars, conferences etc.

5.7.2 Guidelines for Expenditure Analysis

To frame a reasonable guideline for estimating the probable costs involved in the overall development of the NGDF, certain case studies can be used. It is estimated that approximately US$ 5 to US$ 6 billion per annum are required to create and maintain the American SDI. The basis of this estimation was the total annual expenditure that is required to create and maintain the geospatial data in the U.S. As per the U.S. OMB, the federal government spends approximately US$ 4 billion per annum for the purpose. Compared to this figure, the NSDI development cost is not that significant. By the government preventing duplication of effort in data collection and related activities huge savings can be made. For the U.K. it is estimated that around US$ 2 billion is required

for U.K. NTDB development. However, the direct expenditure on the U.K. NSDI work is estimated as only 0.2% of the total amount required for the creation and maintenance of U.K. NTDB. While in the case of development of the U.S. NSDI, it is only around 0.15% of the total expenditure required for the creation of and maintenance of the geospatial data sets required for the U.S [Rhind, 2000].

In the absence of such figures, estimating the overall NSDI development cost for the U.A.E will be difficult. The above-mentioned figures, therefore, could be used as a guideline for the U.A.E. in framing the cost involved in the U.A.E. NGDF development.

5.7.3 Business Cases to Convince the Authority for Funds

Like any other country, in U.A.E. also funds required for such activities are coming only from federal sources. As a result of budget constraints on government expenditures, it is becoming a daunting task for many organizations to survive. Until it can be proven that there will be real cost benefits to any new development, the government will be reluctant to mobilize the required funds. Therefore, it is obligatory for the geospatial data producers to substantiate the benefits that can be generated from implementing and maintaining the NSDI [Rhind, 2000].

As a result, there is an urgent need to create formal business plans for a venture that will generate profits. Unless this is done, existing achievements may not be sustained a lot, despite the presence of influential personalities, who act as prime movers for such initiatives. Such individuals, however, may move on and it is unlikely that their replacements can maintain the same eagerness [Rhind, 2000]. This is very much true in

the case of the U.S., U.K. and Qatar. Despite having very influencing personalities, like the secretary of the U.S. department for the interior or the U.K. government minister for OS, no substantial achievement has so far been made.

5.8 Conclusion

The foremost requirement is a council that oversees the development and maintenance of any national level infrastructure, such as a geospatial data framework. Guidelines for the formation, structure, and functioning of the geospatial data council were discussed in the initial part of this chapter. The role of the council was identified as one of persuading not commanding, a team spirit among the member agencies. As many players are involved, institutional arrangements for harmonious coexistent are required. Strategies for the development of such rules and regulations were clearly explained with respect to international practices.

As NSDI initiatives are coming under economic scrutiny, mechanisms for cost recovery are necessary. The development of such system at the local level is happening because of vigorous e-governance initiatives in certain emirates. It is possible that irregular practices will prevail in the country in marketing the geospatial data and its services, similar to what has happened elsewhere in the world. Therefore, it is essential that controls, standards, and a framework of policies be configured at the national level.

Generating funds for the creation of any new development is becoming difficult for many government organizations as a result of the deficit in public funds. Under these circumstances, it may not be possible to mobilize any additional funds for any

development until the cost benefits of such a process can be demonstrated to the government. Therefore, the demands for formal business plans are increasing for such initiatives.

Institutional arrangements are the foremost requirements without which it will not be possible, for the U.A.E, to implement the NSDI. Though some emirates are making outstanding efforts to implement such localized systems the absence of national coordination will make such initiatives chaotic. As a result of this, with the passage of time, conflicts may prevail in the standards and regulations, pushing the U.A.E into more complex and critical situations than now.

Chapter 6 - Data Discovery, Visualization and Access

6.1 Introduction

'The pressing challenge is not how to collect and store data, nor how to write the most efficient mathematical algorithms, rather it is how to make information known, easily accessible, and understandable to the largest possible groups of stakeholders' [Bishr and Radwan, 2000, p. 135]. A better strategy is to "advertise" the availability of these data sets in a common format with proper documentation describing the quality and the characteristics of the data, facilitating easy "discovery" and access using common Internet tools [Tosta, 1997a]. The resultant increased availability of the data would encourage organizations to utilize the available resources for more productive "cross-organizational" geospatial data analysis and operations than laborious data creation efforts [Lucet, 2001].

Although the goal of such processes is the same, the whole mechanism of geospatial data discovery and access is denoted differently by various NSDI initiatives. The term "Catalogue Services" are used by the Open GIS Consortium; the Australian SDI initiatives refer to it as "Spatial Data Directory"; while the U.S. FGDC addresses it as "Clearinghouse" [Nebert, 2001]. Such a service remains as one of the key ingredients of the NSDI initiatives in any country, and is more technically challenging than political, compared to any other component of the NSDI [Masser, 1998]. Hence, this chapter will deal with the technicalities involved in the development of such initiatives. Based on this, feasible guidelines for implementing such services for the U.A.E. will also be discussed in this chapter.

The absence of any tangible initiatives for implementing an NSDI in the country remains a challenge for mobilizing enough resources for the purpose. Therefore, certain easy-to-implement and economically feasible solutions are required to demonstrate the potential benefits of data exchange and sharing. As a beginning, with the availability of a better and cost-effective Internet infrastructure in the country that offers a highly secured and fast data access mechanism, data producing agencies are encouraged to advertise the details of available data. The resultant increased availability of data would increase the demand for better transfer methods for accessing the rich content of spatial information

In the absence of national standards for the data transfer, this process necessitates more complicated topological and attributes mapping tools than those normally supplied by the GIS software vendors. Thus, the author would persuade the geospatial data agencies to deploy more meaningful data translators that process spatial data independent of source and destination formats. This would facilitate meaningful data access and exchange. The mechanisms for advertising the data and possible conversions into the desired formats using spatial data translators will be discussed in the remaining sections of this chapter. These are proposed only as makeshift arrangements until the U.A.E. spatial data transfer standards and the U.A.E. NGDC are in place.

6.2 Methods of Data Discovery, Visualization, and Access

Metadata, the Internet, and the distributed search tools are the three major components that facilitate the discovery, evaluation, and downloading of framework data sets [Tosta, 1995]. The mechanism commonly adopted for the purpose is similar to

a library catalogue system. In such a system, the characteristics of the geospatial data sets available in an organization, including the contact information, are catalogued in a database. The information can then be easily discovered by using a database search application. The difference with spatial data sets, compared to the conventional query and search, is the simple spatial queries. In the complete setup, however, data sets are not stored in the database. The results of a query by a user are URL addresses pointing to the online services of the data provider. Using the locator, the user further accesses the data sets for any necessary download. Wherever online availability of data is lacking, other related contact information is provided in the metadata to assist the user in offline transactions of the required data sets.

The most popular among this type of services are the National Geospatial Data Clearinghouse (NGDCH) provided by the U.S. FGDC [Tosta, 1995], as part of the American NSDI initiative. The clearinghouse server functions as an arbitrator between geospatial data providers and users in the country, holding the interface to many metadata databases that are scattered around the U.S. and other parts of the world. Most users of the geospatial data are currently using the clearinghouse as a window to discover the data set maintained by the U.S. federal and state government geospatial data servicing agencies [Plewe, 1997].

6.2.1 Query and Search Mechanism

To initiate a search or query, the user sends the desired area of spatial extents or the name of the area to the clearinghouse server. The server forwards the query to the registered database servers using standard Internet protocol. Each registered node, which

belongs to the various data producing agencies of the country, compares the query against the metadata contents of the respective databases and returns the matching results to the clearinghouse. Subsequently this is gathered and formatted at the clearinghouse server and a list containing mostly the locator information is sent to the user. The entire process of query and search mechanism is illustrated in Figure 6.1.

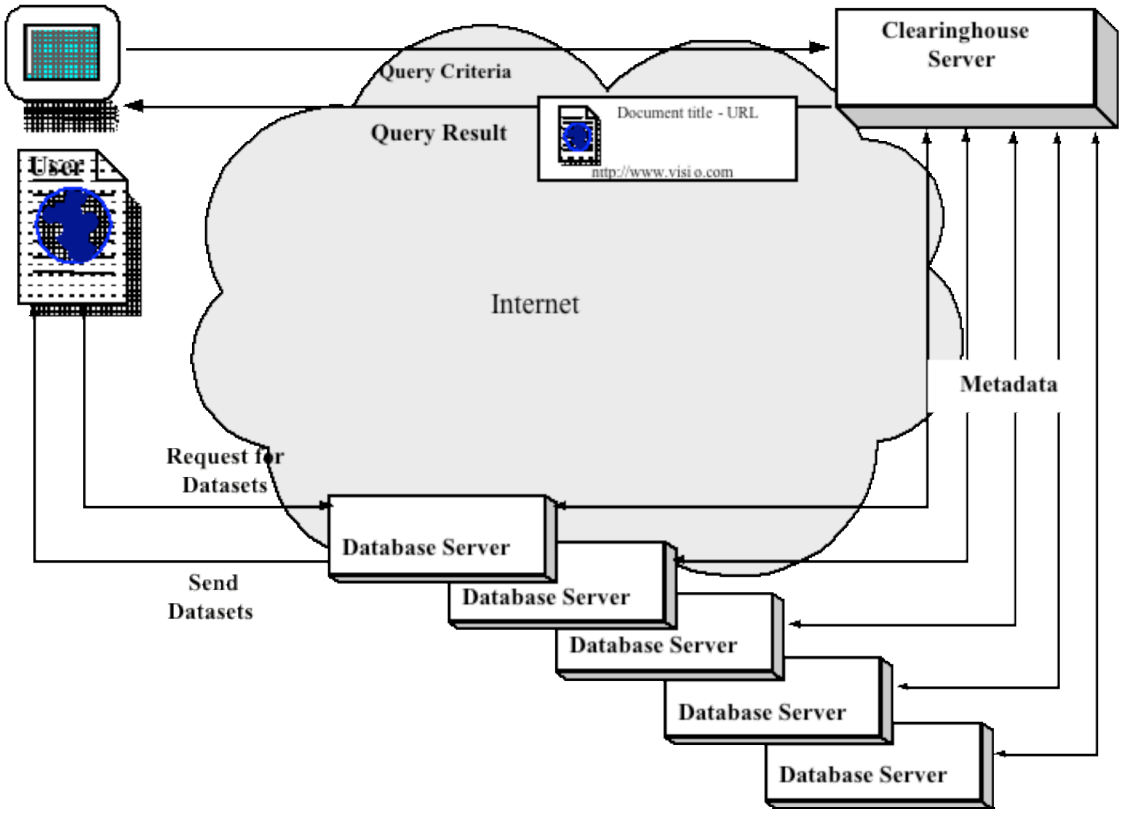

Figure 6.1
Concept of clearinghouse for accessing the geospatial datasets through metadata (adapted from Plewe [1997] and Bishr and Radwan [2000]).

6.2.2 Dynamic Map Browser

Today more advanced searching tools have been incorporated into the clearinghouse nodes allowing the user to enter spatial queries in a more perceptive manner. This allows the user to narrow the search by drawing an area on the

dynamically displayed footprint of the map, thus facilitating access to more accurate and specific details of the data. Advanced Java-based interfaces are currently available for making such facilities in the map-based server [Plewe, 1997].

6.3 Guidelines for Data Catalogue Services for the U.A.E.

One of the responsibilities of the working group, coming under the directives of the proposed council, is to supervise the development of data catalogue services such as a clearinghouse for the U.A.E. Therefore the ideal location for the development and maintenance of such a service is the council headquarters. The working group, in consultation with all the participating agencies, will develop the specifications and the policies regarding the service and will closely monitor the ongoing developments and maintenance. This necessitates a service center for this purpose.

6.3.1 Geospatial Data Clearinghouse Service Center

The geospatial Data Clearinghouse Service Center should be formed under the direct control of the working group responsible for the purpose. The Center should provide all the required services to the geospatial data community in general and the member agencies in particular. The center will maintain the server, and related software and hardware, in addition to the other assigned developmental activities.

The clearinghouse server will be an arbitrator between the geospatial data producers and the users. The server will be entrusted with two main functions; namely searching the global metadata, and supplying the user with the URL of the metadata

services. Therefore, the server should provide the following functions for easy discovery of the data sets requested by the users [Bishr, Radwan, 2000]:

- Necessary tools for the geospatial data producers, for registering the metadata and further maintaining it on the server. Since the operation needs additions and updating, all such access is to be controlled through the user name and password.
- Graphic User Interface (GUI) for normal queries to receive query parameters from the users.
- Query processing tools to search the global metadata server or the other registered data sets with the clearinghouse.
- Collating and formatting tools for processing the matching results containing mostly the locator information, and sending them to the user.

The process of developing and maintaining the geospatial data clearinghouse is only a technical challenge. It could be easily developed with minimal cost, as there are enough technical details available from the many countries considered to be leaders in this field. To begin with, federal data producing agencies could take the initiative and as a first step, document the characteristics of the data according to the metadata content standard. Moreover, wherever possible, the agencies could participate in exchanging the data in the desirable formats, as all these details are clearly defined in the metadata, and this would initiate such practices in the country.

There are institutional issues with regard to the financing and other related logistics needed for a centralized system. Resolving these issues is difficult in the absence of a coordinating council at the national level. Considering this scenario, the

author would like to propose some easy-to-implement solutions to begin with, as a start for the wider initiative. The idea behind this strategy is to make the decision-makers aware of the great potential of an integrated approach in geospatial data sharing and exchange. The details of such an arrangement are explained in the section 6.4.

6.4 Easy-to-Implement Solutions for the U.A.E.

For many years, the U.A.E. has been vigorously involved in geospatial data activities and, as a result, huge amounts of geospatial data exist in the country. These rich sources of information were considered to be the exclusive property of the agencies due to the autonomy in the functioning of these agencies. Consequently, the data become inconsistent, impeding their exchange and sharing, and hence they become useless for others.

Interestingly, most of these data sets are generated and managed by standard GIS management software that supports industry standard formats, facilitating its easy access and exchange among the various users. Moreover, the U.A.E. possesses a very efficient data communication infrastructure, which supports secured and large bandwidth data transfers across the continents. The telecom services of the country offers up to 100 MB secured transfer rates with very economic tariffs to government as well as to private agencies in the country (www.etisalat.net.ae). Moreover, the telecom services offer hosting services for geospatial data with higher transfer rates. This shows that the country offers a very congenial environment for any geospatial data agencies, for advertising their geospatial data sets. Accordingly, the author would encourage the agencies to start developing catalogue services for making the data transparent to user,

thereby increasing their accessibility and further dissemination by making use of the excellent telecommunication and Internet infrastructure in the country.

6.4.1 Agency Specific Geospatial Data Catalogue Services

The prerequisite to a data catalogue service is the complete documentation of the characteristics of the available geospatial data sets according to the metadata content standards. The documentation is advertised using easy-to-access Internet tools that enable the user to remotely access information and services from any client and discover the data belonging to that particular agency. The processes involved in such a service are illustrated in Figure 6.2.

This allows the user to have enough information on data definitions, coding schemes, schemas, definitions, attributes, quality, accuracy, and contact information. Through the server, maintained at the local site, the data-producing agency will ensure the following for the geospatial data community requesting such a services [Bishr and Radwan, 2000].

- Provision for converting the characteristics and contact information of all the available data sets into the metadata content standard.
- Availability of the metadata to the users requesting details of the geospatial data sets.
- Necessary mechanisms for converting the requested set of data into national spatial data transfer standards or user requested format.

- Transaction mechanism for delivering the data online through the commonly available transfer protocols such as File Transfer Protocol (FTP).
- Wherever possible, facility for abstracting the metadata to preserve it in the global metadata, for the clearinghouse.
- Wherever possible, facilities for registering the metadata into the clearinghouse server using the necessary tools.

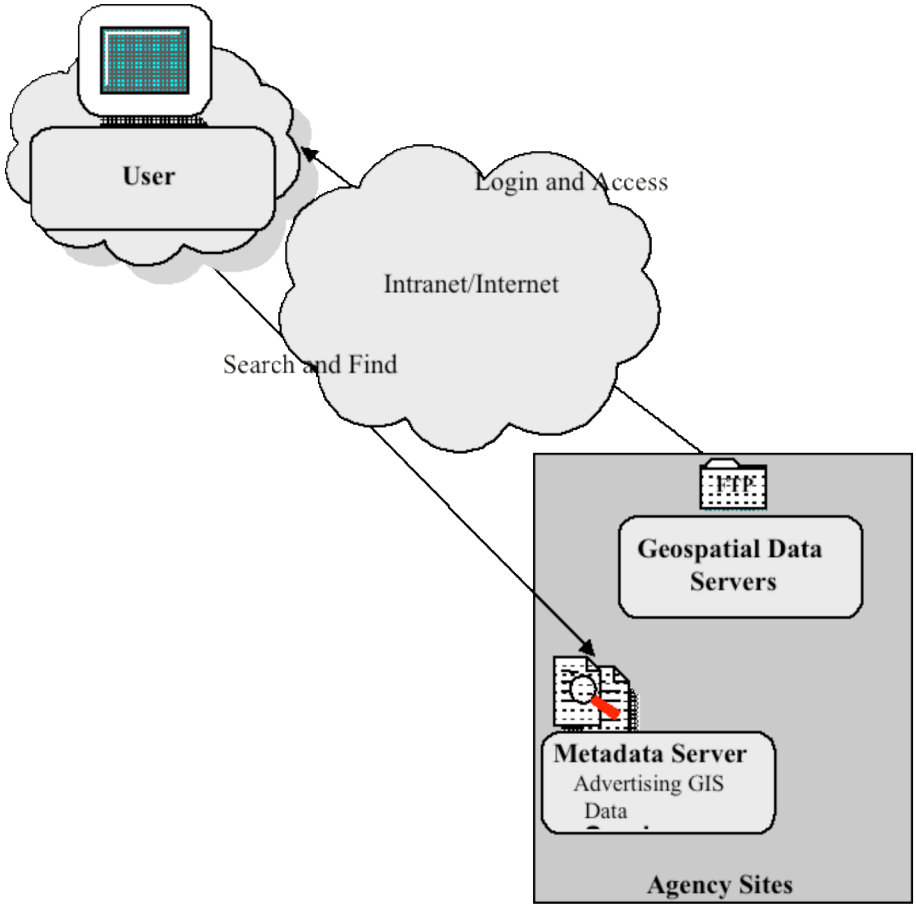

Figure 6.2
Concept of agency specific Geospatial Data Catalogue Services through metadata (adapted from ArcNews, [2002]).

Security and access controls are provided to ensure the protection of the data. Data updating and clearinghouse registering are controlled through the user name and

passwords ensuring the right of access to the responsible persons. Subsequent to the discovery of the data, authorized users could download the data, using Transfer Controlled Protocol (TCP)/Internet Protocol (IP) based FTP. The requisite is that the agencies maintain the data in a more common and easy-to-download industry standard formats.

In the U.A.E., the Military Survey Department of the U.A.E. Armed Forces (www.msd.org.ae) and the Dubai Municipality (www.dubai-municipality.org.ae) are offering online services for geospatial data access. The former is offering small-scale digital maps, while the latter is offering large-scale urban data for exploration and further downloading through highly secured servers. So far, no agency in the country has a metadata-based search and discovery system.

To ensure the availability of the most current information, the catalogue is updated whenever the spatial data is updated with the content, format, and standards. These transfers are not always wholly successful, however, and much work needs to be done after the data are transferred. Today many organizations want to exchange the definitions behind the graphic data and this cannot be resolved without a common standard [Clarke, 1995]. Therefore, the absence of national standards for data transfer necessitates more meaningful data translators than those supplied by the GIS software vendors. Consequently, the author proposes the development of spatial data translators, which process spatial data independent of source and destination formats, to facilitate meaningful data access and exchange. Accordingly, a mechanism for implementing such translators are explained in the section 6.4.2, as a makeshift arrangement until the

national spatial data transfer standards and the coordination council are in place for the country.

6.4.2 Semantic Data Translators.

In a heterogeneous geographic information system environment, like in the U.A.E., with various data sets in different formats and with the lack of standards because of the absence of a national coordination council, the quick way to make the data universally available is to convert the data into the desired formats and exchange. A good semantic data translator (SDT) would be better able to resolve complicated topological and attribute mapping problems than conventional mapping tools. It is quite possible to develop a new set of software to satisfy the data conversion requirements of organizations that are interested in sharing and exchanging information. There are very efficient spatial data translators available on the market. Therefore a less expensive approach is to purchase such software for the common use so that member agencies of the NGDC could concentrate on more productive activities. One such product available on the market is the 'Feature Manipulation Engine (FME) produced by Safe Software Inc [2001].

FME is much more than a simple data translator. In addition to format conversion, the FME is capable of performing sophisticated processing during the translation process. It may even be used as a configurable spatial and attribute processing utility reading from and writing to the same data format [Safe Software Inc, 2001].

SDT Architecture

The purpose of the SDT is to perform certain geometric and attribute mapping, based on the rules and specifications defined in the mapping file, and convert the source data format to the destination format. To achieve this, a simple architecture is presented in Figure 6.3. Source spatial data with a predetermined format are subjected to several operations as explained below:

- Topology operations for creating a shape from another shape. Normally polygons are created from the line geometry bounding the area of the feature and connecting the line geometry, representing the same feature, together to form a single entity.
- Geometric Operations for reducing unwanted vertices from a line, point entity creation from the polygon with smaller area, doing basic mathematical operations such as calculating area and length.
- Attribute operations such as data conversion from one structure of the data model to another. It reads or writes feature attributes from or to external tables, joins multiple relational tables, etc.

After to the data are subjected to these operations, the feature is matched, between the source and destination format, based on feature type and attribute. When a proper match is found, the format of the feature is converted into the destination format based on the rules of transformation provided in the control or mapping file.

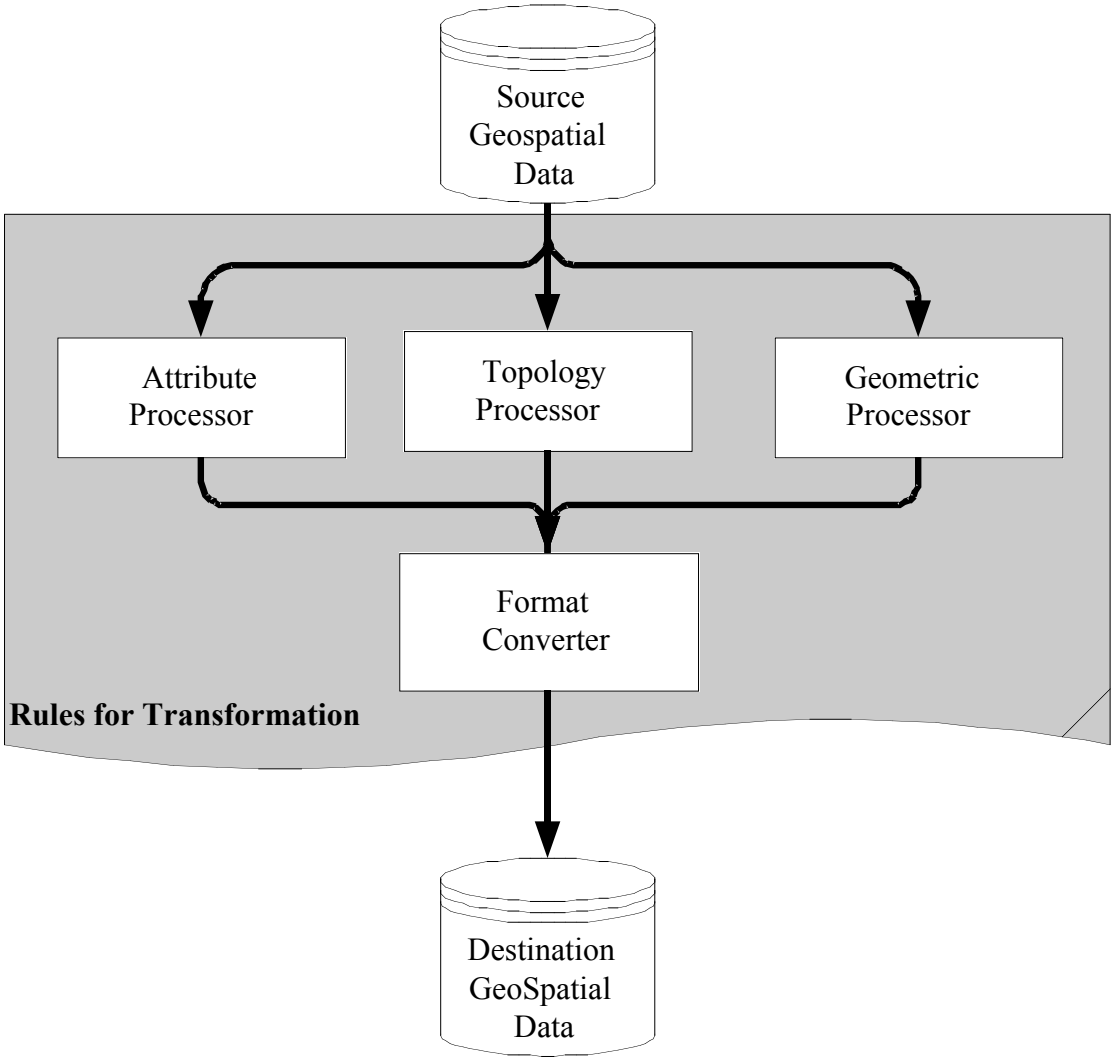

Figure 6.3
Simple architecture of semantic data translator
(Adapted from SAFE Software Inc. [2001])

The most important thing in the translator development is the design of rules for transformations. Making the rules demands absolute understanding of formats, coordinate systems, schemas, etc., of the source and destination data. Again, complete documentation of the data characteristics in a common format is essential here as well.

SDT in Stand-Alone Configuration

To achieve smooth data transfer and exchange, the agencies involved in the process should possess the SDT configured for transforming the data in the agency-specific format to a wide variety of formats that satisfy the requirements of the U.A.E. GIS community. The data in the required format are translated in batch mode and supplied physically to the user as illustrated in Figure 6.4.

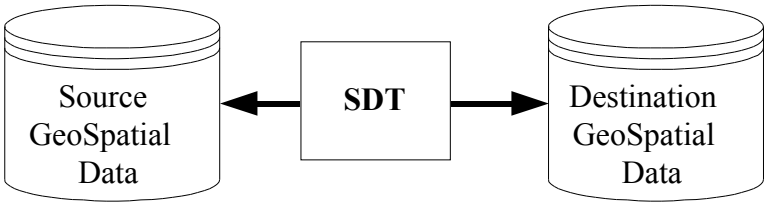

Figure 6.4
Stand-alone configuration for direct batch translation.

SDT in Distributed Environment

In a distributed environment, it is easy to maintain a translator at the central server, so that any privileged user can access the data and transform it to a desired format as illustrated in Figure 6.5. The prerequisite here again is complete documentation of the common format preserved on a central server. Direct interface to the metadata could be made possible to format the transfer data in a user specific form.

Considering the prevailing situation in the U.A.E. with agencies preserving the data in agency-specific format, which quite often is vendor specific, without any proper documentation, then implementing and maintaining the SDT may be a cumbersome task.

In addition to this, when the vendor comes up with new model the situation demands changes in the data model and the related data conversions. As a result, the SDT needs to be re-configured again with the new model, increasing the burden on the agencies.

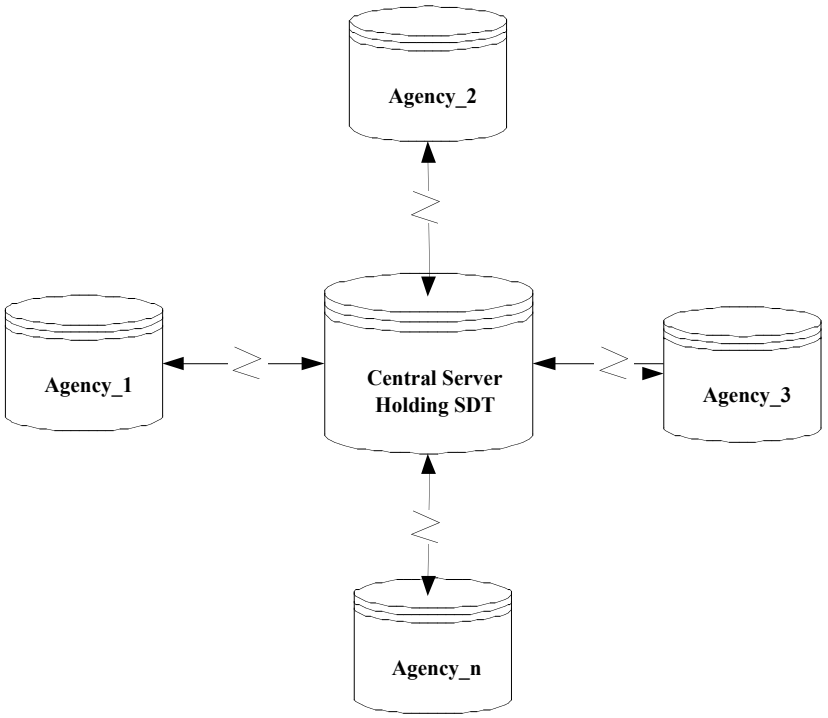

Figure 6.5
SDT in a distributed environment for dynamic data translation.

This is an inexpensive method, however, for resolving the geometric and attribute mapping problems between different systems maintaining data in various formats. It could be used as a quick remedial measure for large data producers like the Military Survey Department, to supply data without any format constraints. The process could facilitate an open data transfer and exchange culture in the U.A.E.

6.5 Conclusion

Quite often, resources are wasted by collecting the same thematic data repeatedly for a given area, using different references and standards, because there is a lack of knowledge about its availability and proper documentation. As a result, people continue to develop their own applications specific data sets, even if they already exist and could be utilized [Lucet, 2001]. The challenge, therefore, is to make these data sets transparent to the agencies themselves and others in the country. The services facilitating such transparency are more technically challenging compared to any other components of the NSDI. The technicalities involved in the development of such initiatives were addressed in the initial sections of this chapter to provide better guidelines for initiating such a process in the U.A.E.

It has further been observed that, in the absence of a national body for monitoring geospatial data activities, it will be difficult to develop a national clearinghouse for the country. However, the author encourages the geospatial data agencies to start developing localized catalogue services for publicizing the characteristics of the rich content of available data sets by making use of the congenial and economic communications infrastructure in the country. The author considers this as an incentive for the wider NSDI initiative.

The resultant increased availability of the geospatial data sets would demand more efficient access and transfer mechanisms. Therefore, the author encourages the geospatial data agencies to deploy of more meaningful data translators facilitating complex topological and attribute mapping. This is proposed only as a makeshift

arrangement until the national spatial data transfer standards and a coordination council is in place.

One of the biggest problems in making the data publicly available is the lack of legislation that stipulates the law governing copyright protection and data copying. Lack of standardization and standard documentation on the data may also lead to several forms of metadata available in the catalogue services. Such institutional issues would be major constraints in implementing these solutions in the country.

Chapter 7 - Summary and Recommendations

7.1 Summary

To some extent, the barriers to better investments in spatial data in the U.A.E. are no different than those in other countries. In particular, non-uniform geospatial data standards, overlapping jurisdictions, and problems related to uncoordinated geospatial data activities are the obstacles commonly found even in most developed countries. Hence, it becomes necessary for the U.A.E. to establish national initiatives, such as an NSDI, to overcome these shortcomings. However, the survey conducted by the author showed that the institutional arrangements in the U.A.E are still not mature enough for such an infrastructure. In fact, this is clear at both the federal and the local government levels.

At the national level, for example, no government body exists that is responsible for the co-ordination and formulation of policies on geospatial data creation, maintenance, and dissemination. At local level, overlapping responsibilities on geospatial data production persist because of a similar lack of a coordinating body.

On the legal side, the authorization to facilitate data access among the various geospatial data agencies has not yet been resolved. Regardless of this, in some emirates, certain progress has been made towards managing the spatial data activities through a centralized authority. The GIS center of Dubai emirate is the best example of this. Such activities are limited to their own jurisdictions, however, data are quite often inconsistent with those available at the national level. This is mainly due to the lack of standards and proper legislation to facilitate the right of access and dissemination.

This report has attempted to define the commonly used geospatial data sets and to resolve the critical factors hampering the sharing and exchange of these data sets among the various geospatial data agencies of the country. It is expected that this could serve as a starting point to establish the framework data sets, thus making an initial step towards the implementation of an NSDI for the U.A.E. In order to identify these data sets, a detailed survey was conducted among the twenty-one local, federal, and commercial organizations involved in the geospatial data activities, as explained in the Chapter 3. The results of the survey were used to identify and define the commonly used data sets with all their elements.

Chapter 4 of the report covered the strategies required for making these data sets a framework data set for the U.A.E. This was done with the perspective of framing common geospatial data standards for the country. Since many stakeholders are involved in the creation and maintenance of the data framework, national level institutional arrangements are required.

Accordingly, in Chapter 5, adequate guidelines for framing such policies were outlined. Also appropriate strategies were discussed for mobilizing the additional funds required for the purpose. Moreover, some easy-to-implement solutions are required to demonstrate the potential benefits and the technicalities of such an arrangements. These aspects are covered in Chapter 6 of the report.

7.2 Recommendations

Based on the experience gained from this study, the author wishes to recommend the following strategies. It is hoped that the implementation of the outlined process will establish a plan for the successful implementation of a National Spatial Data Infrastructure for the U.A.E.

1. The author believes that data sharing and exchange, among various agencies of the country, could be accomplished.

   For the purpose, it is recommended to have an incremental approach by which processes are developed and established at the local government levels first and gradually move to establish them at the federal level.

2. To qualify for framework data, the geospatial data sets that are identified as the most commonly used in the country, should be acquired and maintained within an organizational arrangement and should conform to the technical standards.

   Therefore, it is recommended that the geospatial data sets identified and listed in section 4.3.1 should be generated and maintained within the organizational arrangements and in accordance with the geospatial data standards of the U.A.E.

3. Geospatial data standards are a pre-requisite for achieving a collaborative building-up of common data sets. Therefore the creation and the implementation of the geospatial data standards is an essential constituent of the NSDI program.

It is recommended to initiate a strategy for developing the U.A.E. national geospatial data standard covering the data model, data transfer formats, data classification, data coding, and reference system as explained in section 4.5.

4. In the U.A.E. the MSD is the national mapping agency of the country. It is already effectively involved in the creation of geospatial data standards, covering data models, data classification, data coding, data transfer formats, and a reference system for various data sets covering the whole country.

   Therefore, it is recommended that the geospatial data standards developed by the U.A.E. MSD, in harmony with international practices, for its various geospatial data sets, should be adopted as the national geospatial data standards.

5. Eighty percent of the U.A.E. area is geo-referenced based on the Clarke 1880 reference ellipsoid. Accordingly, most of the geospatial data identified in section 4.3.1 as the most commonly-used are generated and maintained based on this reference system only. A study conducted by the survey section of Dubai municipality of the U.A.E., however, shows that the existing geodetic network based on Clarke 1880 ellipsoid is not suitable for geo-referencing the geospatial data that requires better accuracy satisfying the needs of the majority of data users in the country. In search of an accurate referencing system as part of the study, Dubai municipality concluded that the International Terrestrial Reference Frame (ITRF) is best suited for establishing the geodetic framework

   Therefore it is recommended to a common geo-reference system for the country based on International Terrestrial Reference Frame (ITRF).

6. The U.A.E. MSD has initiated a project for classifying and encoding the topographic features that are identified to be included in the U.A.E. NTDB. As a result, a detailed features catalogue has been created for the country. Subsequently, a very comprehensive data dictionary entitled 'U.A.E. National Topographic Database – Data Dictionary' has also been developed explaining all these features with proper codes, geometric representations, and data models showing the entity relationships.

Therefore it is recommended that the feature classification, coding, and related specifications formulated and explained in the data dictionary of the MSD be adopted as the national standards.

7. The U.A.E. MSD has taken a lead in the development of metadata content standards for the country based on the 'Content Standard for Geospatial Metadata' developed by the U.S. FGDC. The popularity and the wide acceptance of the U.S. FGDC standards was the rationale behind this approach. Moreover, the process would save a lot of resources that otherwise would have been wasted by re-inventing the wheel.

Therefore, it is recommended that the metadata standard accepted by the MSD, be adopted as the national metadata content standard for the U.A.E.

8. The Internal Standard Organization (ISO) Technical Committee on Geographic Information/Geomatics (ISO/TC211) suite of standards is accepted by many countries, including Canada and the U.S., for defining rules and standardized schemata for the definition and description of geospatial data and its management.

Therefore, adopting such international practices for the U.A.E. would definitely save time and effort especially in the absence of any strong initiatives for developing or implementing such standards at the national level.

Therefore, ISO/TC211 based standard is recommended for the U.A.E. national standard for geospatial data exchange.

9. Policies on data acquisition, maintenance, and distribution, and the legal protection of data, are the paradigms within which the framework data sets are developed. As a result, many such policies and legal frameworks are developed by the agencies that are actively involved in the process. Absence of such an institutional arrangement is considered as one of the reasons behind the prevailing autonomy in the functioning of the government organizations, thus causing the duplication of effort in the geospatial data activities.

   Therefore, it is recommended to frame a national level institutional arrangement facilitating the joint creation, maintenance and smooth dissemination of geospatial data as explained in the Chapter 5.

10. The process of creating national framework data sets and a related framework is a joint effort. This necessitates the formation of a coordination body at the national level so that these data sets are generated and maintained consistently in compliance with the set of standards and institutional framework.

    Therefore it is urgently recommended to form, a national geospatial data coordination council to promote better inter-agency relationships and to ensure

that set standards and procedures are strictly followed by the participating agencies.

11. For the U.A.E., as a result of a forced shift towards commercialization of mapping practices in some emirates, the right environment is there for an adequate information pricing policy. However, as a result of the vigorous e-governance initiatives for delivering and marketing geospatial data services in some emirates, policies are being created that are limited to the local needs. This may encourage other agencies also to go for such independent policies. Therefore, due to the absence of any national initiatives for a common pricing policy, irregular practices may develop in marketing the geospatial data and their services in the country.

    Therefore it is recommended to have a common geospatial data pricing policy for the country as explained in section 5.6.1.

12. Geospatial data producing agencies possess certain rights on the 'facts' contained in the database and the efforts invested in the collection of these 'facts'. The existing copyright law of the U.A.E. is not adequate to cover the rights on the 'facts' contained in the database and the efforts invested in their collection and maintenance.

    Therefore it is recommended that the existing copyright law of the country be amended with sufficient clauses to cover the proper definitions for the database and their contents, the rights of the data producers, access rights of the users for different types of use, including the commercial one, as explained in the section 5.6.3.

13. The absence of any tangible initiatives for implementing an NSDI in the country remains a challenge to mobilize enough resources for the purpose. Therefore certain easy-to-implement and economically feasible solutions are required to demonstrate the potential benefits of data exchange and sharing. As a beginning, considering the availability of the better and cost-effective Internet infrastructure in the country, which offers highly secured and fast data access mechanisms, the geospatial data agencies could advertise the details of the data sets maintained by them for easy access by potential users.

Therefore it is recommended that all the concerned agencies produce complete documentation on the characteristics of the available geospatial data sets as per the metadata content standards. These documents should be advertised using the easy-to-access Internet tools as explained in section 6.4.1.

14. The U.A.E. offers a congenial data communication infrastructure, facilitating remote economic user access to information and services from any client. As a result geospatial data could be made transparent to all GIS users through data catalogue services, facilitating the discovery of the data with all its details in a properly documented form.

Therefore, considering this very scenario, it is recommended to form Geospatial Data Clearinghouse Service Centers under the direct control of the proposed national council, to provide all the details of the geospatial data sets available in the country.

15. It is expected that such Web-based geospatial data services would increase the availability and the demand for geospatial data. As a result better transfer methods would be required to make available the subsets of the data demanded by the users. The absence of any national standards for data formats and transfers necessitate more complicated topological and attribute mapping tools than normally supplied by the GIS software vendors. This may require more meaningful data translators, which process spatial data independent of source and destination formats, facilitating meaningful data access and exchange.

Therefore, it is recommended to deploy some good semantic data translators that are already available on the market, such as the 'Feature Manipulation Engine' produced by Safe Software Inc. This would save a lot of resources compared to developing new sets of software for the purpose.

16. The initial expenditure required for converting these data sets, according to the set norms of the framework, is very substantial. As the conversion responsibility belongs to agencies, it may put a heavy financial burden on them amidst the budget constraints and related pressures from the government. Consequently, the entire process of development may be jeopardized, if agencies are made responsible for finding the resources required for the purpose.

It is therefore recommended to mobilize a common national fund through the geospatial data council. Funds could then be distributed accordingly among the member agencies based on set priorities.

17. Like any other country, in U.A.E. also, the mobilizing the funds required for such activities are becoming a daunting task for many, amidst the budget constraints on government expenditures. Until a real case of cost benefits of any new development is submitted to the government, it would not be possible to mobilize the required funds.

Therefore, it is recommended that formal business plans be created, through some meticulous measurement of the business virtues, demonstrating the potential benefits of implementing a NSDI for the U.A.E.

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APPENDIX A

Survey for Geospatial Data Activities in the United Arab Emirates

- A Questionnaire

Conducted by

Saleh Saad Alhubail

Questionnaire

The main objective of the research is to design a conceptual model of a framework data for the proposed U.A.E. National Spatial Data Infrastructure (U.A.E. NSDI). The aim is

- to identify the most commonly used geospatial data sets in the country
- to identify the geospatial data producers and their scope of activities.
- to explore geospatial data standards and specifications used for the creation, maintenance and the dissemination of these data sets in the country.
- to identify the existing institutional and policy arrangements for the creation, maintenance and the dissemination of the geospatial data.

Organization information

Organization name:…….

Address:

……

Tel:…… fax: …… E-mail:…….

Contact person:……..

Tel:…… fax: …… E-mail:…….

Part I: Policy and Management issues:

1. Is your organization consider as?

a. [ ] Federal organization. b. [ ] Local organization. c. [ ] Private organization.

2. Does your organization create, integrate, or distribute digital geo-spatial data?

a. [ ] Yes b. [ ] No.

3. Does your organization like to share digital geo-spatial data with other organizations?

a. [ ] Yes b. [ ] No

4. Does your organization permit others to redistribute your data?

a. [ ] Yes, with no restrictions. b. [ ] Yes, with restrictions c. [ ] No

5. Does your organization have a policy for data distribution?

a. [ ] Yes. b. [ ] No.

6. Regarding the digital geo-spatial data, does your organization consider as?

a. [ ] producer only. b. [ ] user only. c. [ ] both.

7. If your organization consider as a producer, does it coordinate data creation with other organizations?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

8. Does your organization update digital geo-spatial data?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

9. If your organization updating geo-spatial data or plan to do so, what is the updating cycle?

a. [ ] daily.

b. [ ] weekly.

c. [ ] monthly.

d. [ ] yearly.

e. [ ] each 2 to 5 year.

f. [ ] only when needed.

10. If your organization consider as a producer, to what level has your organization create digital geo-spatial data covering your service area?

a. [ ] Completed. b. [ ] Still in progress c. [ ] Planned.

11. Does your organization distribute digital geo-spatial data to other users?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

12. Does your organization has its own standard to create, update, integrate or distribute digital geo-spatial data.

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

13. Does your organization use same standards to create, update, integrate or distribute digital geo-spatial data used by other organizations?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

If (a) or(c) please specify the organization name:……

14. Does your organization create and maintain digital geo-spatial metadata?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

15. Does your organization has its own standard for metadata creation?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

16. Does your organization use same standards to create metadata used by other organizations?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

If (a) or(c), please specify the organization name:…….…….

17. What kind of network system does your organization use for digital geo-spatial data access?

a. [ ] Intranet b. [ ] Internet c. [ ] LAN d. [ ] Other e. [ ] None.

Comments:……
……

18. Does your organization let others from out side your organization access to your digital geo-spatial data?

a. [ ]Yes. b. [ ]No. c. [ ] plan to do.

19. If your organization consider as user only, what is the main sources of your digital geo-spatial data?

a. [ ] through governmental organizations that create digital geo-spatial data.

b. [ ] through contracts with privet sectors.

c. [ ] through other users.

If (a) or (c) please specify the organization name……

20. Does your organization share the funds for creating or gathering digital geo-spatial data with other organizations?

a. [ ]Yes. b. [ ]No. c. [ ] plan to do.

If (a) or (c) please specify the organization name:……

21. What is the approximate annual value that your organization spends for gathering, updating or creating geo-spatial data?

a. [ ] less than million Dhs.

b. [ ] between 1 and 5 million Dhs.

c. [ ] between 5 and 10 million Dhs.

d. [ ] more than 10 million Dhs.

22. Does your organization have membership with any international/national committee deals with geo-spatial data issues?

a. [ ]Yes. b. [ ]No. c. [ ] plan to do.

If (a) or(c), please specify the committee name……

23. Does your organization like to share common digital geo-spatial data set with other organizations?

a. [ ]Yes. b. [ ]No. c. [ ] plan to do.

24. When your organization search for digital geo-spatial data needed but does not have it, is the wanted data at other organizations?

a. [ ] easy to find and compatible.

b. [ ] hard to find and compatible.

c. [ ] easy to find but not compatible.

d. [ ] hard to find and not compatible.

e. [ ] cannot be found.

25. When your organization find digital geo-spatial data wanted but does not have it, is the data?

a. [ ] can be easily released by the owner.

b. [ ] hard to be released by the owner.

c. [ ] cannot be released.

26. Does your organization pay to re-use other's digital geo spatial data?

a. [ ]Yes. b. [ ]No.

Part II - Definition of the technical specification.

27. What kind of applications does your organization use digital geo-spatial data?

27.1 [ ] mapping.

27.2 [ ] public safety.

27.3 [ ] transportation.

27.4 [ ] natural resources.

27.5 [ ] environmental.

27.6 [ ] agriculture.

27.7 [ ] engineering.

27.8 [ ] utilities services.

27.9 [ ] lands development.

27.10 [ ] military.

27.11 [ ] national security.

27.12 [ ] others, *please specify in the comments below.*

Comments:……

28. What software system used in your organization?

28.1 [ ] ESRI – ARC/INFO.

28.2 [ ] ESRI – ArcView.

28.3 [ ] ESRI – ArcCAD.

28.4 [ ] ESRI – Atlas.

28.5 [ ] ERDAS – IMAGINE.

28.6 [ ] Bentley systems – Microstation.

28.7 [ ] Intergraph – FRAMME.

28.8 [ ] Intergraph – MGE.

28.9 [ ] MapInfo.

28.10 [ ] AutoDesk – AutoCAD.

28.11 [ ] CARIS.

28.12 [ ] Other, *please specify in the comments below.*

Comments:……

.

29. What type of spatial data model does your organization used?

a. [ ] Raster b. [ ] Vector c. [ ] Both.

30. What themes of digital geo-spatial data that your organization creates or interested in?

30.1 [ ] Buildings and build up areas.

30.2 [ ] Roadway data. Which include roads, and roads associated features.

30.3 [ ] Hydrography.

30.4 [ ] Hypsography.

30.5 [ ] Geodetic and survey points data.

30.6 [ ] Utility information such as electrical power lines or water pipeline .

30.7 [ ] Cadastral information such as parcels mapping.

30.8 [ ] Land Cover data such as agriculture features or cultivated areas, forests…etc.

30.9 [ ] Aeronautical data such as air routs, air port areas…etc.

30.10 [ ] Boundaries data for services or jurisdiction areas…etc.

30.11 [ ] Geo-referenced digital images such as satellite photos or orthoimages.

30.12 [ ] Other , *please specify in the comments below*.

Comments:……
……..

31. In the buildings theme what categories that your organization interested in?

31.1 [ ] buildings in general.

31.2 [ ] governmental.

31.3 [ ] industrial.

31.4 [ ] residential.

31.5 [ ] military.

31.6 [ ] education.

31.7 [ ] other, , *please specify in the comments below*.

Comments:……
…….

32. In the roadway theme what categories that your organization interested in?

32.1 [ ] all roads in general.

32.2 [ ] main roads.

32.3 [ ] secondary roads.

32.4 [ ] bridges.

32.5 [ ] tunnels.

32.6 [ ] culverts.

32.7 [ ] parking areas.

32.8 [ ] others, *please specify in the comments below*.

Comments:……

……

33. In the hydrography theme what categories that your organization interested in?

33.1 [ ] bottom features (coral reef, sand, rocks….etc).

33.2 [ ] coastline.

33.3 [ ] depth contour.

33.4 [ ] sounding points.

33.5 [ ] shallow water areas.

33.6 [ ] marsh.

33.7 [ ] water wells.

33.8 [ ] streams.

33.9 [ ] lakes.

33.10 [ ] dams.

33.11 [ ] canals.

33.12 [ ] maritime area.

33.13 [ ] maritime routs.

33.14 [ ] others, *please specify in the comments below*.

Comments:……

……

34. In the hypsography theme what categories that your organization interested in?

34.1 [ ] DTM data.

34.2 [ ] spot heights.

34.3 [ ] contour lines.

34.4 [ ] ridge lines.

34.5 [ ] cliffs.

34.6 [ ] faults.

34.7 [ ] valley lines.

34.8 [ ] others, *please specify in the comments below*.

Comments:……

…….

35. In the geodetic and survey data theme what categories that your organization interested in?

35.1 [ ] planimetric/altimetric geodetic point first order.

35.2 [ ] planimetric/altimetric geodetic point second order.

35.3 [ ] planimetric/altimetric geodetic point third order.

35.4 [ ] planimetric/altimetric geodetic point forth order.

35.5 [ ] benchmark point first order.

35.6 [ ] benchmark point second order.

35.7 [ ] gravimetric point.

35.8 [ ] magnetic point.

35.9 [ ] boundary point.

35.10 [ ] other, *please specify in the comments below*.

Comments:……

…….

36. In the utility theme what categories that your organization interested in?

36.1 [ ] electrical power lines.

36.2 [ ] electric poles.

36.3 [ ] telephone lines.

36.4 [ ] pipe lines (water, oil, gas, ….etc).

36.5 [ ] tanks (water, oil, gas, ….etc).

36.6 [ ] manholes (water, electrical, sewage, ….etc).

36.7 [ ] others, *please specify in the comments below*.

Comments:……

…….

37. In the Cadastral theme what categories that your organization interested in?

37.1 [ ] privet parcels and associated survey corner points boundaries lines.

37.2 [ ] non privet parcels and associated survey corner points boundaries lines.

37.3 [ ] others, *please specify in the comments below*.

Comments:……

…….

38. In the land cover theme what categories that your organization interested in?

38.1 [ ] bare lands areas (sand dunes, rocks, gravel, …etc).

38.2 [ ] agriculture areas (tree plantation, cultivated areas, …etc).

38.3 [ ] natural vegetation areas (scrub, mangrove, wood, …etc).

38.4 [ ] others, *please specify in the comments below*.

Comments:……

…….

39. In the Aeronautical theme what categories that your organization interested in?

39.1 [ ] air route lines.

39.2 [ ] air ports areas.

39.3 [ ] heliports.

39.4 [ ] airstrips/ runways.

39.5 [ ] others, *please specify in the comments below*.

Comments:……

……..

40. In the boundaries data theme what categories that your organization interested in?

40.1 [ ] international boundary lines.

40.2 [ ] national boundary lines.

40.3 [ ] administrative boundary lines.

40.4 [ ] administrative areas.

40.5 [ ] others, *please specify in the comments below*.

Comments:……

……..

41. What is the approximate positional accuracy of the digital geo-spatial data that your organizations produce or used?

a. [ ] More accurate than 1:1000 scale.

b. [ ] 1:1000 to 1:5000 scale.

c. [ ] 1:5000 to 1:10000 scale.

d. [ ] 1:10000 to 1:25000 scale.

e. [ ] 1:25000 to 1:50000 scale.

f. [ ] Less accurate than 1:50000 scale.

42. What is the approximate vertical accuracy of the digital elevation data that your organizations produce or used?

a. [ ] less than one meter.

b. [ ] 1 to 5 meter.

c. [ ] 5 to 10 meter.

d. [ ] more than 10 meter.

43. What kind of ellipsoid does your organization use?

a. [ ] Clark1880. b. [ ] WGS84. c. [ ] WGS72. d.[ ] other.

Comments:……
……
…

44. What horizontal datum does your organization use?

a. [ ] Nahrwan. b. [ ] Adindan. c. [ ] Arc1950. d. [ ] other.

Comments:……
……
…

45. What vertical datum does your organization use?

a. [ ] Ras-ghemais b. [ ] Ghantut c. [ ] Abadan d.[ ] other.

Comments:……
……
…

46. What map projection does your organization use?

a. [ ] UTM. b. [ ] Cassini. c. [ ] Lambert conformal. d.[ ] other.

Comments:……
……

47. What kind of coordinate system does your organization use?

a. [ ] Cartesian coordinate. b. [ ] geographic coordinate. c. [ ] plain coordinate.

Comments:……
……

Thank you for your corporation. Please forward your comments regarding this survey in the following address:

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P.O. Box 7423
Abu Dhabi, U.A.E.
Telephone: +971-.2- 6315427.
E-mail: salehhub@emirates.net.ae

APPENDIX B

Sample List of Geographic Features and their Geometric Representation of U.A.E. NTDB [U.A.E. Armed Forces, 2002b].

SN	CODE	Feature Name	Point	Line	Area
1	AAA00001	Administrative Office	X	*	X
2	AAA00002	Administrative Boundary	*	X	*
3	AAA00003	Air Facility – Abandoned	*	X	X
4	AAA00004	Airport – Military	*	*	X
5	AAA00005	Airport Complex – Civilian	*	*	X
6	AAA00006	Airstrip	*	X	X
8	AAA00007	Antenna	X	*	*
9	AAA00008	Archaeological Site	*	*	X
10	AAA00009	Azba (temporary Building)	X	*	X
11	AAA00010	Barqa	X	*	X
12	AAA00011	Barrier	*	X	*
13	AAA00012	Bastion/Rampart	*	X	*
14	AAA00013	Benchmark Point	X	*	*
15	AAA00014	Block/Zone	*	X	*
16	AAA00015	Boat/Ship Yard	*	*	X
17	AAA00016	Border / Boundary Point	X	*	*
18	AAA00017	Boulder	X	*	X
19	AAA00018	Breakwater	*	X	X
20	AAA00019	Bridge	X	X	*
21	AAA00020	Building General	X	*	X
22	AAA00021	Built-up Area	*	*	X
23	AAA00022	Burial Ground	*	*	X
24	AAA00023	Butts	X	X	*
25	AAA00024	Parcel Corner Point	X	*	*
26	AAA00025	Canal	*	X	X
27	AAA00026	Cave	X	*	X
28	AAA00027	Channel - Ferry Track	*	X	X

29	AAA00028	Chimney	X	*	*
30	AAA00029	Cliff	*	X	*

APPENDIX C

Sample Content of Data Dictionary [UAE Armed Forces, 2002b]

3.4 Geodetic Dataset

Benchmark Point

Feature Code: AAAB0010

Descriptions

Benchmarks are fixed elevation markers, for which the precise altitudes are known along with its positional information. Normally it is a form of vertical control point. A series of such points are measured across the country. These points form a network of benchmarks. Usually a monument is constructed, on these points, using a concrete structure with a brass cap at the top.

The brass cap carries necessary identification marks such as benchmark number and the details of the government authority responsible for maintaining such monuments. Figure 4.1 shows a UAE benchmark monument.

Geometric Representation

The feature is represented as the point entity. The precise altitude information, along with the location information, is measured using high precision GPS receivers. The measurement is taken exactly at the geometric center of the monument. The Geodesy Section is responsible for surveying and maintaining such control networks and the Section maintains the related information.

Figure 4.1
Feature benchmark monument and the geometric representation

Table 4.1 - Feature attributes

Name	Description
EXT_CODE	Key to link the external attribute tables
A_Name	Name of the Benchmark Point in Arabic Language
E_Name	Name of the Benchmark Point in English Language
Station_Number	Identification Number of the Benchmark Point
Datum	Name of the Datum
Network_Name	Name of the Network such as APGN, AGSN, ATGN
Monument_Type	Such as concrete round, square, brass cap; Standard Iron
Monument_Shape	Shape of the monument structure
UTM_Easting	X Location of the point in UTM Coordinates System
UTM_Northing	Y location of the point in UTM Coordinate System
UTM_Zone	Zone number of the UTM Coordinate System
Status	Current Status of the monument such as existing etc.
Area_Type	Type of the surrounding area such as sandy, muddy etc.
Observation_Method	Nature of observation such as GPS reading etc.
ZValue	Elevation from the Means Sea Level in meters

Geometric Representation Qualifier

⇒ Position Definite

⇒ Position Approximate

Object – Relationship Model

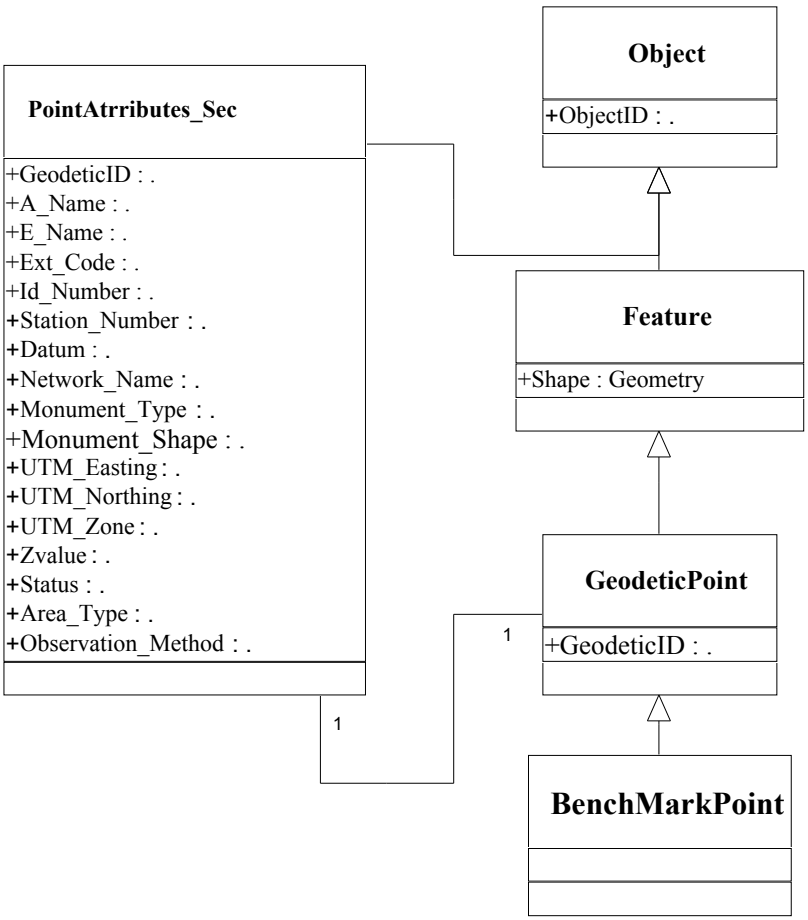

Figure 4.2
Object-relationship model of feature benchmark point

APPENDIX D

Research Contact Authorities Information List

1. Director, Technical Affairs, Services & Transportation, Works Department, P. O. Box 3, Abu Dhabi.
2. Director, Building Management Directorate, Works Department, P. O. Box 3, Abu Dhabi.
3. Chief Engineer, Roads & Traffic Engineering Directorate (External Roads), Abu Dhabi Municipality, P. O. Box 263, Abu Dhabi.
4. Chief Engineer, Roads & Traffic Engineering Directorate (Town Roads), Abu Dhabi Municipality, P. O. Box 263, Abu Dhabi.
5. Civil Aviation Department, P. O. Box 20, Abu Dhabi.
6. Engineering Services Manager, ADCO, P. O. Box 270, Abu Dhabi.
7. General Manager Abu Dhabi Transmission & Despatch Company (Transco), P. O. Box 173, Abu Dhabi.
8. Manager Projects, ADNOC-FOD, P. O. Box 4188, Abu Dhabi.
9. Manager, Etisalat, Abu Dhabi Branch – External Planning, P. O. Box 300, Abu Dhabi.
10. Manager, Technical Services Division, Abu Dhabi Gas Company (ATHEER), P. O. Box 345, Abu Dhabi.
11. Municipal Engineer, Abu Dhabi Municipality, P. O. Box 263, Abu Dhabi.
12. The Chief Engineer, Drainage Network Division, P. O. Box 2282, Abu Dhabi.
13. Town Planning Department, P. O. Box 862, Abu Dhabi.
14. Environmental Research & Wildlife Development Agency, P. O. Box 45553, Abu Dhabi.

15. Dubai Land Department.
16. Dubai Municipality.
17. The Director, Abu Dhabi Municipality, P. O. Box 263, Abu Dhabi.
18. Deputy Managing Director, Transmission & Dispatch Company, P. O. Box 173, Abu Dhabi.
19. Director Water, Abu Dhabi Distribution Company, P. O. Box 219, Abu Dhabi.
20. Director Electricity, Abu Dhabi Distribution Company, P. O. Box 219 Abu Dhabi.
21. Abu Dhabi National Oil Company, P. O. Box 898, Abu Dhabi.
22. M/s John Taylor & Sons, P. O. Box 2774, Abu Dhabi.
23. M/s De Leuw Cather International, P. O. Box 46736, Abu Dhabi.
24. Halcrow Intl. Partnership, P. O. Box 46024, Abu Dhabi.
25. Al Ain Municipality.
26. Town Planning Department, Al Ain.
27. Sharjah Municipality.
28. MAPS geo systems, Sharjah
29. Sharjah Petrol Department.
30. Sharjah Traffic Police.
31. Abu Dhabi police department.
32. Ministry of Interior.
33. Dubai Electricity and Water authority.
34. Dubai Police.

APPENDIX E

Results of the Survey Information Analysis

Survey for Geospatial Data Activities in the United Arab Emirates

The author has distributed a questionnaire (see Appendix A) to all the geospatial data activity agencies in the United Arab Emirates. The main purpose of distributing the questionnaire was to identify the organizations that are responsible of the production and the utilization of geospatial data in the United Arab Emirates.

The main objective of the survey was to define the common geospatial data sets used by the geospatial agencies in the U.A.E. The percentage of data utilization by the agencies was the main criteria in identifying the commonly used geospatial data sets. The survey concentrated mainly on the available spatial data sets and not on the attribute data. It is expected that this could serve as a starting point to establish the framework data sets, thus making an initial step towards the implementation of an NSDI for the U.A.E.

In order to identify these data sets, a detailed survey was conducted among the local, federal, and commercial organizations. The author has received the information from 21 departments and organizations, both local and government, that are devotedly involved in the geospatial data activity. The results of the analysis of the survey information are illustrated below.

Part I: Policy and Management issues:

Q1. Is your organization Consider as?

a. [ ] Federal organization b. [ ] Local organization. c.[ ]Private organization.

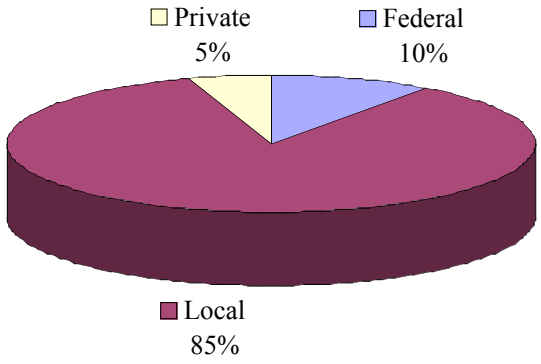

Figure A.1 – Type of Geospatial Data Organizations

Q2. Does your organization create, integrate, or distribute digital geo-spatial data?

a. [ ] Yes b. [ ] No.

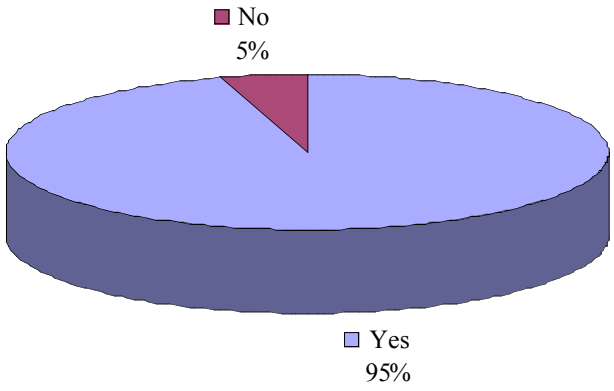

Figure A.2
Nature of Geospatial Data Activities of the Organizations

Q3. Does your organization like to share digital geo-spatial data with other organizations?

a. [ ] Yes b. [ ] No

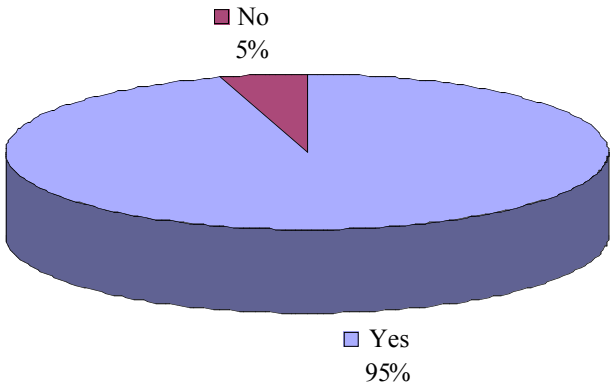

Figure A.3
Status Viability of Data Sharing of the Organizations

Q4. Does your organization permit others to redistribute your data?

a. [ ] Yes, with no restrictions. b. [ ] Yes, with restrictions c. [ ] No

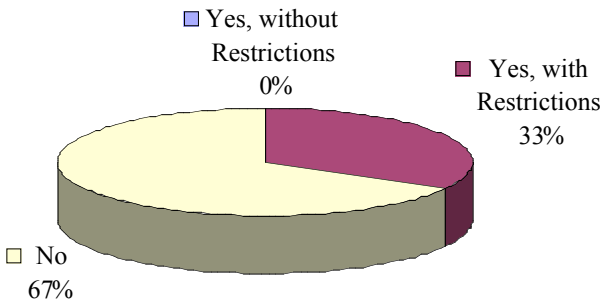

Figure A.4
Status of Data Redistribution Policy of the Organizations

Q5. Does your organization have a policy for data distribution?

a. [ ] Yes. b. [ ] No.

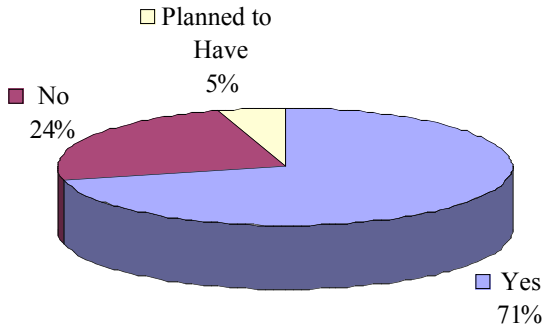

Figure A.5
Status of Data Distribution Policy of the Organizations

Q6. Regarding the digital geo-spatial data, does your organization consider as?

a. [ ] producer only. b. [ ] user only. c. [ ] both.

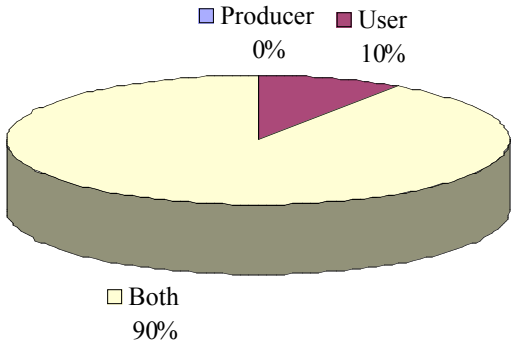

Figure A.6
Nature of Geospatial Data Activity of the Organization

Q7. If your organization consider as a producer, does it coordinate data creation with other organizations?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

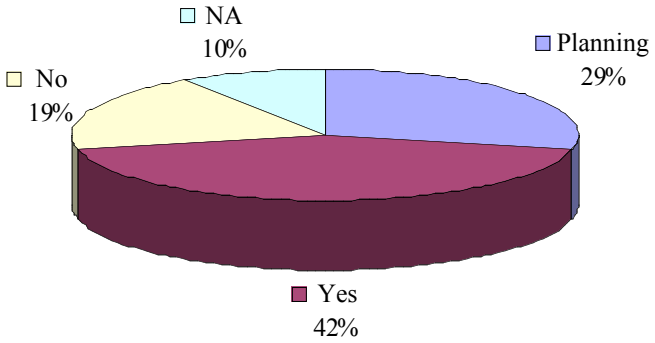

Figure A.7
Status of Data Creation Coordination between the Organizations

Q8. Does your organization update digital geo-spatial data?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

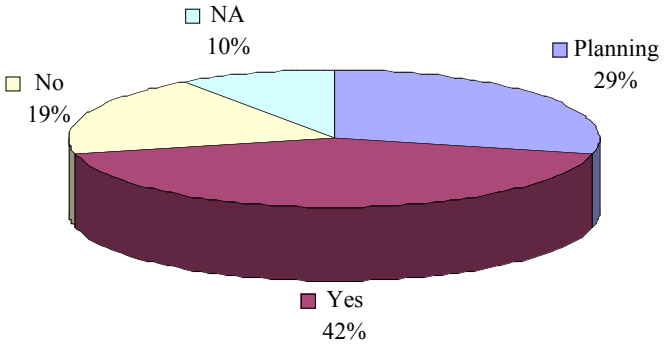

Figure A.8
Status of Data Updating Activity of the Organizations

Q9. If your organization updating geo-spatial data or plan to do so, what is the updating cycle?

a. [ ] daily.

b. [ ] weekly.

c. [ ] monthly.

d. [ ] yearly.

e. [ ] each 2 to 5 year.

f. [ ] only when needed.

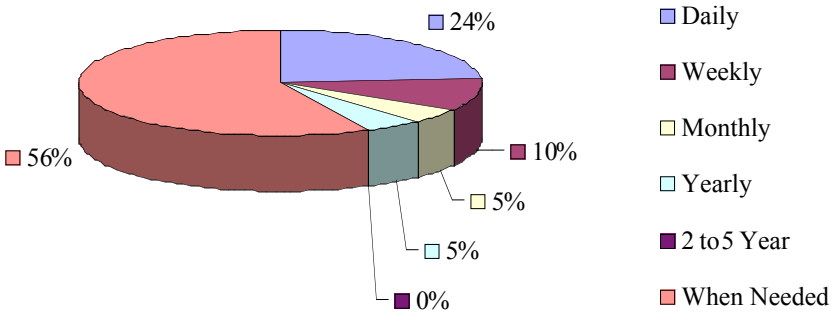

Figure A.9
Status of Data Updating Cycle of the Organizations

Q10. If your organization consider as a producer, to what level has your organization create digital geo-spatial data covering your service area?

a. [ ] Completed. b. [ ] Still in progress c. [ ] Planned.

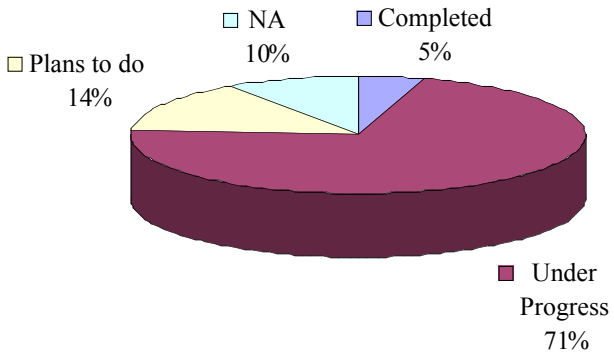

Figure A.10
Status of Data Creation Coverage Area of the Organizations

Q11. Does your organization distribute digital geo-spatial data to other users?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

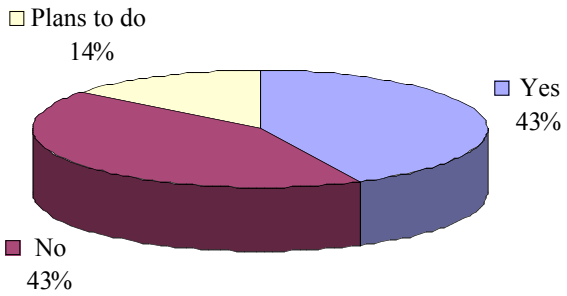

Figure A.11
Status of Data Distribution Practice between the Organizations

Q12. Does your organization have its own standard to create, update, integrate or distribute digital geo-spatial data?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

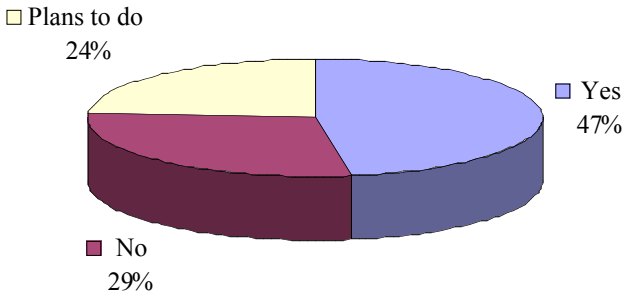

Figure A.12
Status of maintaining Geospatial Data based on Standards

Q13. Does your organization use same standards to create, update, integrate or distribute digital geo-spatial data used by other organizations?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

If (a) or(c) please specify the organization name:……

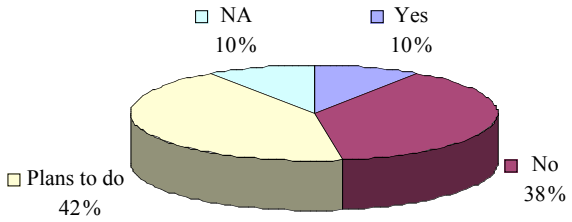

Figure A.13
Status of Common Geospatial Data Standards between the Organizations

Q14. Does your organization create and maintain digital geo-spatial metadata?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

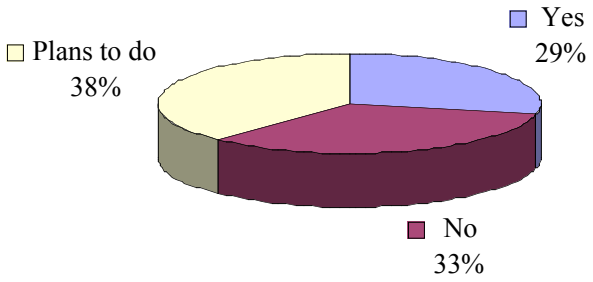

Figure A.14
Status of Maintaining Geospatial Metadata Standards in the Organizations

Q15. Does your organization have its own standard for metadata creation?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

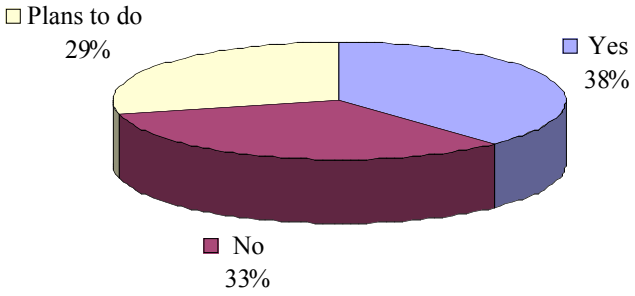

Figure A.15
Status of Maintaining Independent Metadata Standards in the Organizations

Q16. Does your organization use same standards to create metadata used by other organizations?

a. [ ] Yes. b. [ ] No. c. [ ] plan to do.

If (a) or(c), please specify the organization name:…….

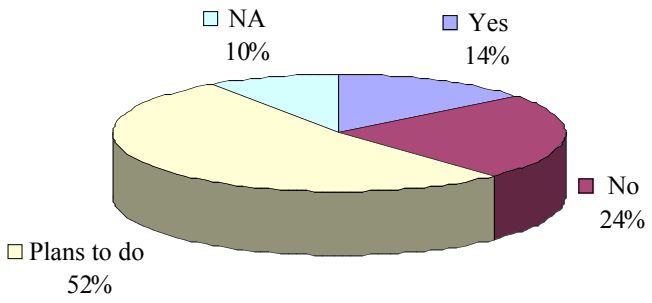

Figure A.16
Status of Maintaining Common Metadata Content Standards among the Organizations

Q17. What kind of network system does your organization use for digital geo-spatial data access?

a. [ ] Intranet b. [ ] Internet c. [ ] LAN d. [ ] Other e. [ ] None.

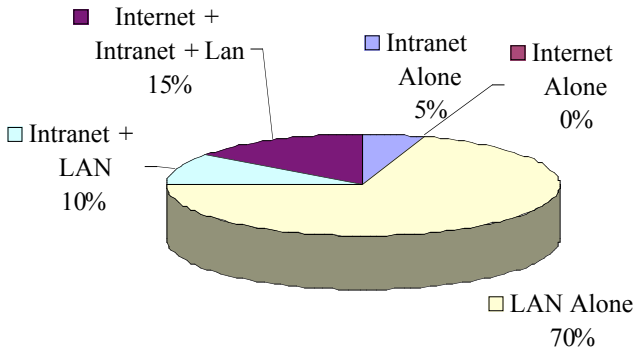

Figure A.17
Status of Geospatial Data Access Media of the Organizations

Q18. Does your organization let others from out side your organization access to your digital geo-spatial data?

a. [ ]Yes. b. [ ]No. c. [ ] plan to do.

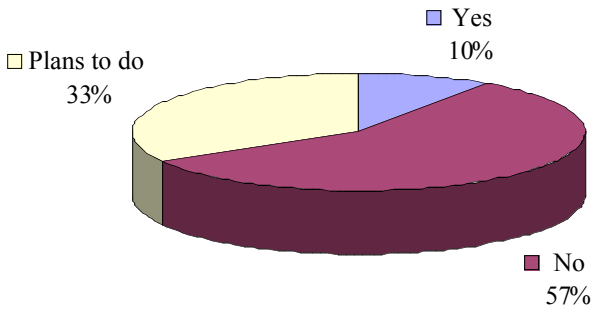

Figure A.18
Status of Geospatial Data Access Practice among the Organizations

Q19. If your organization consider as user only, what is the main sources of your digital geo-spatial data?

a. [ ] through governmental organizations that create digital geo-spatial data.

b. [ ] through contracts with privet sectors.

c. [ ] through other users.

If (a) or (c) please specify the organization name……

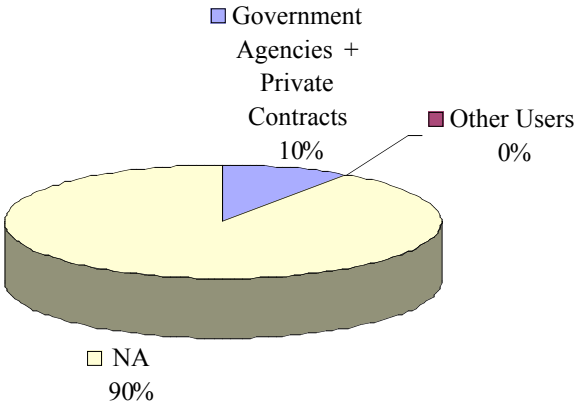

Figure A.19
Status of the Data Sources for the Geospatial Data Users

Q20. Does your organization share the funds for creating or gathering digital geo-spatial data with other organizations?

a. [ ]Yes. b. [ ]No. c. [ ] plan to do.

If (a) or (c) please specify the organization name:……

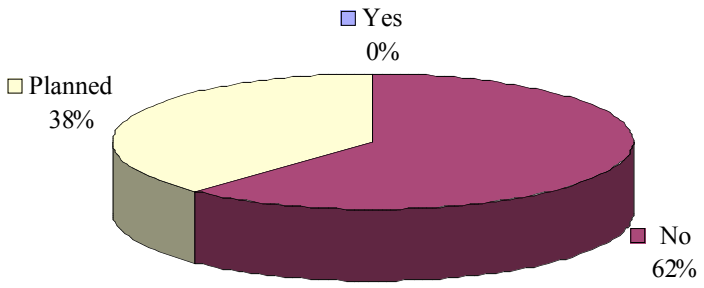

Figure A.20
Status of Data Creation Cost Sharing Practices among the Organizations

Q21. What is the approximate annual value that your organization spends for gathering, updating or creating geo-spatial data?

a. [ ] less than million Dhs.

b. [ ] between 1 and 5 million Dhs.

c. [ ] between 5 and 10 million Dhs.

d. [ ] more than 10 million Dhs.

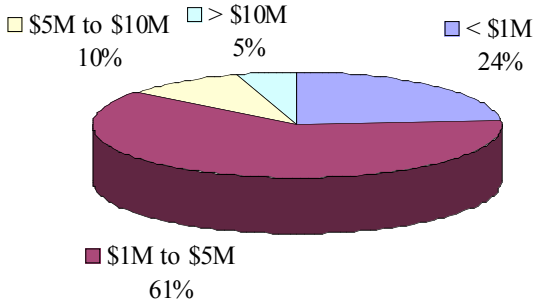

Figure A.21
Status of Data Creation Expenses of the Organizations

Q22. Does your organization have membership with any international/national committee deals with geo-spatial data issues?

a. [ ]Yes. b. [ ]No. c. [ ] plan to do.

If (a) or(c), please specify the committee name……

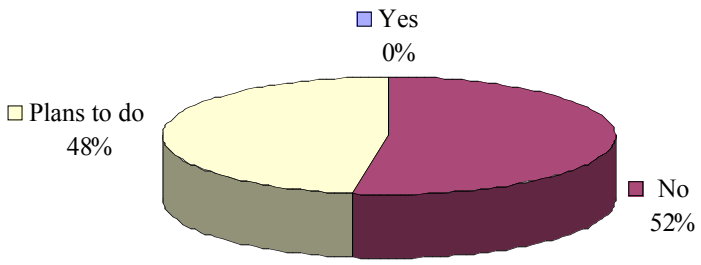

Figure A.22
Status of Participation with Data Policy Coordination Committees

Q23. Does your organization like to share common digital geo-spatial data set with other organizations?

a. [ ]Yes. b. [ ]No. c. [ ] plan to do.

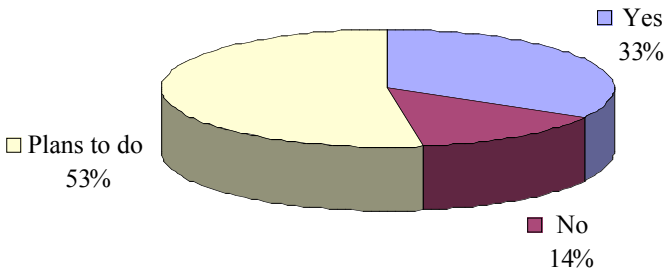

Figure A.23
Status of Organization Willingness in Data Sharing Practices.

Q24. When your organization search for digital geo-spatial data needed but does not have it, is the wanted data at other organizations?

a. [ ] easy to find and compatible.

b. [ ] hard to find and compatible.

c. [ ] easy to find but not compatible.

d. [ ] hard to find and not compatible.

e. [ ] cannot be found.

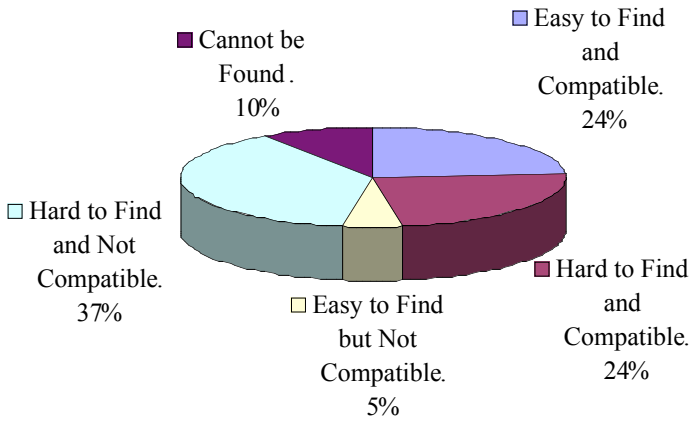

Figure A.24
Status of Practical Difficulties in Acquiring Geospatial Data Sets

Q25. When your organization find digital geo-spatial data wanted but does not have it, is the data?

a. [ ] can be easily released by the owner.

b. [ ] hard to be released by the owner.

c. [ ] cannot be released.

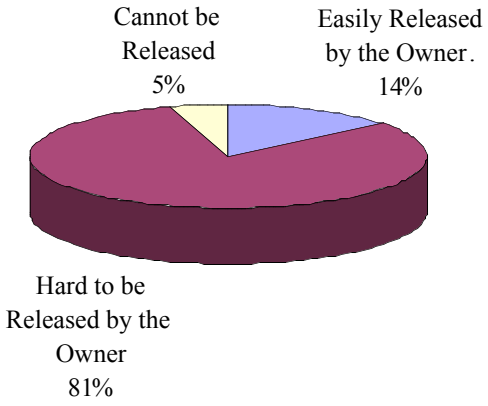

Figure A.25
Status of Practical Difficulties in Procuring Available Data Sets

26. Does your organization pay to re-use other's digital geo spatial data?

a. [ ]Yes. b. [ ]No.

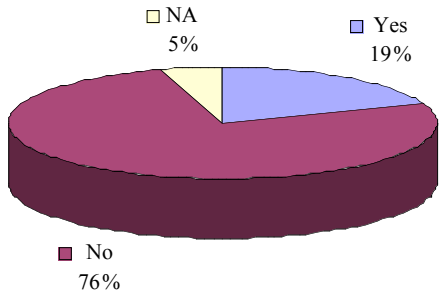

Figure A.26
Status of Royalty Fees Practices in Re-Using the Procured Data

Part II - Definition of the Technical Specification.

Q27. What kind of applications does your organization use digital geo-spatial data?

27.1 [ ] mapping.

27.2 [ ] public safety.

27.3 [ ] transportation.

27.4 [ ] natural resources.

27.5 [ ] environmental.

27.6 [ ] agriculture.

27.7 [ ] engineering.

27.8 [ ] utilities services.

27.9 [ ] lands development.

27.10 [ ] military.

27.11 [ ] national security.

27.12 [ ] others, *please specify in the comments below.*

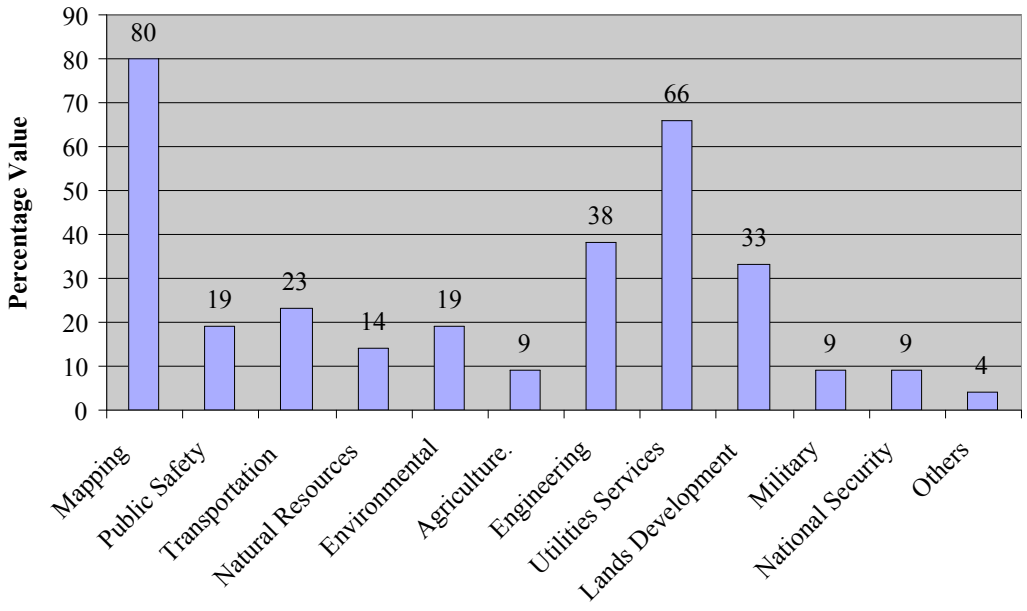

Figure A.27
Type of Application for Which the Geospatial Data is used

Q28. What software system used in your organization?

28.1 [ ] ESRI – ARC/INFO.

28.2 [ ] ESRI – ArcView.

28.3 [ ] ESRI – ArcCAD.

28.4 [ ] ESRI – Atlas.

28.5 [ ] ERDAS – IMAGINE.

28.6 [ ] Bentley systems – Microstation.

28.7 [ ] Intergraph – FRAMME.

28.8 [ ] Intergraph – MGE.

28.9 [ ] MapInfo.

28.10 [ ] AutoDesk – AutoCAD.

28.11 [ ] CARIS.

28.12 [ ] Other, *please specify in the comments below.*

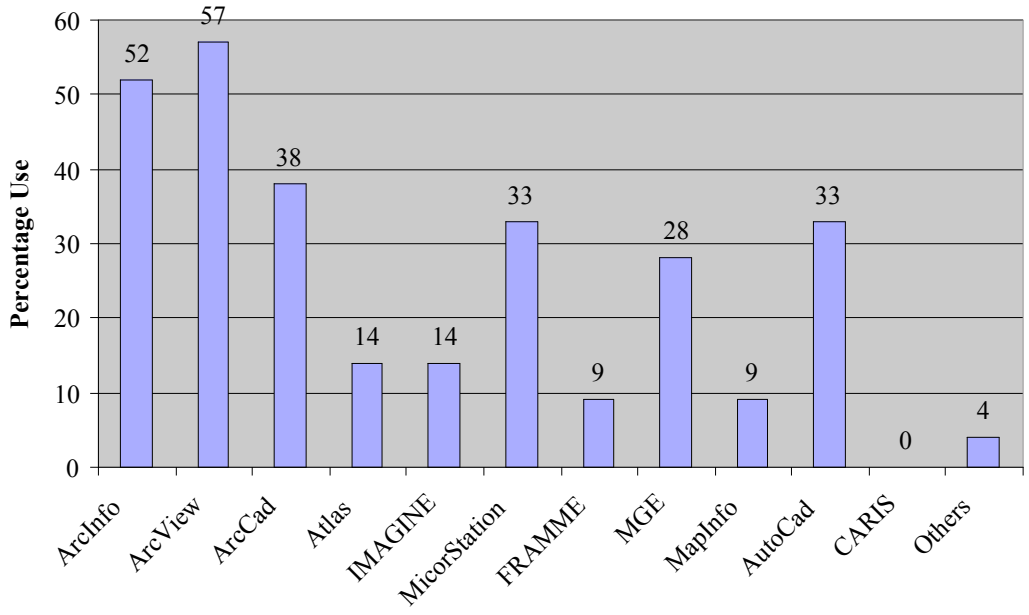

Figure A.28
Type of GIS Software Used to maintain and manipulate Geospatial Data

Q29. What type of spatial data model does your organization used?

a. [ ] Raster b. [ ] Vector c. [ ] Both.

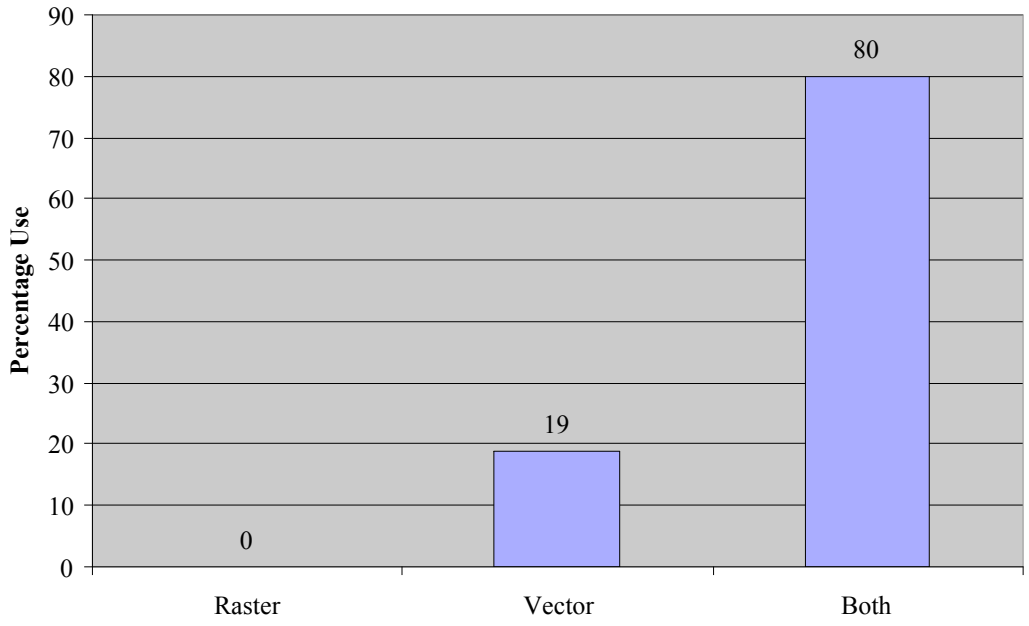

Figure A.29
Type of Data Model used to maintain Geospatial Data

Q30. What themes of digital geo-spatial data that your organization creates or interested in?

30.1 [ ] Buildings and build up areas.

30.2 [ ] Roadway data. Which include roads, and roads associated features.

30.3 [ ] Hydrography.

30.4 [ ] Hypsography.

30.5 [ ] Geodetic and survey points data.

30.6 [ ] Utility information such as electrical power lines or water pipeline .

30.7 [ ] Cadastral information such as parcels mapping.

30.8 [ ] Land Cover data such as agriculture features or cultivated areas, forest, etc.

30.9 [ ] Aeronautical data such as air routs, air port areas, etc.

30.10 [ ] Boundaries data for services or jurisdiction areas, etc.

30.11 [ ] Geo-referenced digital images such as satellite photos or orthoimages.

30.12 [ ] Other , *please specify in the comments below*.

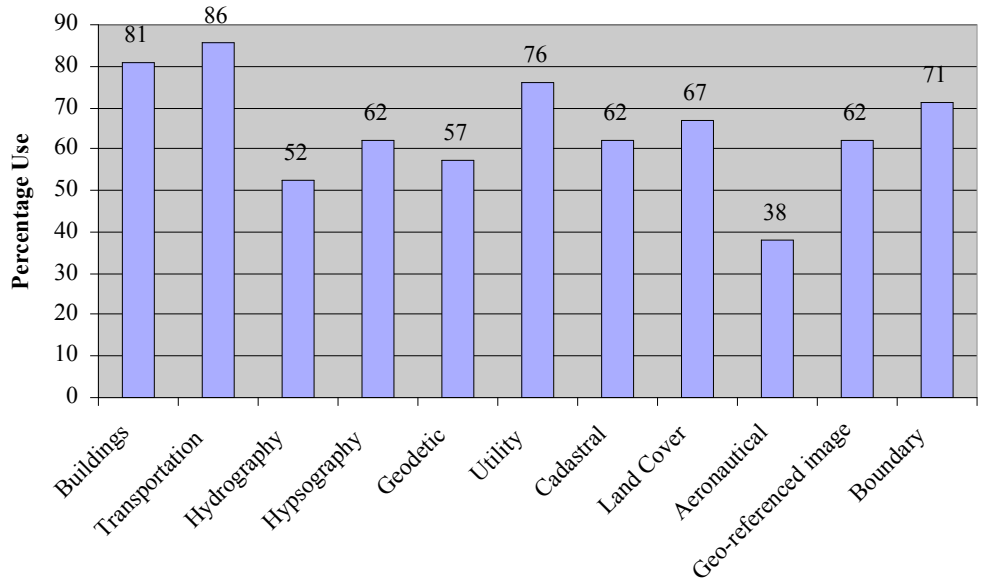

Figure A.30
Percentage Use of Geospatial Data Sets in the U.A.E.

Q31. In the buildings theme what categories that your organization interested in?

31.1 [ ] buildings in general.

31.2 [ ] governmental.

31.3 [ ] industrial.

31.4 [ ] residential.

31.5 [ ] military.

31.6 [ ] education.

31.7 [ ] other, , *please specify in the comments below*.

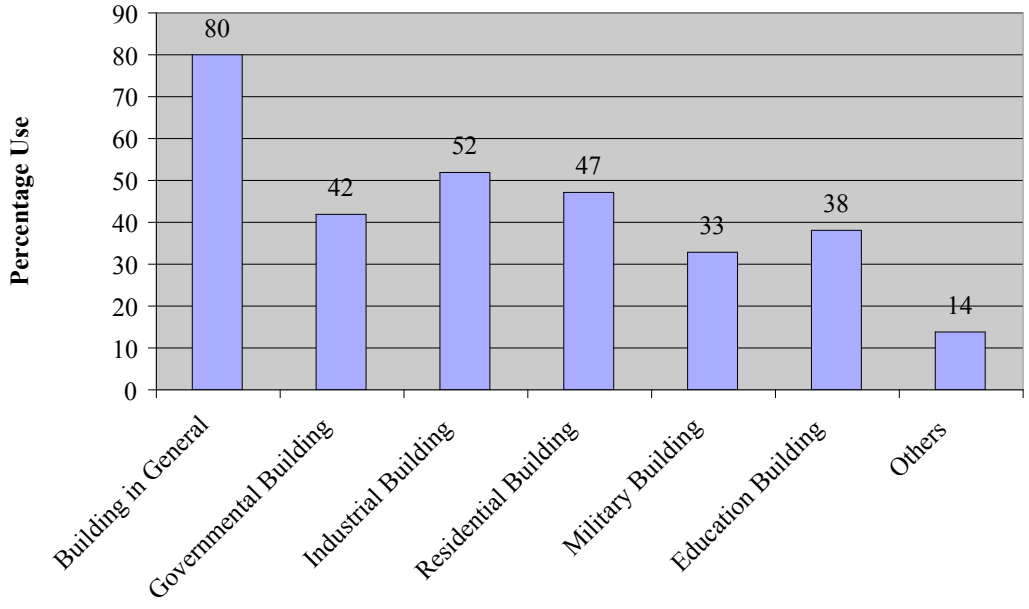

Figure A.31
Status of Building Type used by the Organization

Q32. In the roadway theme what categories that your organization interested in?

32.1 [ ] all roads in general.

32.2 [ ] main roads.

32.3 [ ] secondary roads.

32.4 [ ] bridges.

32.5 [ ] tunnels.

32.6 [ ] culverts.

32.7 [ ] parking areas.

32.8 [ ] others, *please specify in the comments below*.

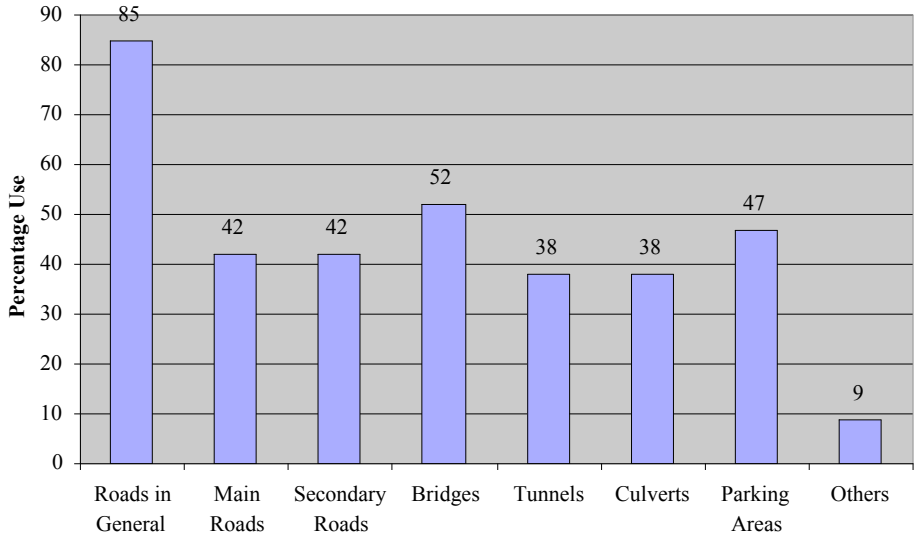

Figure A.32
Percentage Use of Transportation Features

Q33. In the hydrography theme what categories that your organization interested in?

33.1 [ ] bottom features (coral reef, sand, rocks….etc).

33.2 [ ] coastline.

33.3 [ ] depth contour.

33.4 [ ] sounding points.

33.5 [ ] shallow water areas.

33.6 [ ] marsh.

33.7 [ ] water wells.

33.8 [ ] streams.

33.9 [ ] lakes.

33.10 [ ] dams.

33.11 [ ] canals.

33.12 [ ] maritime area.

33.13 [ ] maritime routs.

33.14 [ ] others, *please specify in the comments below*.

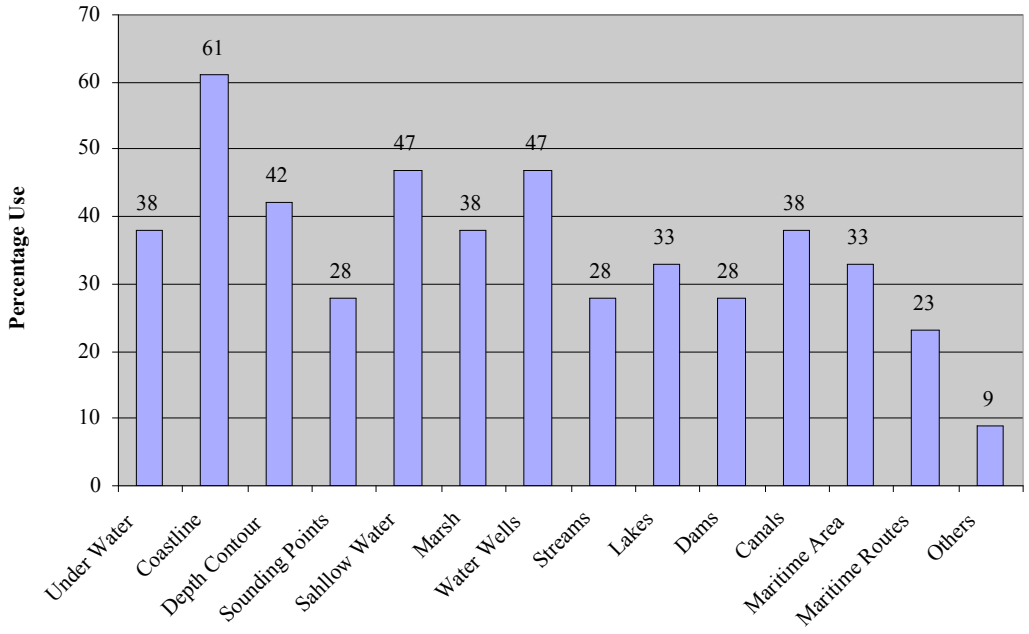

Figure A.33
Percentage Use of Hydrography Features

Q34. In the hypsography theme what categories that your organization interested in?

34.1 [ ] DTM data.

34.2 [ ] spot heights.

34.3 [ ] contour lines.

34.4 [ ] ridge lines.

34.5 [ ] cliffs.

34.6 [ ] faults.

34.7 [ ] valley lines.

34.8 [ ] others, *please specify in the comments below*.

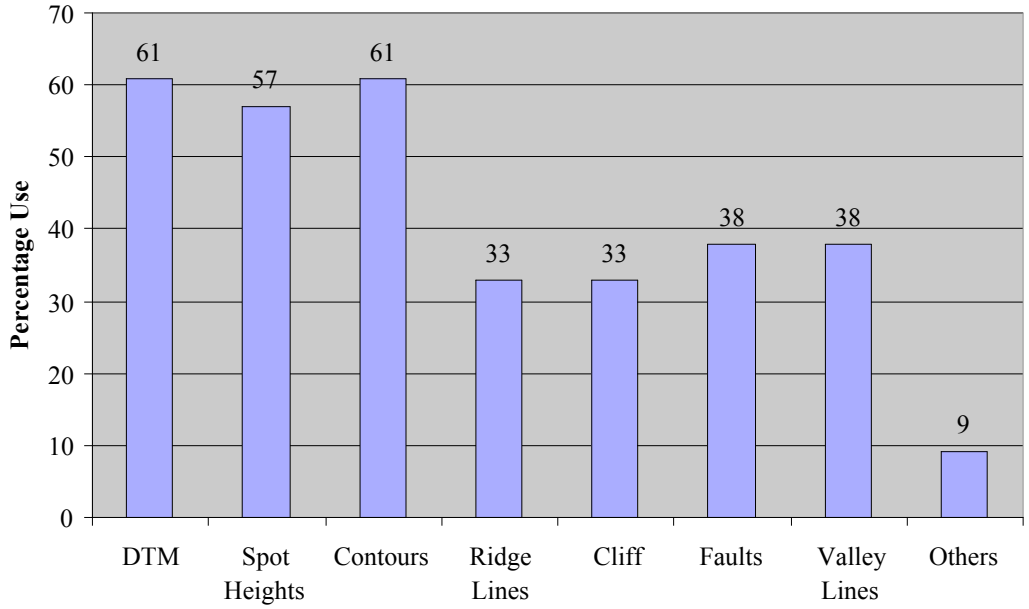

Figure A.34
Percentage Use of Physiography Features

Q35. In the geodetic and survey data theme what categories that your organization interested in?

35.1 [ ] planimetric/altimetric geodetic point first order.

35.2 [ ] planimetric/altimetric geodetic point second order.

35.3 [ ] planimetric/altimetric geodetic point third order.

35.4 [ ] planimetric/altimetric geodetic point forth order.

35.5 [ ] benchmark point first order.

35.6 [ ] benchmark point second order.

35.7 [ ] gravimetric point.

35.8 [ ] magnetic point.

35.9 [ ] boundary point.

35.10 [ ] other, *please specify in the comments below*.

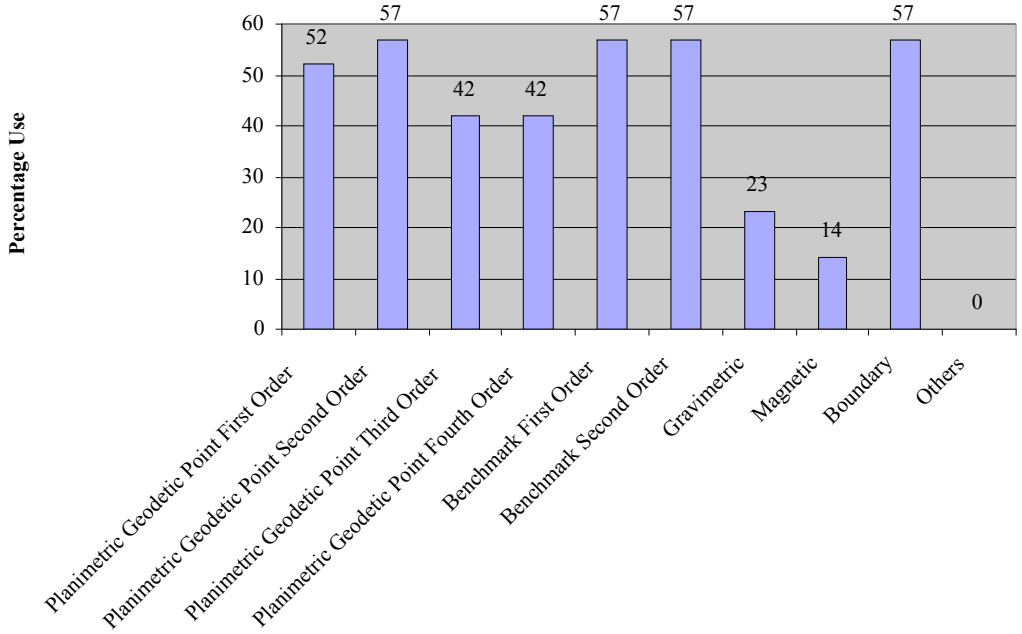

Figure A.35
Percentage Use of Geodetic Features in the country

Q36. In the utility theme what categories that your organization interested in?

36.1 [ ] electrical power lines.

36.2 [ ] electric poles.

36.3 [ ] telephone lines.

36.4 [ ] pipe lines (water, oil, gas, ….etc).

36.5 [ ] tanks (water, oil, gas, ….etc).

36.6 [ ] manholes (water, electrical, sewage, ….etc).

36.7 [ ] others, *please specify in the comments below*.

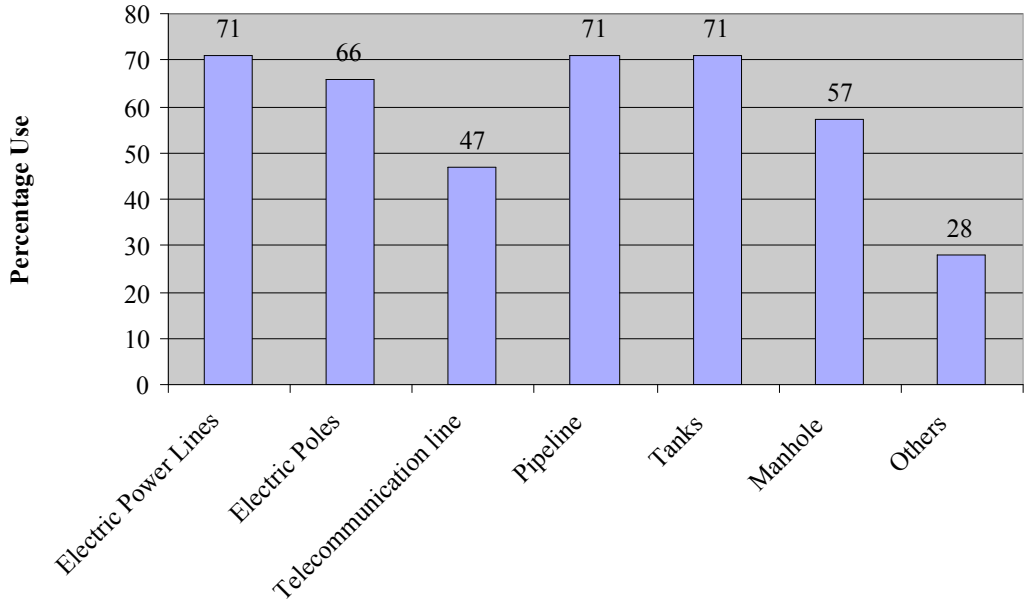

Figure A.36
Percentage Use of Utility Features in the Country

Q37. In the Cadastral theme what categories that your organization interested in?

37.1 [ ] privet parcels and associated survey corner points boundaries lines.

37.2 [ ] non privet parcels and associated survey corner points boundaries lines.

37.3 [ ] others, *please specify in the comments below*.

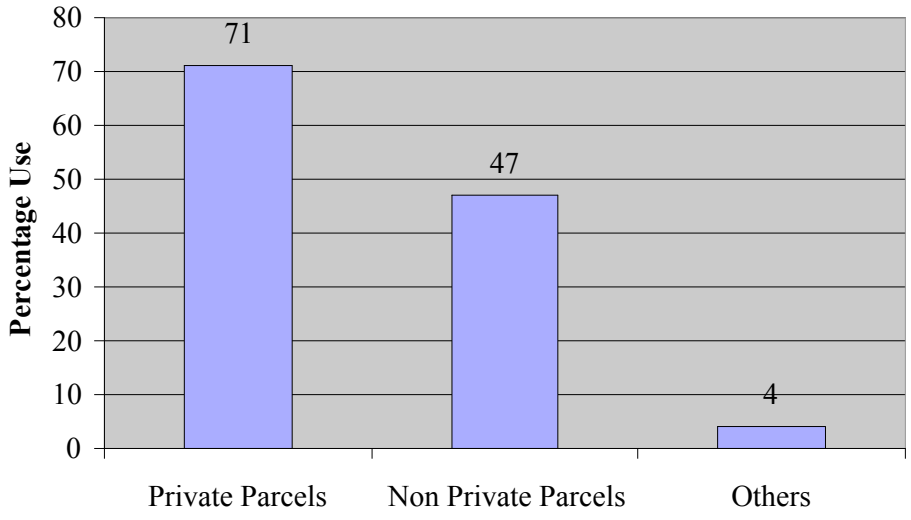

Figure A.37
Percentage Use of Cadastral Data sets Use in the Country

Q38. In the land cover theme what categories that your organization interested in?

38.1 [ ] bare lands areas (sand dunes, rocks, gravel, …etc).

38.2 [ ] agriculture areas (tree plantation, cultivated areas, …etc).

38.3 [ ] natural vegetation areas (scrub, mangrove, wood, …etc).

38.4 [ ] others, *please specify in the comments below*.

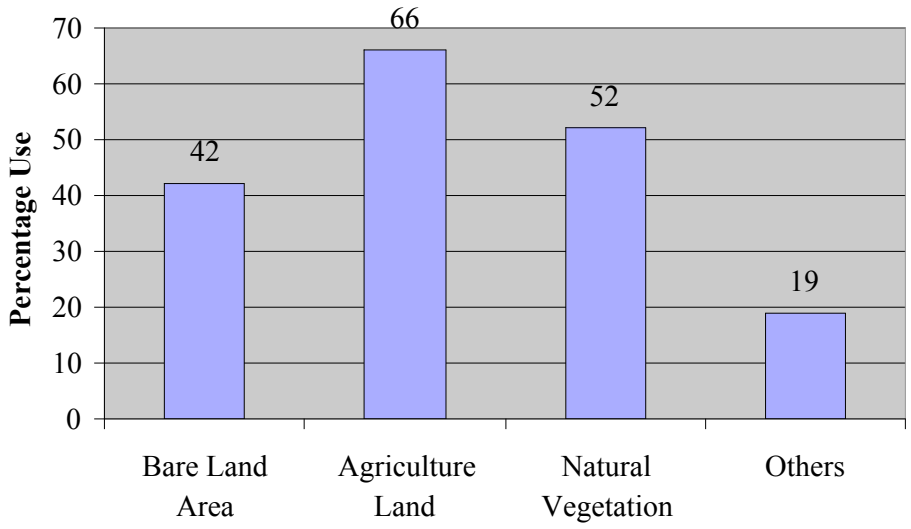

Figure A.38
Percentage Use of Land Use in the Country

Q39. In the Aeronautical theme what categories that your organization interested in?

39.1 [ ] air route lines.

39.2 [ ] air ports areas.

39.3 [ ] heliports.

39.4 [ ] airstrips/ runways.

39.5 [ ] others, *please specify in the comments below*.

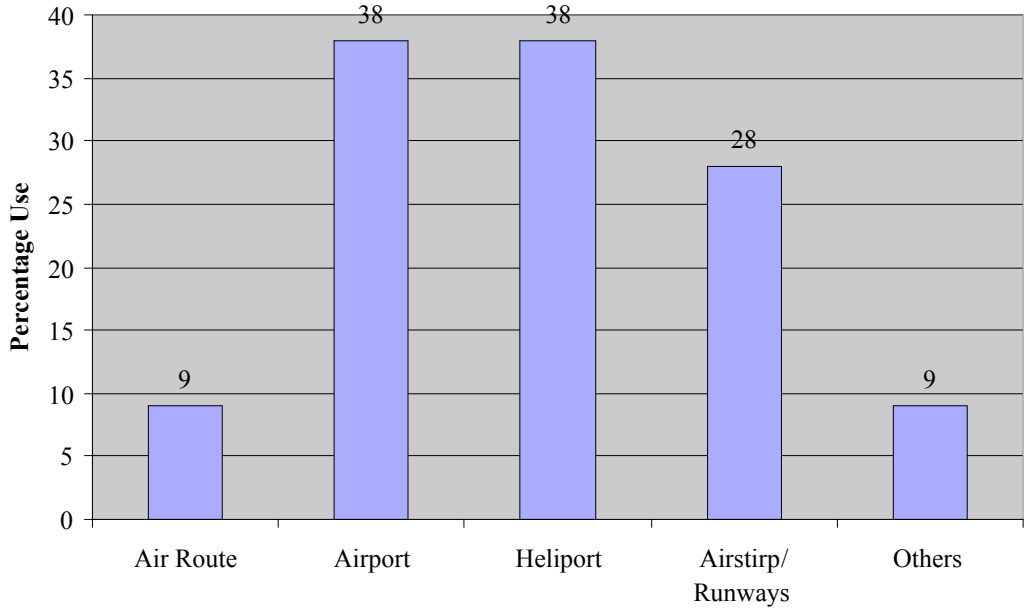

Figure A.39
Percentage Use of Aeronautical Feature

Q40. In the boundaries data theme what categories that your organization interested in?

40.1 [ ] international boundary lines.

40.2 [ ] national boundary lines.

40.3 [ ] administrative boundary lines.

40.4 [ ] administrative areas.

40.5 [ ] others, *please specify in the comments below*.

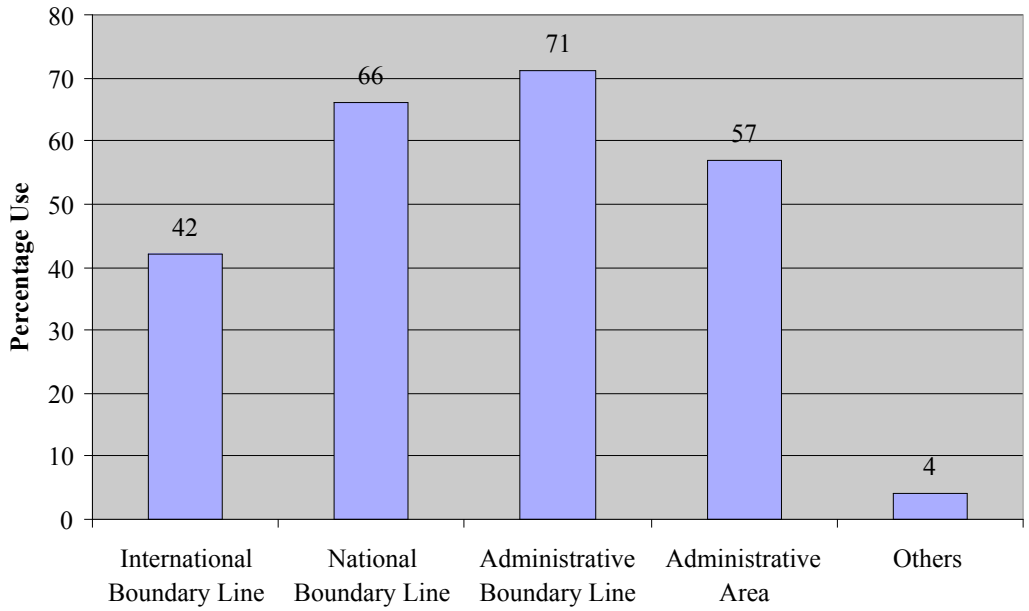

Figure A.40
Percentage Use of Demarcation Features in the Country

Q41. What is the approximate positional accuracy of the digital geo-spatial data that your organizations produce or used?

a. [ ] More accurate than 1:1000 scale.

b. [ ] 1:1000 to 1:5000 scale.

c. [ ] 1:5000 to 1:10000 scale.

d. [ ] 1:10000 to 1:25000 scale.

e. [ ] 1:25000 to 1:50000 scale.

f. [ ] Less accurate than 1:50000 scale.

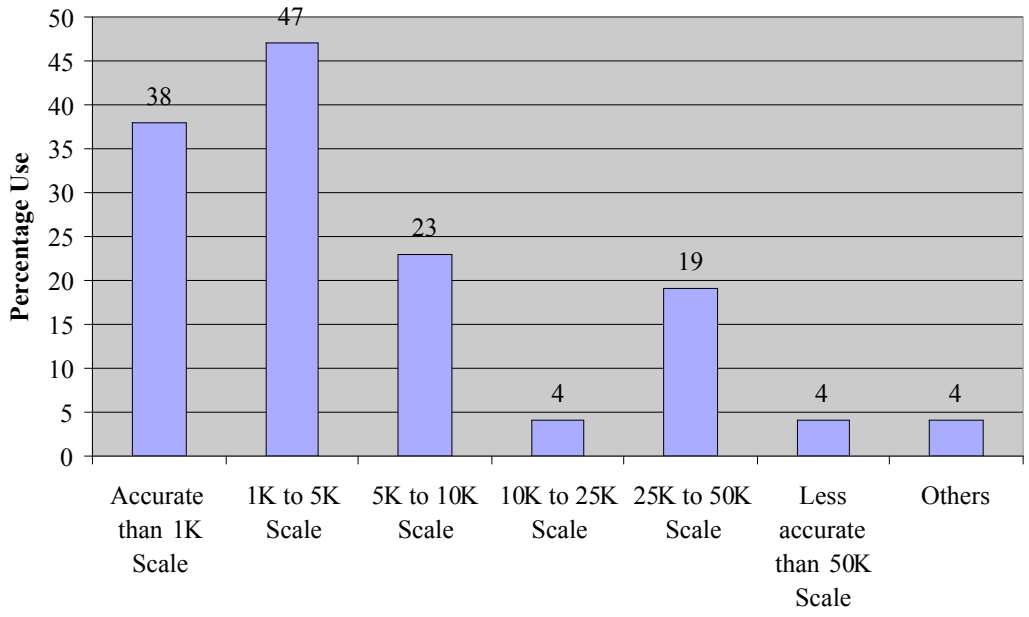

Figure A.41
Status of Positional Accuracy Requirement of the Organizations

Q42. What is the approximate vertical accuracy of the digital elevation data that your organizations produce or used?

a. [ ] less than one meter.

b. [ ] 1 to 5 meter.

c. [ ] 5 to 10 meter.

d. [ ] more than 10 meter.

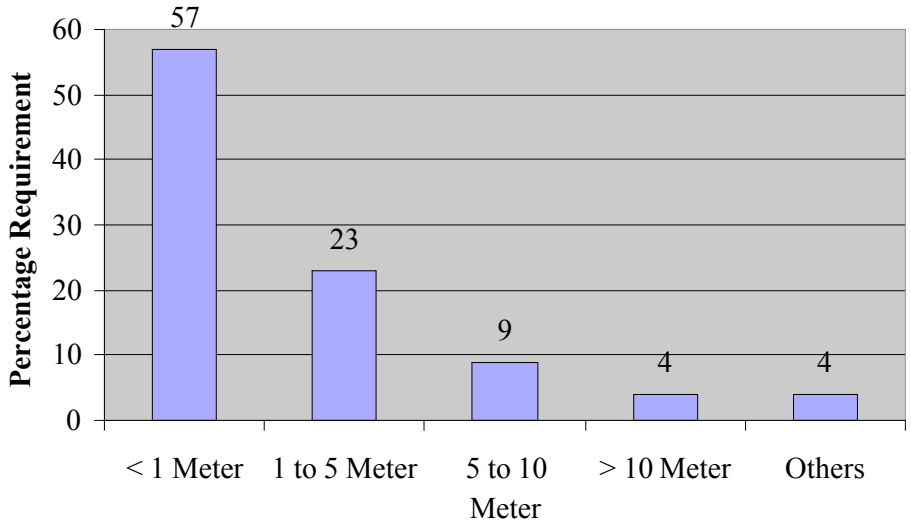

Figure A.42
Status of the Vertical Accuracy Requirements of the Organizations

Q43. What kind of ellipsoid does your organization use?

a. [ ] Clark1880. b. [ ] WGS84. c. [ ] WGS72. d.[ ] other.

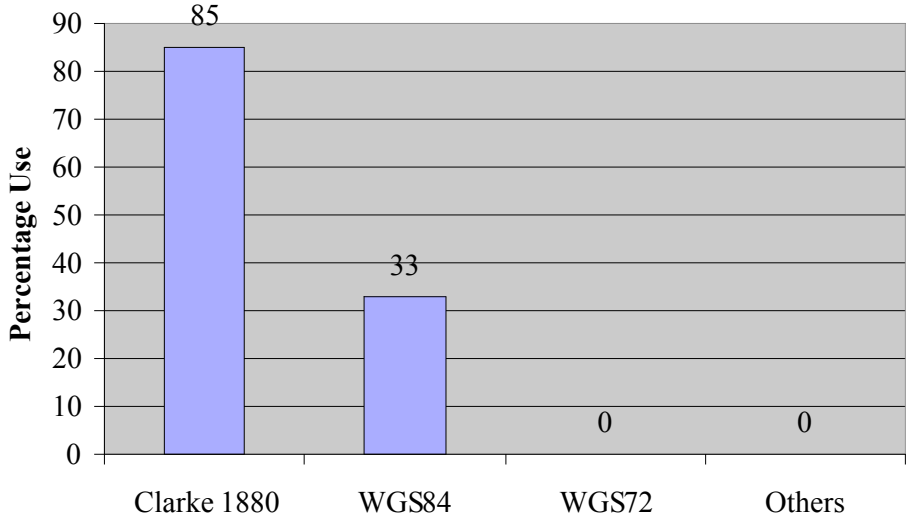

Figure A.43
Type of Ellipsoid Used in the Country to Geo-reference the data

Q44. What horizontal datum does your organization use?

a. [ ] Nahrwan. b. [ ] Adindan. c. [ ] Arc1950. d. [ ] other.

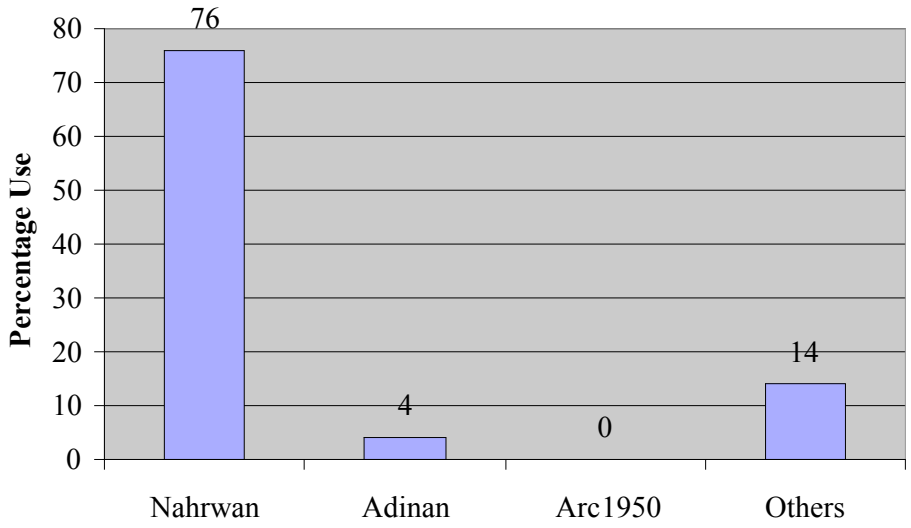

Figure A.44
Type of Horizontal Datum Used in the country

Q45. What vertical datum does your organization use?

a. [ ] Ras-ghumais b. [ ] Ghantut c. [ ] Abadan d.[ ] other.

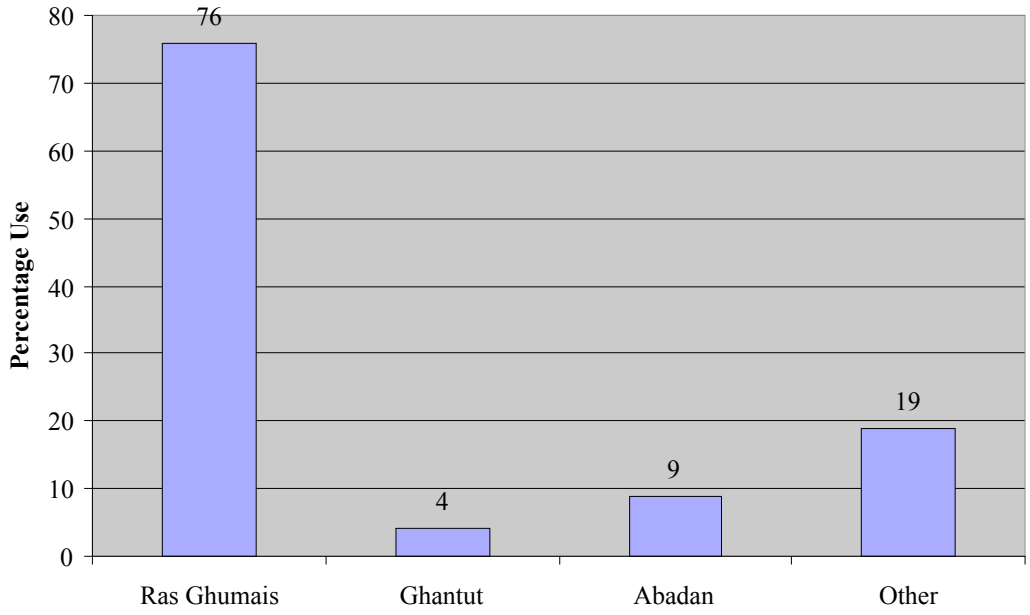

Figure A.45
Type of vertical Datum Used in the Country

Q46. What map projection does your organization use?

a. [ ] UTM. b. [ ] Cassini. c. [ ] Lambert conformal. d.[ ] other.

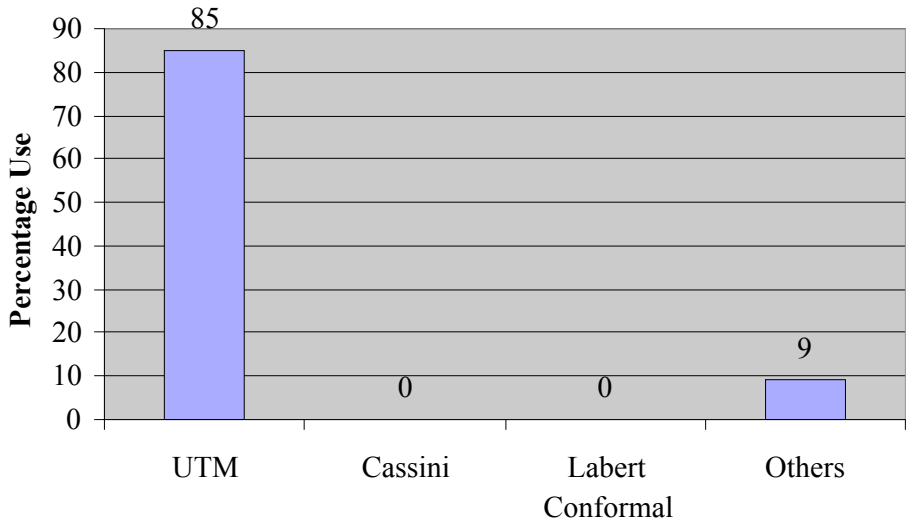

Figure A.46
Type of Map Projection Commonly Used in the Country

Q47. What kind of coordinate system does your organization use?

a. [ ] Cartesian coordinate. b. [ ] geographic coordinate. c. [ ] plain coordinate

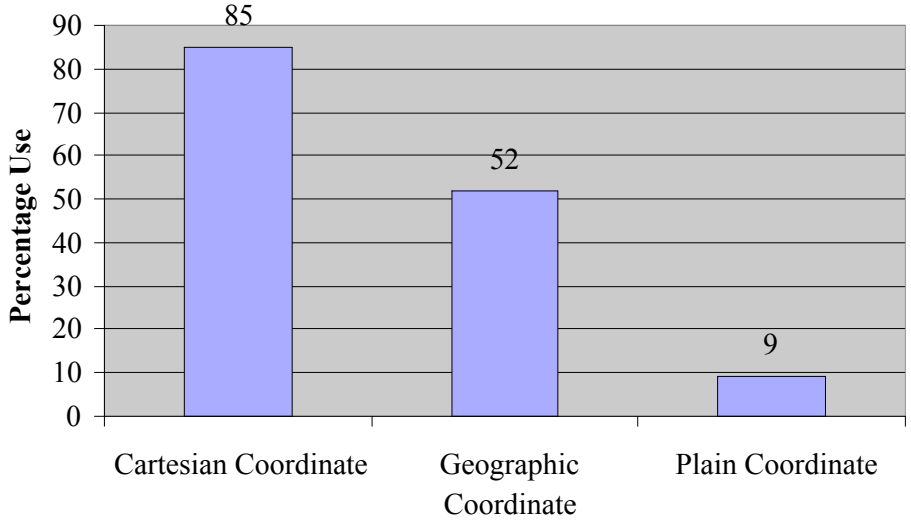

Figure A.47
Type of Coordinate System Used in the Country

VITA

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