Chapter 7

Summary and Conclusions
SUMMARY AND CONCLUSIONS

Urban planning is conceived as the art of shaping and guiding the physical arrangement and structure of towns in harmony with socio-cultural, economic and environmental needs. A comprehensive town plan includes proposals with regard to communication network, buildings layout, preservation of civic amenities, zoning regulations, open spaces, local development schemes and environmental concerns. A carefully developed plan is a four-stage process which includes statement of the goal, analysis of system structure, evaluation and selection of suitable solution and design for implementation. Development of urban plan is a complex process which requires enormous amount of data to support the decision making process. A substantial part of this information is spatial in nature such as layout of housing, road and drainage system, land use/land cover etc. Such type of data is provided by latest spatial technologies of Remote Sensing techniques, Geographic Information System and Global Positioning System in combination.

Geographic Information System (GIS) is a set of tools for collecting, storing, retrieving, transforming and displaying spatial data from real world for a particular set of purposes. The data in GIS is acquired through different means such as maps, reports, field surveys, aerial photography, satellite images etc. The spatial technology integrates the data from all sources forming a centralised database. The data in GIS is stored into two formats namely spatial and non-spatial. The features that have geographical location are under the preview of spatial data. The information and details of these features are called non-spatial or attribute data. Whole range of spatial data in GIS is represented with raster and vector data models. In raster model data represented are stored in the form of regular grid of cells that plays a vital role in carrying out various GIS analyses. The vector model stores data in the form of point, line and polygon defined by x and y coordinates.
The heart of GIS lies in its analytical capabilities which is primarily a process for looking at geographic patterns in the data and finding relationships between features. The spatial operations such as overlay, buffer, 3D modelling and network analysis empowers the GIS system to carry out complex analyses for realistic decision-making. Apart from data storage and graphical display, GIS has also the ability to examine locational aspects such as proximity, accessibility, connectivity and density. The technology also provides ground for what-if analysis to reach at an optimal solution.

Hence, GIS is essentially perceived as a tool for urban and regional research, policy analysis, policy simulation and planning.\textsuperscript{1} The well-developed spatial information system makes tangible contribution in land and public utility management for their effective planning.

Remote Sensing data is one of the most important sources of information about the surface of the earth. The technique, through which information about an object or physical phenomenon is collected, without coming into any physical contact with the same, is known as Remote Sensing. The basic principle behind this technique is Electro Magnetic Radiation (EMR), radiated from the objects with different intensity. All objects on the surface of earth emit different amount of energy in different wavelength based on their structural, chemical and physical characteristics which is unique to each of them. The sensor on-board in the satellite records the energy received that subsequently forms an image. The geo-referenced images are true representation of the ground. Using various elements such as colour, texture, tone, shape, size, pattern etc. the information is extracted from the image that may be used for decision-making.

The Remote Sensing data can be acquired in the form of aerial photographs and satellite images. The major players in this field of satellite data are LANDSAT, SPOT, IRS, IKONOS etc. In all these products spatial resolution determines the quality and level of information in the imagery. The selection of the image type depends upon the level of information required. The

launch of high-resolution satellites such as IKONOS and QuickBird has opened new vistas for urban information base with greater detail.

Determination of coordinates is basis for any spatial system to work. Although coordinates are available in the base maps but the precise readings of local features are not available. This is where Global Positioning System (GPS) plays a vital role. GPS is a set of satellite and control system that allow a specially designed GPS receiver to determine its location anywhere on the earth, 24 hours a day. In urban planning the device is used for determination of accurate coordinates of the utility or any parcel which is used as reference. One of the significant applications of GPS today is online vehicle tracking system.

**Urban Planning and GIS Synthesis**

In all spheres of urban planning and management, spatial technologies have a greater role to play due to the fact that such activities necessarily have spatial component. The blend of planning objectives with modern spatial science has resulted into better management and maintenance of urban infrastructure across the globe. Various urban related issues that were difficult to deal with in the past, in absence of such technological development have become easier today. Once GIS integrates the spatial and attribute data, the planner has powerful tool at hand to be used for information dissemination and spatial analysis.

The implementation of GIS for the purpose of controlling and monitoring development plan involves data gathering and updating, development of GIS database, development of user interface and application of GIS database. Such activities culminate into the origin of an integrated system where same data can be utilised by various departments.

Although urban planning is the largest user of spatial technologies but its implementation is not problem-free. The biggest hurdle is the availability of reliable data especially at local or micro levels. The infrastructure maps are either not available or badly maintained. Accurate data is very crucial for any successful GIS system.

The advantages of GIS and Remote Sensing in urban planning are manifold. The satellite images obtained from Remote Sensing techniques
provides synoptic view which provides a real perspective of the whole area to the planners where plan has to be implemented. The images of different time periods and their interpretation form the historical record depicting evolution, form, function and morphological structure of the city through corridors of time. The information of land occupancy, landforms, and spatial arrangement of structure and patterns of city is natural output of Remote Sensing products.

Base map preparation is another significant area of application for spatial technology. Remote Sensing equips us with the tool to prepare the latest base maps that forms the ultimate geographic reference for all information pertaining to land, its use and ownership. The historical geographic data helps greatly in change detection in terms of land use, city growth which is a valuable information for planners. The dynamic nature of the city constantly requires the update of infrastructure facilities at specific location. The decision of the location of these facilities should be located is a critical issue. The analytical tools of GIS provide this solution, where defined criteria are fed into the system to get suitable site for locating a facility that serves the area optimally. Such kind of job is not possible by traditional methods.

The study area, the Gulf Cooperation Council (GCC) countries, is amongst the most high per capita income nations of the world. The six-member organisation was formed in 1981 with the objective to protect the economic, social and cultural interests apart from security, through mutual cooperation and coordination. Similar characteristics in terms of geographical size, economy, society, culture, religion and language provide an obvious ground for the formation and smooth functioning of the organisation.

The society of Arab Gulf is often referred to as patriarchal which is essentially a pre-modern society based on kinship and tribal values. Such type of social formation is characterised by dominance of males in decision-making and defining social relations. Whole society of the region had been divided into numerous tribal groups defining the identity of a person. The Ottomans consolidated the Arab region and ruled over, before the power was transferred to the Britishers.
The inherent patriarchal nature of the Arab society perhaps shaped the present day political systems in the Gulf countries. After liberation of the these countries from colonisers in 1960s, the power was handed over to the present ruling families in each of the Gulf states, for instance, Al-Saud in Saudi Arabia, Al-Sabah in Kuwait, Al-Thani in Qatar, Al-Khalifa in Bahrain. They founded the monarchical form of government where Emir or Sultan is the ultimate authority, ruling the country with the help of self-appointed ministers belonging to his family. The power is transferred to the crown prince after the death of the monarch. Though the process of democratisation has begun, but at a slow pace. Comparatively, Kuwait is more liberal in terms of holding elections and empowering its citizens with voting rights including females.

The economy of the Gulf countries is mainly based upon secondary and tertiary sectors whereas the primary sector has negligible share. The common economic thread that binds them together is the huge wealth of oil and gas reserves. The largest share of national income is derived from these natural resources therefore, the Gulf economies are rentier in nature. The oil boom in 1970s revolutionized the economy of Gulf states altogether, where largest share in Gross Domestic Product (GDP) has been oil revenue. Comparative figures suggest that in absolute terms the GDP may not be high, but in terms of per capita income these countries are at par with the developed nations of the world. The growth rate of GDP is indeed promising, which is around 5 per cent per annum. But this growth rate may not adequately represent the development of their economies because the high growth rate is the result of exploitation of available non-renewable natural resources rather than other sources. The fact that the Gulf economies are still one of the largest importers of durable and non-durable goods in the world, reveals the kind of production process they are engaged in. Although many of them are making efforts to diversify the economy but non-availability of the required raw material have confined them to the establishment of only oil-based industries. Therefore, the Gulf economies cannot be regarded as stable ones in absence of strong industrial base. It would be difficult for them to sustain with the non-renewable natural endowment for longer period of time.
Geographically, the small size of the GCC countries characterised by the hot and arid conditions leading the region to acquire desert character has limited the scope of agricultural development. The population base is also very small ranging between less than 1 million to 3 millions in most of the states, Saudi Arabia being an exception. The Gulf States are among the nations that are experiencing high population growth rate. The situation is not alarming, but in view of the dwindling natural resources and increasing demand for investment in social capital has resulted in adopting various measures to bring down the growth rate. The improved medical facilities have brought down the mortality rate whereas fertility rate remains more or less the same resulting into high percentage of natural growth rate. The study has remarked that about 40-50% of the Gulf states' population is below 15 years of age. This condition has obvious consequences necessitating more and more investment in human resource development for providing education, health and employment opportunities.

One of the peculiar features of the Gulf countries is the large-scale existence of foreign manpower. In 1990, foreign workers comprised two-third of the total population of the Gulf. The highest concentration is in the UAE followed by Qatar and Kuwait. Since the expatriates perform most of the work, often they outnumber the citizens. The welfare nature of state has imbibed the reluctance towards work culture among the nationals. The heavy dependence on expatriates is result of lower population base, lower female participation in labour force and lack of technical training. But now these states have formulated a policy to replace foreign manpower with the citizens within stipulated time frame. There are laws stating that any public or private firm has to employ certain percentage of national work force. As a result, various vocational training institutes within the states are operating currently to train the nationals in order to take up future jobs. It was concluded from the field visit that most of the administrative positions are given to the nationals irrespective of their qualification and experience. The current trend indicates that the number of expatriates will go down appreciably in near future.
One of the striking features of the GCC countries is the high level of urbanisation. All of the Gulf countries have urban population of more than 80 per cent and some of them even touch a figure of 98 per cent, in compare to the world figure being about 50.5 per cent. The study reveals majority of the Gulf population is concentrated in the capital cities and urban agglomerations. Low level of total population of these countries has not posed much problem in managing concentration of the people in urban centres. Adequate infrastructure facilities had been provided to the citizens without any interruption. But today due to the rapid growth of population the pressure on urban infrastructure is mounting up. Hence, countries of Gulf region are developing new townships in different capacities providing with modern infrastructure to accommodate additional population and release extra burden of the existing cities.

The development of social sector in the Gulf countries has been impressive. The welfare-oriented governments have invested heavily in the social amenities that have resulted in improvement of the standard of living. The ambitious and consistent effort towards educational facilities has improved the literacy rate of the native population remarkably in recent decades. The average literacy rate of the region was about 80 percent in 2000. Health care system in the GCC countries is one of the finest in the world. The number of specialised hospitals, clinics, doctors per thousand population and other related indicators have gone up.

Infrastructure development in the GCC countries today is one of the best in the world. The huge oil money has attracted best consultants and companies of world to build the infrastructure. The excellent road conditions and 6 or 8 lane expressways provide better connectivity. Personal vehicles are preferred rather than public transport. Other amenities such as water supply, communication network, drainage and sanitation are also well developed. More than 90 percent houses are provided with safe drinking water on regular basis. Access to sanitation is also nearly 100 per cent in most of the states. The telephone network is widely spread over the country and the service is provide free of cost, except a nominal fee for the connection. Uninterrupted electricity supply is also a basic feature of provision of public facilities here. The
government provides built houses to the citizens in case they don’t want to build their own houses. Multi-storeyed residential towers with suitable planning are built to accommodate the people.

The influx of huge oil money has set the stage for investment in infrastructure development through adopting new technologies. Entire Gulf region is at incipient stage in terms of adoption of the GIS technology in urban planning and infrastructure management except the State of Qatar where it is fully operational. The successful GIS implementation in Qatar is attributed to the integration model on which whole system is working. But the current status is achieved through consistent effort and high degree of motivation, recognising the potential of this very technology.

Among Gulf countries the United Arab Emirates has also made remarkable headway in terms of GIS implementation. The major user of this technology are the municipalities besides telecommunication services provided by Etisalat. Among the different Emirates of the UAE, the Dubai Municipality is leading other ones as far as advancement in Information Technology is concerned. Only Dubai Municipality could make GIS public and influence the life of common man through launching its website. All the locational information of the city can be retrieved. Abu Dhabi Municipality is the oldest user of GIS especially in Town Planning Department. Other utility agencies are also moving towards this direction. Abu Dhabi Municipality also has plans for integrated GIS covering all the utility agencies in the Emirate. Al-Ain Municipality has also witnessed application of GIS in various departments of the municipality. But still they are in transitional phase of transferring from GeoMedia platform top the Enterprise GIS.

The status of GIS in Bahrain is also promising. The 12 municipalities of Bahrain are in the process of implementing spatial technology in various fields such as urban planning, resource management, cadastral mapping etc. In near future it is expected that Bahrain will implement an integrated and country-wide GIS system through its centralised GIS centre.

Oman has also witnessed the adoption of GIS technology in different fields such as Water Ministry, Land Survey Department, Environmental
Management etc. Although spatial technology has been started in the urban management but its full potential has not been realized. The country seems to be enthusiastic about implementation of this technology in maiden areas too.

The Kingdom of Saudi Arabia started GIS application through its Space Research Institute administered GIS lab based in Riyadh. It has also received international award for implementation of GIS. The Kingdom has lot of scope to use the technology for urban planning especially where it has not shown much advancement.

Since the focus of the study is the Kuwait and Qatar, a comparative analysis is being attempted in the following sections.

**GIS in Kuwait and Qatar: A Comparative Analysis**

The evolution of GIS in Qatar was steered by a top government official, Sheikh Ahmad bin Hamad Al-Thani, who is recognized as champion of GIS in the state. Under his dynamic leadership, a user need study was conducted in 1989 across all the government departments, especially utility agencies. The recommendation of the survey committee resulted into formation of a nodal agency known as Centre for GIS (CGIS). The role of this agency was to implement GIS in the state in the systematic and organised fashion involving all the government agencies. Thus, the CGIS played the fundamental role in implementing GIS in Qatar.

The GIS in Kuwait saw light of the day due to the lead taken by the Kuwait Municipality, particularly in urban planning. An ambitious project known as Kuwait Utility Data Management System (KUDAMS) became the foundation and starting point for GIS implementation in Kuwait subsequently. Transformation of paper-based utility network records into digital copy was a commendable job performed by this project that paved the way for adoption of fully functional GIS system in Kuwait. The superstructure of present day GIS application was built on available database with KUDAMS. The Municipality of Kuwait shouldered the responsibility of conversion of data from CAD format to GIS with the help of ESRI, a world fame GIS solution provider.
Presently in Qatar, there are 17 ministries and agencies using GIS as an integral part in their planning and management tasks. All the utility and infrastructure agencies such as telecom, road, drainage, water, electricity, planning council, cadastral and land registration etc. are the major user of GIS technology in their day-to-day operations. All of them use a common dedicated high-speed fibre optic network known as GISnet, to access the data from the central server. Telecom agency (Q-Tel) is the largest user of GIS that includes planning, execution and maintenance of its network efficiently with the help of the ArcView GIS based application called TEAMS. The Ministry of Electricity uses GIS intensively for planning, transmission and distribution purposes. Various GIS based applications have been developed in the ministries such as water, road and sewer to carry out their daily operations. Each application is developed for specific tasks within the departments.

In Kuwait, only a few ministries and agencies have implemented GIS as a scientific tool for performing their routine task in better way. The potential of GIS is not recognised fully by the different ministries. The largest user of GIS is the Kuwait Municipality that has discretionary power to ensure the realistic and futuristic comprehensive planning and development of the city. Recognising the prospects of the spatial technology the Ministry of Public Works began to introduce it in infrastructure management. But the use of GIS is partial in their whole function, it merely represents the data on the computer screen spatially. A GIS based comprehensive Environmental Information System has also been developed for Kuwait enabling different user groups for visualisation and analysis of environmental issues for policy formulation. No indication was found in other ministries for the use of GIS during the field survey in substantive manner.

**Urban Planning**

In the backdrop of haphazard city growth, especially Doha, the capital city of Qatar, the government developed the Master Plan in early 70s. Witnessing the complexities and dynamism of urban planning in modern era, the Ministry of
Municipal Affairs and Agriculture started taking initiatives towards implementing modern technologies such as GIS to control and guide the countries development. Therefore, GIS application was made a fundamental part in Physical Development Plan (PDP) of the Qatar initiated during 1994-97 period. After preparation of base maps, the policy map was overlaid to find out the areas where particular planning regulation was supposed be implemented. The policy map of a specific area is obtained through overlaying the national policy map on the local area map that is linked with policy texts too. The GIS made these maps accessible in various combinations at all geographic detail. As a GIS based planning tool, the PDP has been formulated to maximize the electronic search, retrieval and analysis feature of the spatial technology. The usability of this data structure relies to a larger extent on GIS' ability to integrate both spatial and non-spatial data. All the final PDP plans are in the GIS format which help effectively to plan, control, monitor and assess the ongoing and proposed development projects and find development alternatives.

The study reveals that Kuwait Municipality has also been active user of GIS technology as planning and management tool. Kuwait Third Master Plan incorporated GIS as an integral part during 1991. The current plan also known as Review of Third Master Plan keeps all the urban maps defining regulations and policy frameworks. The location of facilities like school, market, parks etc. need in-depth analysis to find its optimum utilisation. The Kuwait Municipality surpasses the Qatar counterpart by carrying out site suitability analysis, a major function of urban planning. By accessing the municipal site online the owner can see the planning regulation applied to his plot that saves time of the officials as well as citizens in sharing this information. In spite of achieving such an admirable position, there exist a further scope of improvement within the system. With the facility to update and produce town plans and maintain inventory of land use and facilities, it can be extended to perform 3-D
evaluations and the visual impact of proposed development in order to perform
data analysis, as developed in Hong Kong.2

Parcel Information Systems (PIS) in both the countries are very
comprehensive providing every details of the parcel. The role of PIS is to keep
record of land parcel boundaries and land status information for all private and
government plots, to prepare cadastral maps and to provide enquiry facilities.
With land parcel boundaries it also contains the associated information such as
land status, long and short leases, date of expiry of leases and proposed land
uses. In both the states of Kuwait and Qatar, the provision has been made to
browse and zoom at each parcel visually or else one can enter the unique parcel
number to display the required plot with its details through accessing the
websites.

The development of PIS is not unique to these states. Various other
countries have implemented GIS for this purpose but covering normally single
city. But the Qatar and Kuwait have done it for the almost whole country which
is a gigantic job. The best part of their system is that everything is available on
the Internet and is accessible to all.

Infrastructure Management

The implementation of GIS in infrastructure development and management has
been inspiring in Qatar. The utilities such as electricity, water, telecommunication, road and drainage began with its application in a big way.
Initiated in late 1990s, the way public services are provided by these agencies
have been transformed due to application of spatial technology with the turn of
the century. Today, due to digital database interspersed with spatial location of
the utility and its visualisation helps the agencies in its planning and
maintenance of the same. For instance, the telecom agency (Q-Tel) in Qatar,
locate the place on the map from where any request of new connection is

2 Anthony Gar-on Yeh, “LIS in Hong Kong”, in Les Worrel (ed.), Geographic Information Systems:
received. The planning map and physical network of the telephones are displayed with its full details such as main line, connection cable, distribution point etc. Once the area map is displayed, the nearest distribution point is located and new connection is provided. The whole task is carried out without physically visiting the site except for the connection of cables, reducing much time wasted in physical survey. The fault management has also become very painless due to the search option with the help of Q-Tel ID, provided by the system developed, known as Telephone Locating System. The system locates the place of fault spatially and prints the address to be handed over to the maintenance department for quick fixation. The electricity and water department are also using similar methods. The study underlines the fact that Qatar has gone far ahead in adoption of GIS technology in the field of infrastructure covering almost every agency which has proved very successful.

But, Kuwait is yet to catch up with the technology in the field of infrastructure management. The Ministry of Public Works responsible for providing such facility is using the technology of GIS in minimal way. The services covered by the ministry are mainly pavements, bridges, right of the way, storm water and sewer systems. All the information related to these infrastructure is stored in Oracle database and the interface is designed by using the Developer 2000, making KIIMS operational. The GIS is merely used for displaying the map and positions of the segment requested. Hence, there is ample scope to improve the system for better management of infrastructure in the background of ever-changing and dynamic nature of urban systems. Other ministries such as water and electricity or telecommunication have not shown any headway towards the adoption of such technology as of now. But in future rest of the utility agencies are expected to follow the suite. The successful implementation of GIS in the Kuwait Municipality would cast impact on others and guide them towards its adoption. Recently held Kuwait GIS-ESRI Users Group Conference in March 2004 and enthusiastic participation of the utility agencies, apart from others, is the metaphor of the positive attitude and keenness towards GIS technology.
Environmental Management
Protection of environment is increasingly gaining attention of planners and environmentalist in the recent past. The sustainable development has been a major concern throughout the world. With this notion, various countries are making effort to develop the environmental information systems. The analysis reveals the fact that Kuwait Environmental Information System (KEIS) is most comprehensive GIS based environmental system in the Arabian Gulf region. The user-friendly KEIS, developed by the committed, Kuwait Institute of Scientific Research (KISR) stores all kinds of environmental data covering marine, fisheries, terrestrial to name a few. The Avenue language based menu driven system enables the user to visualise the data and carry out some analysis as well.

Environment GIS in Qatar was developed with the objective to cater the needs of Supreme Council’s a major concern for environmental protection by integrating all related data. Under the umbrella of National Centre for Environmental Information, two applications related to environmental control have been developed. The application Environmental Site Assessment and Management System is developed on ArcView GIS with the task to monitor and manage waste disposal sites, environmental evaluation and produce site suitability map. Another application known as Marine Environment Management and Monitoring Program is mainly used for visualisation of temporal and spatial variations in the environment variables in the coastal water and sea-bed sediments.

Thus, it can be argued that Kuwait has taken the lead in terms of GIS based environmental management systems over the counterpart Qatar due to its broad coverage. Data visualisation forms the major function of KEIS except few basic capability of analysis such as interpolation, buffer operation etc. Although Qatar’s environmental system is still evolving, but its capability for site suitability analysis for dumping site is impressive feature that can be incorporated into KEIS as well.
Integration Model: The Qatar Experience

The success story of Qatar GIS model can be attributed to two main factors. First, the incessant support and initiative by the top official of the government and second, the integration model adopted by all the user agencies. The consistent effort of the minister Sheikh Ahmad bin Hamad Al-Thani towards this end resulted into full-blown integrated GIS system in Qatar. The constitution of Centre for GIS (CGIS) was major step that integrated all the GIS implementation activity in the state. The CGIS acted as a nodal agency with the responsibility of centralised data creation, storage and sharing.

Each participating agency in the societal GIS of Qatar created its own database in-house or by outsourcing. The detailed information relevant for respective departments is available on their internal server (private) which may be accessed only by them. The facility maps with their networks are available on the public server maintained by the CGIS. This data is accessible to all the user departments. The data is updated by the respective agencies and sent to the public server on continuous basis. Thus, any information needed by any department is available in updated form. The minute details of a utility service such as diameter of pipe and pressure level in water supply are not shared on the public server ensuring internal security. This provides flexibility to the participating agency to decide which data can be shared with others. If the related agencies plan for any work schedule, they can access the relevant data of the other department so that they can inform them in case their utility network is affected. For this purpose they don’t need to request the specific department for information, rather they get all the relevant information from CGIS public server. For instance, if road work has to be carried out the sewer department or water supply department would be informed to carry out their task in integrated manner saving time and energy.

The data management becomes easier as all the utility agencies have right to update their own information and send back to the CGIS server. One nodal agency cannot take care of all kinds of update. The data dictionary and
other data structures are strictly followed to make data compatible as it is decided by the nodal agency i.e. the CGIS.

Another notable feature of Qatar GIS is the frequent meeting of all the Coordinators of the participating agencies to discuss their technical problems encountered with each other so as to reach at optimal solution. The GIS unit of each department is more governed by CGIS than the department itself. The regular meeting of the GIS coordinators provides them the feeling of oneness and enhance cooperation with each other.

Thus, the working model of integrated GIS is the conception of a centralised agency at the national level responsible for development of National Spatial Information System. The base map which is non-changeable should be created and maintained by the central agency itself. But the update should be in decentralised mode e.g. each agency should update their own database. The National Data Dictionary standards should be developed and agreed upon by the stakeholders following a protocol. Additional data dictionary for their internal use can be developed by themselves, as this data is not intended to share. So the data at national level would be structured and at department level it might be unstructured. Any agency should not be allowed to change the standards without prior permission of the central agency and other partners as well. They must come to the national board to modify any protocol. The information required by the ministries should be shared on give and take basis.

The above discussion reveals the significant role of GIS in integrating the developmental activities and revolutionizing the provision of urban amenities to the citizens to embark upon the betterment. Most of the developing nations are into planning phase to improve the urban amenities. Hence, they can learn from the experience of Qatar and opt for better planning and management incorporation GIS technology. Therefore, The integration model of Qatar for developing and implementing national GIS has many features to be adopted by developing countries towards achieving similar goals. The developing nations can be benefited from the conceptual framework and formulate policies and programs to suite their own environment. In this
context here we examine the effort made by India towards building National GIS.

Towards Building National GIS: The Indian Context

Although the Qatar GIS model may not be accepted in its very form in India as it widely differs in terms of geographic extent, administrative set-up, population size and prevailing socio-economic conditions but we can certainly adopt the conceptual part of it towards creating and organising the database so as to pave a path for data integration which is backbone for any agency seeking to grow with the objective of implementing GIS. The policy frameworks adopted in Qatar for building up national GIS can serve as guiding principle for the same. The Qatar experience underlines the fact that creation of NSDI is most significant step towards achieving the objective of national GIS. This activity involves various technical, methodological organisational and mobilization of resources. Following inline with the Qatar model it could be adopted in Indian context too with little modifications in the way to building a national GIS forum.

The first and foremost task of the government should be to form a central agency or ministry who is responsible for coordination and development of national GIS database. The centralised effort would eliminates substantial duplication and redundancy in data creation, as virtually identical digital products are created by different agencies to satisfy their often very specific needs. The cost of creating and maintaining these digital spatial data incurs high cost so it is more important that data created should be shareable, and that the collected data may be fully utilized to realize all its potential benefits.

Survey of India (SOI) has been responsible for creation of maps at various scales for the entire country. Now the agency is in the process of evolving into a centralized digital geographic information base, but it is still in its incipient stage. The SOI should be given discretionary power to act as
governing agency for mapping the country specifying data standards and other technical specifications as similar to that the task performed by CGIS in Qatar.

Seeking to the above objective of forming a nodal agency in Indian context the vast expanse of the country would create obstacle for one agency to manage and achieve the task of NSDI. Hence, in order to develop the information infrastructure it should involve other agencies so as to organise the activity within the set timeframe. The NSDI structure in India has rightly involved various agencies such as Survey of India, National Remote Sensing Agency etc. The greatest challenge perhaps lies in organising the effort of all the stakeholders seeking to the national standard. In Qatar it was possible for CGIS to monitor and develop national spatial database due to its small size, but it won’t be that easy task for India. Since various other public and private agencies has been involved but it is very important for NSDI Executive Council to evolve national data dictionary, format and symbology and standardise. It should be made mandatory for all participating agencies to follow the standard to avoid any discrepancy in the database integration.

In India, most of the states have developed State Remote Sensing Application Centre (SRSAC) and others are planning to set up such agencies that would take care of data requirement of the respective states. These agencies should be strengthen and assign the task of data creation pertaining to the state while following the national standards. The creation of spatial data needs to be closely monitored and supervised by the central agency to ensure conformity with the national standards. The national database should be centrally managed so that data can be accessed and shared among the user agencies form a central public server.

One of the major hurdles in the path of adopting data integration model and evolving national GIS is the reluctance of the ministries and agencies to share their data with others. Therefore, there is an ardent need to create awareness among these agencies about the data sharing benefits. The level of information to be shared among the different departments can be mutually decided.
The urban civic agencies are facing the problem of duplication in the absence of data integration and sharing. For instance, there are overlapping tasks performed by Municipal Corporation of Delhi, Delhi Development Authority and Town and Country Planning Department. Few of them have adopted GIS technology but these are stand-alone systems. All the utility agencies’ database should be integrated, as most of them are inter-related. Activity of one agency affects another in some way or the other. The *modus operandi* of the Qatar model of infrastructure management is based on integrated model. If one agency plans to carry out any task, all the related agencies are informed so that entire task is carried out at a time. But in Indian cities, due to lack of proper coordination same work is performed time and again by different agencies for instance, the digging up of the road several times by different agencies such as sewer, electricity, telecommunication etc. to carry out their work schedule. This not only creates inconvenience to the community at large but also leads to wastage of time and money.

**Building National Spatial Data Infrastructure in India**

The significance of shared digital spatial database is widely recognised throughout the world today. Towards achieving the goal of nationwide GIS implementation certain priority areas have to be set up. Development of National Spatial Database Infrastructure (NSDI) is considered to be primary task for nationwide GIS. The experts estimate that about 80 percent of the total cost for development cycle is devoted to the most crucial aspect of data creation, so it is the most challenging task. World regions such as Europe, Asia and the Pacific are developing and evaluating the feasibility of a national spatial data structure. South Africa; Australia and many other countries are also working on regional spatial data structure. What it all comes down to is the sharing of data, one of the most valuable resources of the country.

**The Need:** Transparent access to myriad databases could provide the information for countless applications, e.g., facility management, real estate transactions, taxation, land-use planning, transportation, emergency services,
environmental assessment and monitoring, and research. In the above context, the establishment of NSDI would be the right step for the country. The NSDI must aim to promote and establish an infrastructure, at the national level for the availability of organized spatial (and non-spatial) data and multi-level information networking to contribute to local, national and global needs of sustained economic growth, environmental quality and stability and social progress.

As a national infrastructure, NSDI will have the potential to serve as a "one-stop" source of spatial information in support of sustainable development and economic growth. Information bases will facilitate the infrastructure development in the country specially the road, telecom, water distribution, sewerage management, land use, environment, land acquisition and so on.

These Spatial information sets are vital to make sound decisions at the local, regional, state and central level planning, implementation of action plans, infrastructure development, disaster management support, and business development. Natural Resource management, flood mitigation etc. are just a few examples of areas in which decision-makers are benefiting from spatial information.

The government of India has initiated the creation of NSDI by forming a task force consisting of experts from various organisations dealing with spatial data. The Science and Technology Ministry is working on development of such infrastructure that has all the data required to carry out development work like construction of roads, water management and crop management. As per estimate, it is envisaged that the NSDI would take anywhere between 5-7 years for becoming operational. But the intermediate milestones could be established in a phased manner to showcase results. Apparently, in India there seems to be a commitment from the top most policy makers to develop NSDI. However, it will not be a bad idea to evolve a realistic time frame for its implementation in a phased manner incorporating immediate, short term and long term actions and goals.
Organisational Framework of NSDI: In order to make the NSDI a reality the Government should follow a clearly defined structure defining the responsibilities, guidelines and commitment by different spatial information generating agencies through an NSDI Act. Since various stakeholders are involved in NSDI, a high-level focus is essential for the same.

On the top of the organisational hierarchy is the National Spatial Data Commission (NSDC) headed by a senior Cabinet Minister as Chairperson, with secretaries of all ministries/departments as members, accompanied by representatives of different stakeholder groups constituted to oversee and coordinate the inter-agency aspects of NSDI.

A NSDI Executive Committee (EC) is proposed that is mainly consists of participating Government agencies that generate spatial data. The NSDI-EC would be charged with coordinating the development of the NSDI and will be the overall technical body to oversee the implementation of the same. The technical issues such as defining data standards, metadata creation an intranet establishment is the few other tasks of the EC.

An NSDI-Nodal Agency will have to be identified—mainly to coordinate the activities and also serve the NSDI-NSDC and NSDI Executive Council. The Nodal Agency would serve as a technical-secretariat for the NSDI, charged with the responsibility of overall coordination and operations. The Department of Science and Technology could be identified as the Nodal Agency to perform these tasks.

Each participating central agency, acting as NSDI Node, will have its own high-level High Powered Committee to address all technical and management aspects of NSDI implementation within the agency.

Participating Agencies of NSDI: The stakeholders in the NSDI will be the Government agencies or the spatial information generators and, on the other hand, the users of such spatial information – government, private or the public sector. The nation over the past years have produced a rich “base” of map information through systematic topographic surveys, geological surveys, soil surveys, cadastral surveys, various natural resources inventory programmes and
the use of the Remote Sensing images. Further, with the availability of precision, high-resolution satellite images, data enabling the organisation of GIS, combined with the Global Positioning System (GPS), the accuracy and information content of these spatial datasets or maps is extremely high.

The NSDI will be a set of GIS database servers – one NSDI Node for each participating agency. Thus, the NSDI will have Nodes for Geological Survey of India (GSI) for geological data; Survey of India (SOI) for topographical data: National Remote Sensing Agency (NRSA) for satellite images and thematic data; NRIS for natural resources management and development data. Each NSDI agency will maintain its own Node as part of an Intranet and link to the “master” NSDI server.

Each of the NSDI Nodes will be on an Intranet – ensuring full security and “closed-user” access. The NSDI nodes would be linked to the master NSDI Server which will serve as the Gateway on the Internet for the NSDI Intranet Nodes and will host the NSDI Metadata. The NSDI Master Server will also perform the role of the NSDI Electronic Clearinghouse and will “direct” access to appropriate NSDI Nodes based on access protocols.

The above discussion suggest that India is moving towards right direction for NSDI creation in terms of organisational structure and implementation plan, but the real challenge lies in the integration of all the database. For Qatar it was easy to maintain national data due to its small size but for India it may not be that simple. For effective coordination the NDSI act should be strengthened and be given discretionary powers.

**Summing Up**

Summing up the chapter we can state that the implementation of GIS technology in Qatar was with a defined vision and holistic covering the entire nation whereas Kuwait began with individual organisations developing their own GIS systems. The focussed effort by the State of Qatar towards implementing the technology and its success has made it a role model for others. This achievement is a result of high degree of coordination among the user agencies and a powerful nodal agency at national level. Although Kuwait
has made headway in GIS application in its Municipality but many agencies and ministries are yet to realize the potential of the technology. It has to go a long way to have an integrated system of planning and management. The formation of a nodal agency responsible for implementing national GIS in Kuwait is highly recommended as the country has enough potential to do so.

Unlike Gulf States most of the developing nations do not have enough resources to invest in GIS system at a large scale, as it requires massive initial investment. But they can implement the technology in phased manner as per their financial status. Although cost of implementation is high but once the system is evolved it will have return to scale in the long run. India being a giant country with vast geographical area, it can invest in NSDI by allocating resources to the government stakeholders and inviting private players. Still India has to go long way as this very technology is at experimental stage in different parts of the country.

Although this study has attempted to explore the evolution and functioning of GIS in the Gulf countries, there still remain many unanswered questions. There is further need to investigate the areas where GIS has potential role to play. How Kuwait and other Gulf countries can adopt the integrated model in their own environment forms another area of research. Further one can also explore the feasibility of having an integrated GIS based infrastructure management system at the GCC level.