

ANALYSIS OF URBAN PLANNING IN ISA TOWN USING GEOGRAPHIC INFORMATION SYSTEMS TECHNIQUES

Lamya HAIDER, Prof. Mohamed AIT BELAID^(*) Corre, and Dr. Anwar S. Khalil

Arabian Gulf University (AGU), College of Graduate Studies, Desert and Arid Zone Sciences Program, P.O. Box: 26671,
Kingdom of Bahrain, Tel.: +973 39026030; Fax: +973 17239552-belaid@agu.edu.bh

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ABSTRACT:

The main goal of this research was to study the urban planning of Isa town using GIS techniques, since the implementation of the town plan in 1963 until the year 2005, and to assess its stages of development. Furthermore, the study aimed to produce land use maps, establish the statistical inventory of land use categories and their significance and role in shaping the character of the town overtime.

This multi-temporal study used the following datasets:

- Data and statistical reports related to the objectives of the study, gathered from various Ministries in the Kingdom of Bahrain.
- Aerial photograph (1950) of the study area showing the vacant land area of Isa town, surrounded by palm trees and rural settlements.
- Three Topographic Maps (scale of 1:10.000) of Isa town for the years 1977, 1991, and 2005.
- The original urban plan of Isa town, implemented in early 1963.

The adopted methodology is composed of the following steps:

- 1) Acquisition and review of relevant literature, topographic maps, field survey, and statistics related to social and urban development.
- 2) Pre-processing, including digitizing of topographic maps, in order to extract and determine land use maps/categories for the years 1977, 1991 and 2005, and conversion of data from INTERGRAPH Microstation to ESRI ArcGIS.
- 3) Production of an urban database, including land use maps for three decades, ground observations and statistics in order to analyze the urban plan, and urban development of Isa town during that time.
- 4) Compilation and edition of the study results, in terms of land use maps, land use changes, roads and transport network.

The findings of the study were:

- 1) The three generated land use maps (1977, 1991, 2005) show the town urban planning development as well as land use categories, which include residential, roads and transport, recreational facilities, religious, commercial, educational services, infrastructure and government buildings.
- 2) The land use changes occurred between the years 1977 and 1991 (14 years) shows an increase in all land use categories mainly residential (298 ha) followed by roads and transport (212 ha), education (38 ha), commercial (29 ha), recreation (26 ha), government buildings (10 ha) and religious (5 ha).
- 3) The land use changes that occurred between the years 1991 and 2005 (14 years) shows also an increasing trend in all land use categories, but with lower rate than the previous period (1977-1991): residential (112 ha) followed by transport (18 ha), education (12 ha), religious (7 ha), commercial (5 ha), recreation and government buildings (3 ha) each.
- 4) The analysis of spatial and temporal data for the year (2005) shows that residential is the main function of Isa town, which occupies 51.0% of the planned area, followed by education (7.0%), recreation (5.3%), and commercial (3.2%).
- 5) The roads and transport network is crowded and this leads to high road density, which occupies 26.5% of the total area, due to the coexistence of different services within the design.
- 6) The present Isa town urban planning does not conform to the original urban plan proposed by the Ministry of Housing in 1963. It shows a combination of two different models: the Gridiron Plan, and the Linear Model.
- 7) The flaws in the urban planning design leads to many environmental and socio-economical problems, which are mainly related to urban expansion, longer journey to work, transport congestion, and urban pollution.

The study proposed the following recommendations:

- b. Re-planning of road network to better organize the town entrance and establish the external and circular roads to ensure access to all parts of the town. Furthermore, avoid passing of traffic through the town centre by streamlining major roads and underpasses, and use of public transport.
- a. Discontinue the horizontal expansion plans, and establish new vertical blocks around Isa town to decrease the pressure on the land.
- c. Compliance with the rules and obligations of the proposed urban plan initiated by the Ministry of Housing.
- d. Development of an urban GIS Database for planning and management of Isa town.

(*) Corresponding Author

1. INTRODUCTION

1.1 General Context

One of the challenges that face the Kingdom of Bahrain is land management due to the increase in the population. In 1960s the two main towns in Bahrain (Manama and Muharraq) reached very high population density. In 1963 the Ministry of Housing decided to establish a new town to reduce the pressure on the two main towns. At that time, His Highness Shaikh Isa bin Salman Al Khalifa put the foundation stone of the new town called Isa Town. Isa Town was opened in 1965 for urban development. By 1982 there were 3400 residential units and a total population of 21275 residents. The results of the 2001 population census indicated that the number of residential units increased to 5817 units with a total population of 36833 residents. The Isa town became the town with the fourth highest population density in Bahrain (2963 persons/ Km²). The multi-functionality of the town (residential, education, commercial and others) providing services for the whole country of Bahrain has further generated social, economic and environmental problems.

1.2 Objectives

This research aimed to study the urban planning of Isa Town, since its implementation in 1965 until the year 2005 and to assess its stages of development. It aimed also to produce land use maps and to calculate the area of each land use category and its significance and role in shaping the character of the town. The analysis of the topographic maps was performed using GIS techniques (Demers, 2000), in order to investigate the urban planning problems and to provide a base to propose recommendations for better urban planning and management. GIS tools have been also used in the analysis of the road network and in the analysis of the town planning model, in order to recommend various solutions and suggestions.

1.3 Study Area

The study area of Isa town shown in figure (1) is located at 8 kilometres South- East of Manama city in the Kingdom of Bahrain. The geographic locations extend from 50° 07' E to 50° 16' E for Longitudes, and from 25° 20' N to 25° 31' N for Latitudes. It occupies an area of approximately 12.43 km². Isa town is located in an arid land surrounded by Tubli, Jubailat, Jidd Ali, Jurdab, Sanad and Salmabad villages. It is located on low ground (11 m above sea level).

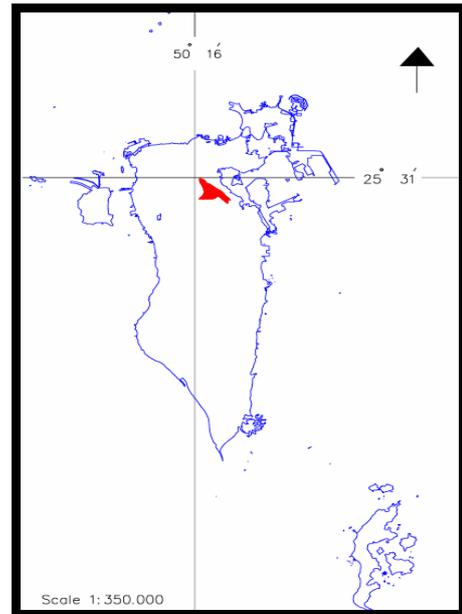


Figure (1): Location map of the study area

2. METHODOLOGY ADOPTED AND DATA USED

2.1 Data Used

The study used the following datasets:

- Data and statistical reports gathered from various Ministries and organisations in the Kingdom of Bahrain (MOH, 1993; CIO, 2006).
- Topographic maps for Isa town for the years 1977, 1991 and 2005 to define the land uses of the town (MOM, 2006).
- Aerial photography for the year 1950.
- Urban Plan of Isa town established in the year 1963.

2.2 Methodology Adopted

Digital topographic map for the year 2005 was provided by the Central Municipality (in DGN format) where Isa town is located. This map has been edited using INTERGRAPH Microstation software to separate the land use categories into different layers. After separating every layer by this software it was possible to convert all the land use layers to the ESRI ArcGIS software (Booth and Mitchell, 1999). The 1991 land use map was derived from the 2005 topographic map, while 1977 map was derived from 1991 land use map. The areas of land use categories can be accessed from the GIS attribute tables (Ait Belaid, 2006). A full database is attached to these coverage layers, in which every polygon is characterized by many attributes like, the category number, area and perimeter of polygons (Ait Belaid, 2003).

After editing the data, the study defined the changes, which occurred over the 28 years period of time with available datasets. By using ArcGIS software every land use category percentage was calculated to see if the land use percentage is within the ideal percentage or not. The study also analysed the land use maps and the road network to show the efficiency of the network. The three generated land use maps show the urban planning development of the town, as well as, the land use categories, which include: Housing, Roads and transport,

Recreational facilities, Religious buildings, Commercial, Educational services, Infrastructure and Government buildings.

3. RESULTS AND DISCUSSION

3.1 Land Use Mapping

The proposed land use categories in the study area include all land use types typically found within a town plan. The objective of this analysis was to calculate the efficiency of each category. This percentage will show if the land use category percentage is suitable or not by comparing these percentages with the percentages according to the urban planning theory (Al Dalemi, 2002). After analysing the town urban planning development, a statement can be made regarding the degree of success of the town planning. The analysis also can measure the town planning success and suggest future decisions and recommendations.

Figures (2), (3) and (4) illustrate the land use maps produced for the years 1977, 1991 and 2005 respectively from the existing topographic maps according to 8 GIS layers. These map show the development of urban planning during the three period of times and vis-versa the reduction of vacant land. Table (1) summarises the areas of various land use categories at the same period of time (Hayder, 2008).

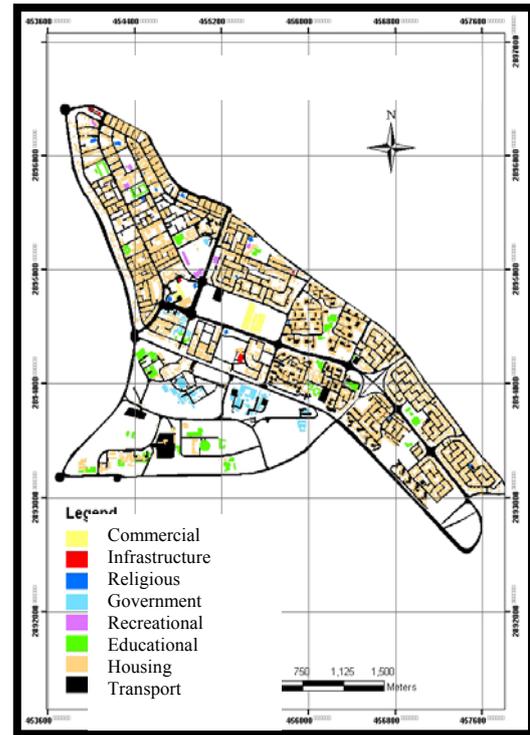


Figure (3): Land use map of Isa town in 1991.

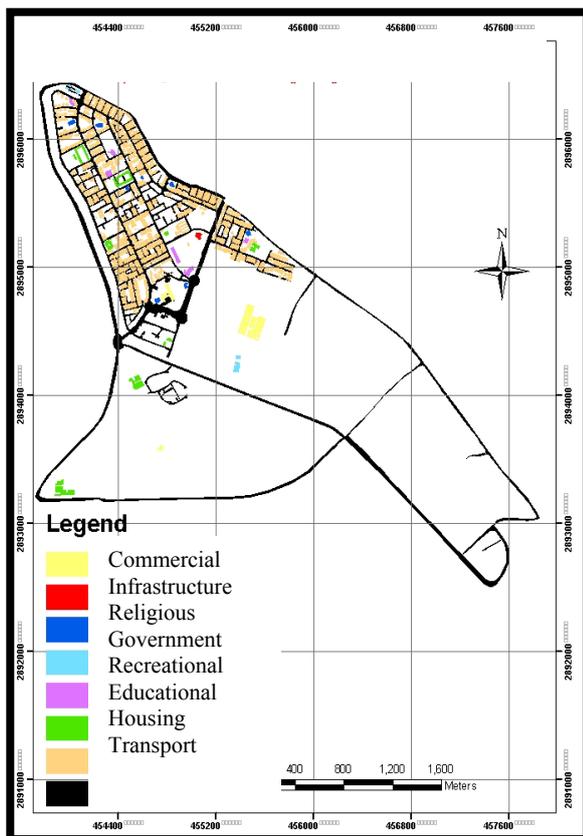


Figure (2): Land use map of Isa town in 1977.

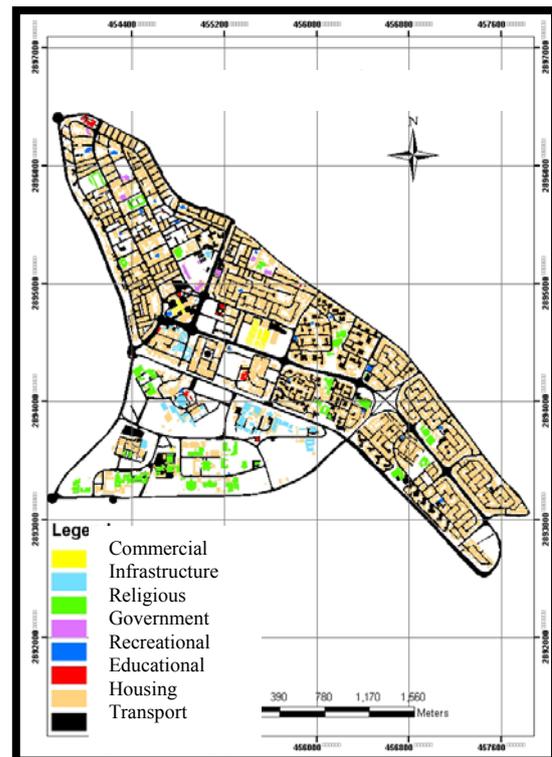


Figure (4): Land use map of Isa town in 2005.

Land Use Categories	Area 1977 (ha)	Area 1991 (ha)	Area 2005 (ha)
Residential	224	522	634
Commercial	6	35	40
Educational	37	75	87
Religious	4	9	16
Recreation	37	63	66
Government	6	16	19
Infrastructure	1	1	2
Transportation	99	311	329
Vacant Land	828	211	50
Total	1243	1243	1243

Table 1: Areas of land use categories in Isa town in 1977, 1991 and 2005.

3.2 Land Use Changes

As shown in table (2) below, GIS is a powerful tool to observe the urban planning development and to measure the efficiency of the land uses categories, in order to provide good management. The table summarises the changes in the areas of various land use categories between the years 1977, 1991 and 2005 respectively.

The land use changes occurred between the years 1977 and 1991 (14 years) shows an increase in all land use categories mainly residential (298 ha) followed by roads and transport (212 ha), education (38 ha), commercial (29 ha), recreation (26 ha), government buildings (10 ha) and religious (5 ha). The land use changes that occurred between the years 1991 and 2005 (14 years) shows also an increasing trend in all land use categories, but with slower rate than the previous period (1977-1991): residential (112 ha) followed by transport (18 ha), education (12 ha), religious (7 ha), commercial (5 ha), recreation and government buildings (3 ha) each (Hayder, 2008).

Land Use Categories	1991-1977 (ha)	2005-1991 (ha)	2005-1977 (ha)
Residential	298	112	410
Commercial	29	5	34
Educational	38	12	50
Religious	5	7	12
Recreation	26	3	29
Government	10	3	13
Infrastructure	0	1	1
Transportation	212	18	230
Vacant Land	-617	-161	-778

Table 2: Land use changes in Isa town between 1977, 1991 and 2005.

3.3 Road Network

The roads and transport network is crowded and this leads to high road density, which occupies 26.5% of the total area, due

to the coexistence of different services within the design. Isa town road network includes 6 types of roads, which are major, minor, local, gathering, free ways and small joint roads.

3.4 Isa Town Model

According to Rashwan (2005), there are fourteen different models for the towns. These models are listed below:

Linear City, Garden City, Satellite Town, Union Town, Lattice Town, Hexagon Cell Town, City of Tomorrow, Rising City, Broad , rea City, Organic City, Lewis Keble, Yasbirt City, Radial Plan, Gridiron Plan. The present Isa town urban planning does not conform to the original urban plan proposed by the Ministry of Housing in 1963. It shows a combination of two different models: the Gridiron Plan, and the Linear Model.

4. CONCLUSIONS AND RECOMMENDATIONS

The findings of the study were as follow:

- 1) The housing, commercial, religious and transport land use areas have exceeded the percentage that was proposed in the original plan and planned for the year 2001, while recreational land use areas are less than the proposed areas.
- 2) The land use categories increased at different rates. However, housing is the main function of Isa town, which occupies 51% of the planned area, followed by educational services with 7% and recreational facilities with 5.3%.
- 3) The original urban planning model of Isa town was the Gridiron model, which has been modified. The present plan shows a combination of Gridiron and Linear models.
- 4) Isa town road network is a crowded network because it occupies 26.5% of the total area of the town. It includes 6 types of roads, which are major, minor, local, gathering, free ways and small joint roads.

The study recommendations are:

- 1) Discontinue the horizontal expansion plans, and establish new blocks (vertical) around Isa town to decrease the pressure on the land.
- 2) Transfer some of the educational buildings to commercial malls or recreational facilities to reduce the pressure on the road network and to enhance the recreational land use.
- 3) Change the traffic circles which are located at the entrances and at the centre of the town to traffic lights to ensure access to all parts of the town and to reduce the traffic congestion.
- 4) Use the vacant land that occupies 4% of Isa town area to establish common parks to reduce the air pollution.

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