Chapter 1

Introduction
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INTRODUCTION

I know of no more encouraging fact than the unquestionable ability of man to elevate his life by conscious endeavour.

-Henry David Thoreau

The present study seeks to analyse the role of Geographic Information System (GIS) and Remote Sensing (RS) in urban planning and infrastructure management in the Gulf Cooperation Council (GCC) countries. The fact that spatial technologies (Remote Sensing and GIS) had been implemented at operational level for urban planning and infrastructure/facility management in Kuwait and Qatar has led me to choose these as ideal case studies. Following intensive studies of the two countries an attempt would also be made to explore the present level of GIS technology in other GCC countries. It is expected that sooner or later such a technological implementation will take place at planning levels in the entire region (Gulf Cooperation Council). Therefore, the study might provide a framework for the same.

The Remote Sensing and GIS have emerged as efficient tools of urban planning in all parts of the world. These are new tools for urban planning and are at an experimental stage in most parts of the globe. Various pilot projects have been taken up in the developed as well as developing countries for better planning and management of their cities and towns. Since Asian countries are new as far as adopting this technology is concerned, as a planning tool, an effort has to be made to find out the feasibility and viability of adopting such a technology to suit their own environments.

The six Gulf States Kuwait, Qatar, Saudi Arabia, Oman, United Arab Emirates (UAE) and Bahrain form an organisation known as the Gulf Cooperation Council (GCC). All these countries portray similar features in terms of geography, economy and society. The GCC was formed following an agreement on the basic details of its charter on the 10th of March 1981.1 The

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organisation was formed to provide the means for realizing co-ordination, integration and cooperation in all economic, social and cultural affairs. Although defence and security were not mentioned initially in the charter, but later they agreed to include defence cooperation in the activities of the organisation.  

The Gulf countries are mainly oil producing and exporting countries. Due to the huge amount of oil income since the mid-1970s, these countries have been investing in the developmental programs. Today these countries are comparable to any developed country of the world in terms of infrastructure development. The use of GIS and Remote Sensing techniques for urban planning with the view of sustainable development, have been a part of their agenda for development and better management of the cities.

Geographical Information Systems are computer-aided decision support and planning tools, which integrate data from maps (spatial data) and other auxiliary data (attribute data) for a geographical area of interest. They can be used to create and maintain geographic databases and are eminently suited for 'what-if-analysis' in any planning related activity.

Remote Sensing (RS) is the technique for collection of information about an object or a physical phenomenon, without being in physical contact with it. The output is received in the form of aerial photographs or satellite imageries. The satellite imageries or aerial photographs provide the source of database pertaining to all features. On the basis of images, its intensity, colour, shape, texture etc., the features are identified using some specialized techniques, which provides the relevant information of a particular place. The information is stored in the form of database, which is an integral part of GIS. The technique of remote sensing provides up-to-date data of a place with high

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2 Details are given in Chapter 2.


level of accuracy. The technique also has provision for cross-checking the information with ground realities.

Urban planning is one of the main functions of GIS. Urban Planning uses GIS both as a spatial database as well as an analysis and modelling tool. The applications of GIS vary according to the different stages, levels, sectors and functions of urban planning. With the increase in user-friendliness and functions of GIS software and the marked decrease in the prices of GIS hardware, it has become an operational and affordable information system for planning. It is increasingly becoming an important component of planning support systems. Recent advances in the integration of GIS with planning models, visualization and aid of Internet will make GIS more useful for urban planning. But the main constraints in the use of GIS in urban planning today are not technical issues, but the availability of spatial data, organizational change and staffing.

In this study an attempt has been made to briefly highlight the traditional urban planning techniques and management of infrastructures and then to find out how the modern GIS-based urban planning and management have improved the situation in the Gulf countries. Since Qatar and Kuwait were the first countries in the Gulf to use GIS and remote sensing techniques for their developmental needs, their existing systems will be studied first. How these two countries have evolved the systems is the focal point of study that includes the study of problems faced in the process of development of these systems. The GIS set up of Qatar is known as Centre of Geographic Information System (CGIS), which is the managing body of GIS related issues and responsible for implementing country GIS. In Kuwait there are instances of GIS-based system for integrated infrastructure management known as Kuwaiti Integrated Infrastructure Management System (KIIMS) apart from GIS-based environmental management system. The KIIMS takes care of overall management of the infrastructure of the country, which includes road networks, bridges, sewer lines etc.

The study also attempts to explore the status of GIS implementation in other GCC countries namely Saudi Arabia, Oman, UAE and Bahrain and to
know as to why they have not come up with GIS-based urban planning. The study also tries to rationalize the changes and policies other GCC countries have to make to implement GIS-based systems which will arise due to diverse physical conditions, population size, economic conditions and governance.

**Objectives of the Study**

Against the above background the major objectives of the this study are as follow:

1. To understand the nature of socio-economic conditions of the GCC countries.

2. To compare the traditional and GIS-based urban planning and infrastructure management systems.

3. To do a detailed case study of the role of GIS and Remote Sensing in urban planning and management of infrastructure systems in Kuwait and Qatar.

4. To evaluate the different sources of data such as field surveys, aerial photographs and satellite imageries which GCC countries are using for GIS-based Management Information System (MIS).

5. To investigate the problems and prospects of using GIS-based urban planning and infrastructure management systems in other GCC countries.

**Survey of Literature**

Urban planning has emerged as a critical issue in the modern world as more than 50% of the world's population is presently dwelling in the urban areas. The pressure on urban centres is mounting day by day due to growth of their size and population, which is reflected in the mismanagement of infrastructure. These problems are of grave concerns particularly in developing countries.
Urban planning has a long history in different nations of the world. The urban planning practices adopted by developing countries have been enumerated in the book by John L. Taylor and David Williams entitled *Urban Planning Practices in Developing Countries*. This book explains the policies adopted by countries like India, China, Korea, and Indonesia etc. The Gulf countries are totally left out. The urban planning practices in the Gulf countries are described in the book by Hugh Roberts titled *An Urban Profile of the Middle East*. But this description is very selective, and considers only a few cities in Oman, Kuwait, Iran and Morocco. There are other works too on urban planning like Liu Thai-ker’s work on *Urban Planning and Development in Singapore: Its Relevance for Other Cities*, Ivan Turok's work on *Competition and Area Selection in Scotland New Urban Policy* etc. After surveying all the available information we find that there has not been any focussed work on the GCC countries in terms of urban planning. Hence there is an eminent need to reflect upon these issues in greater details.

In the modern world of technology, most of the systems have been automated to achieve the goal of efficiency and promptness in day-to-day life. In this direction, urban planning is no exception. The emergence of GIS technology has revolutionized the way we work in different fields such as planning, site selection of facility; transport planning, managing business activities and so on. GIS and remote sensing have been utilised by many countries for better planning and management. The survey of literature reveals that GIS and remote sensing have been utilised in many pilot projects in India. For instance, the E-governance exercise of Mirzapur in UP is the best example. Apart from this, Kerala is using it for transport planning, Andhra Pradesh and Maharashtra are using for municipality planning. Other states are also catching

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up gradually. Some studies have been done in India for instance, R.L.P. Singh’s work on Application of GIS for Preparation of a District Plan: The Bharatpur Experience, in which he has explained how GIS has been used for district planning.  

There have been some instances of using GIS in urban planning and infrastructure in the Middle East countries in general and Gulf countries in particular. There is hardly any published material, which explains about the level of application of GIS technologies in the Gulf countries. Some information is available on the Internet, which is an abstract of a seminar held on this issue in 1998. Several papers were presented in the seminar, which throw some light on the particular issue. Some of the papers are being mentioned here.

A summary paper was presented by Gottfried Konecny on the topic ‘Potential of GIS in the GULF-Region’ in which he has explored the different uses of GIS in different Gulf countries. This paper provides some insight into the level of its use in the Gulf. But it is just introductory in nature and refrains from explanatory inputs. It can be used as a base for further explorations that need to be done thoroughly.

Another relevant paper was presented by Sheikh Ahmed Bin Hamad Al-Thani on the topic ‘GIS in Qatar - An Integral Part of the Infrastructure’ in which he has explained how and why GIS has been adopted in Qatar for infrastructure management. The presentation was merely indicative of the quantum of further exploration on the subject. Another paper was presented by Hussain Jama Ismail Bait-Ishaq and Philip Burden entitled ‘GIS Implementation in the Ministry of Water Resources in Oman’ in which they have described how GIS has been used in water resource management in Oman.

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improving the overall management and water supply in the country. Yet another paper titled 'Kuwait Infrastructure Maintenance Management System' (KIMMS) was presented by Abdul-Aziz Abdul-Rahman Al-Kulaib. In this paper he has described how GIS is being used in maintenance of infrastructure, which includes Bridge management system, Road management system, Sewer management system etc. The author has given the details on how the system was developed and how it is functioning.\(^{12}\) Another paper was presented on Kuwait on the topic 'Towards a GIS-Based Environmental Information System for Kuwait' by Dr. Abdul Nabi Al-Ghadban, Kuwait Institute of Scientific Research (KSIR), Kuwait. In this paper all technical details are given as to how environment planning has been done in Kuwait using GIS.\(^{13}\) Mr. Khaleefa Waleed Al-Jassim has given some insight of urban planning in that explains the use of GIS in the Kuwait municipality.\(^{14}\)

How GIS is being used by the National Survey Authority in Oman was explained in the presentation of Mr. Abdallah Bin Ibrahim Al-Balushi entitled 'The Use of GIS National Survey Authority'. The National Survey Authority is the national mapping agency of the Sultanate of Oman. It was established in 1984, replacing a small Ministry of Defence Office, which had been responsible for the procurement and supply of maps and aerial photographs for both Defence and Civil purposes.\(^{15}\) A paper on 'The Role of GIS in the Development Planning of the Islamic Capitals and Cities' was presented by Amir Ali El-Sabban, Technical Director, Organization of the Islamic Capitals and Cities (OICC), Jeddah, Saudi Arabia. This paper aims to analyse different

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\(^{13}\) Dr. Abdul Nabi Al-Ghadban, "Towards a GIS-Based Environmental Information System for Kuwait". www.gis_esri.com.


applications derived from Geographic Information Systems implementation in the 54 countries of the OICC.\textsuperscript{16}

Lebanon has been using GIS for Integrated Spatial Information System, Staged Waste Water Program, Environmental Impact Assessment, damage assessment of Public building and infrastructure, Community development etc.\textsuperscript{17} as per information given by Jacques Ekmekji, Director GIS Services in his presentation titled ‘Implementing GIS in the Lebanon - A Case Study’.

To make a summary of the present GIS efforts in the Gulf area we can argue that GIS activities have been taken up in all the Gulf States. In Bahrain the emphasis is to bring the efforts of the Central Statistics Organization, the Ministry of Housing, and of Batelco under one standard.

In Kuwait, Kuwait Municipality started out with the design of an integrated urban information system for mapping topography utilities, and the cadastre in 1983. The effort is now extended for planning. The utility ministries are now interested in facilities management, and the Ministry of Defence has automated the provision of small-scale map data, which is needed in projects by KISR.

In Oman GIS uses can be found with the Ministry of Water Resources, the National Survey Authority, and with Petroleum Development. Qatar is a leading example in the world for an integrated GIS.

In Saudi Arabia various GIS activities are taking place for instance, at Arab American Oil Company (ARAMCO) and Telecom industry for facilities management; in the military for mapping; at some universities for projects; and in most of the municipalities for an urban GIS. In the United Arab Emirates all major municipalities such as Abu Dhabi, Al-Ain, Dubai, and Sharjah are using this technology. Apart from this GIS is being used in oil industry, military, and in various utility agencies in varying degrees.

The above survey of literature reveals vividly that GIS has been used in the Gulf countries in various fields. But what is the level of use in urban


\textsuperscript{17} Jacques Ekmekji, “Implementing GIS in the Lebanon - A Case Study”, www.gisqatar.org.qa.
planning and infrastructure management is almost an unexplored field. Since they are using GIS for different purposes, the under-utilisation in urban planning is questioned. Even if they are using it in the urban planning and infrastructure management it needs to be explored and documented so that it can be useful for other economies as well. It is now evident that no work has been done in the Gulf countries in terms of use of GIS and remote sensing in urban planning and infrastructure management. Hence this work is likely to be a pioneer in the field.

Conceptual Framework

The increasing urbanisation of the world's population is inescapable and irreversible. This goes to show that it is necessary and fundamental for policy makers to make technologies like GIS and Remote Sensing imperative for urban planning. Urban planning is a complex phenomenon, which requires enormous amount of data to support the decision. The local authority requires an information system, which will be able to monitor and surveillance the planning regulations and will work as an early warning system. The application of GIS in planning and management is very common in the local authorities in developed countries but in developing countries very few local authorities have invested in GIS. It is mainly due to the high cost and lack of support from the higher management levels.

In the decentralised mode of planning in any country it is obligatory for all local authorities to prepare a Development Plan for the entire area within their jurisdiction. The preparation of this Development Plan goes through various stages and data are obtained from the field survey as stipulated in the Town Planning Act. But unfortunately all these plans are hand drawn hence they consume lots of time for their modification and retrieval. These maps are

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extensively referred to in the Development Control Regulation. The process of Development Control Regulation also becomes time consuming due to the manual process adopted in this case. All these Development Plans can be digitised and GIS can be customised for the purpose of controlling and monitoring development by gathering and updating data, managing database suitable for GIS application and developing user interface and customised application.\(^\text{20}\) This will help different departments to use the database, which has been developed for monitoring which will make the activities of the local authorities faster and economical.

GIS is just one of the formal computer based information system capable of integrating data from various sources to provide the information necessary for effective decision making in urban planning and infrastructure management.\(^\text{21}\) Currently, GIS supports efficient data retrieval, query and mapping. As a toolbox, GIS allows planners to perform spatial analysis, using geo-processing functions such as map overlay, connectivity measurement and buffering.

A substantial portion of these information is geographical in nature such as layout of housing schemes, road and drainage systems, composition and distribution of population, distribution of land use and so forth.\(^\text{22}\) Unfortunately, these data are often inaccessible even to the local administrators. The main reason being the database management system, which is, based on manual filing system which makes retrieval of data difficult and time consuming. Given the dynamic nature of planning and management carried out at local level, it is not surprising that local authorities become one


of the largest users of GIS in advanced and developed countries. But in developing countries very few local authorities have invested in GIS.

The implementation of GIS for the purpose of controlling and monitoring development involves the following stages: Data gathering and updating, development of GIS database, development of user interface, application of GIS database.

**Hypotheses**

The following hypotheses has been tested in the study:

1. GIS-based urban planning and management of infrastructures have great potential for small countries like Kuwait and Qatar.

2. Geographical specificity of the Gulf countries such as their small geographical size and high level of national income have influenced the investment patterns in infrastructure development.

3. The GIS-based Management Information System is more effective than traditional management/administration practices.

4. The existing GIS packages have sufficient potential to work as a part of GIS-based Management Information System.

5. The implementation of GIS-based urban planning and infrastructure management system requires certain qualitatively parameters such as training the manpower and public awareness.

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Methodology

The proposed study has adopted the explorative and comparative methodology. Since all the GCC countries are identical in terms of economy, social structure and physical settings, the nature of urban planning is likely to be similar. Having this in mind, an attempt has been made to study the use and implementation of GIS technology in urban planning in the pioneering states of Qatar and Kuwait. The evaluation of these systems is being done and their success as well as pitfalls is found out. An attempt has also been made to explore the implementation of such system in other Gulf countries namely Saudi Arabia, Oman, Qatar and the UAE.

Apart from secondary sources of information, primary and first hand information has been collected through fieldwork to the countries under study. In order to collect the first hand information field visit to the Kuwait, Qatar and UAE was made with the financial support of the university and Indian Council for Social Science Research (ICSSR). Since secondary data was not sufficiently available, the emphasis was given on personal interviews with the concerned officials.

The visit to the Kuwait was from 6 April 2004 to 4th May during which I visited the agencies that are using GIS and Remote Sensing technology such as Kuwait Municipality and Kuwait Institute of Scientific Research. Interviews with the top officials of these organisations and other academics were also conducted. Some relevant material was also collected from Arab Planning Institute and Arab Town Organisation.

The two weeks visit of Qatar also proved very helpful in accomplishment of the study. Apart from visiting the Centre for GIS (CGIS), the nodal agency for GIS implementation in Qatar, extensive interviews with various GIS user agencies such as Road, Telecommunication, Electricity, Town Planning, Sewer etc. were also conducted. On-site demonstration of GIS system functioning given by the user agencies gave further insight into the application.
In the UAE, interviews with the officials of Dubai Municipality, Abu Dhabi Municipality and Al-Ain Municipality, especially Town Planning Departments were conducted. This exercise enabled me to gather first hand information about their implementation of GIS technology.

Scheme of Chapterisation

The present study consists of a total of seven chapters. First chapter is the introduction of the study that includes an overview of Remote Sensing and GIS technology, urban planning, conceptual framework, literature review, rationale of study, objectives of the study, hypotheses and the methodology adopted.

Second chapter deals with theoretical premises of Remote Sensing and GIS techniques and urban planning in greater detail. Synthesis of spatial technology with urban planning and infrastructure management constitutes the second section of the chapter. Theoretical framework provides a priori understanding of the technology and its application in various fields of natural resource management in general and urban management in particular. The chapter facilitates the comprehension of GIS application in the study area.

Third chapter introduces the study area in terms of their historical, socio-political, demographic, economic background and infrastructure development. The chapter aims at presenting a complete profile of the study area for the better understanding of the background against which the technology in question has been implemented. The chapter also traces the formation of GCC with its goals and objectives.

Fourth chapter presents the detail account of implementation of GIS and Remote Sensing in urban planning and infrastructure management in Kuwait. The chapter begins with exploring history of urban planning in the country covering GIS in Kuwait Municipality, Ministry of Public Works for facility management. It also covers the GIS-based Kuwait Environmental Management System.

Fifth chapter describes the evolution and functioning of GIS in Qatar. A comprehensive analysis of GIS application in different utility agencies of the
country such as road, sewer, telecom, electricity, water supply etc. has been made in this chapter. The chapter presents the complete account of integration model of infrastructure development and management adopted in the country that can be an example for other countries.

Sixth chapter attempts to explore the GIS application in other GCC countries such as Saudi Arabia, Oman, Bahrain and UAE.

Seventh chapter, which is the last one, draws a comparison between both Kuwait and Qatar in terms of GIS implementation and level attained apart from summarising research findings and drawing broader conclusions of the study. Some policy implication for India has also been outlined for the building up National Spatial Data Infrastructure.