A GEOGRAPHIC INFORMATION SYSTEM (GIS) TO DEFINE INDICATORS FOR DEVELOPMENT AND PLANNING IN JORDAN

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Keywords: Geographic Information System (GIS), Data Management, Spatial Information and Analysis, Statistical Analysis, Decision Making, City and Regional Planning.

Abstract: The computerization and the creation of a digital data base is a must for the employment of many of the state of the art tools in the Optimal Planning process. This is easy made using Geographic Information System (GIS). GIS is an effective modern planning technique which gives the power to create maps, integrate information, visualize and solve problems, present future ideas and develop valuable solutions in basically no time while relating information to a geographic component. The planning challenges today are mainly due to overpopulation, pollution, deforestation and immigration, which definitely have a geographic dimension. The Departments of General Statistics/Census in all countries are considered the main source of data for governmental and private agencies. In this work, we are using a Geographic Information System (GIS) to create a database system for Jordan (a developing country) to be used for optimal planning purposes. The created GIS for the country by governorates (12 Governorates) cover all aspects of life including social, economical, resources, among others. All the departments' data in addition to a large quantity of field data that we gathered are utilized to create GIS system. Results of many GIS analysis techniques are presented for demonstration purposes. Different kinds of data will allow concerned people to have proper planning, and development according to existing realities, and can aid in deciding on priorities of such plans. The digitizing of the data is a step will be a great step forward towards optimal and well informed decision making process in the country.

1 INTRODUCTION

Planning is a comprehensive tool to an enormous data to pick patterns, define relations and present the results to help in better and optimal decision making in virtually no time and cost. Planning the future of a country or planning everyday life (such as starting a new business, or finding the best soil for growing vegetables, or the best route to a location, etc.), has a geographical dimension and always related to a map. Thus, GIS role is vital such a process as it has the potential to offer the optimal solution.

GIS is a simulation methodology of all past, present and future situations at a minimal cost compared to other planning tools. It is a computer-based technology and methodology for collecting, managing, analyzing, modeling, and presenting geographic data for never-ending applications. It consists of a data base, map information and computer link to allow viewing, inquiring, interpreting, and visualizing data in many ways that reveal relationships, patterns, and trends in the form of maps, reports, and charts (Burrough, 1986), (Chrisman, 1999), (Ducker, 1979), (Star and Estes, 1990), (Andronache et al., 2006). Ducker (Ducker, 1979) defined GIS as the management of the data to retrieve new related data for ad hoc queries and analysis. Chrisman (Chrisman, 1999) considers GIS to play a role in the society as people measure and represent geographic phenomena, then transform these representations into other form while interacting with social structures. GIS changed the heart of planning and informed decision making

Sadoun B. and Saleh B. (2010).
A GEOGRAPHIC INFORMATION SYSTEM (GIS) TO DEFINE INDICATORS FOR DEVELOPMENT AND PLANNING IN JORDAN.
In *Proceedings of the International Conference on e-Business*, pages 32-38
DOI: 10.5220/0003105000320038

especially in the world of emergencies and life saving process. During Catharine storm in the USA, GIS (created for transportation purposes) was the only way to locate people during the hurricane when all other methods failed (Andronache et al., 2006). It helped in saving the lives of thousands of citizens and opened the eyes to the benefits of GIS technology. GIS and related technology will help analyze large datasets, allowing a better understanding of terrestrial processes and human activities to improve economic vitality, environmental quality, and response to emergencies as well as, finding the way to a supermarket. Today, GIS is a multibillion-dollar industry employing hundreds of thousands of people (planners, engineers, economists, etc.) and used extensively in all aspects of planning.

Jordan is a Middle Eastern country located in Southwest Asia. Administratively, it is divided into 12 governorates: Ajlun, Amman, Aqaba, Al-Balqa, Irbid, Jerash, Al-Karak, Ma'an, Madaba, Al-Mafraq, Tafilah, Az Zarqa (Fig.1). The department of General Statistics in Jordan categorizes its data according to governorates. GIS is used in this work to create a digital data to reflect the different nature of each governorate, its resources, population, etc. The created digital data for the country will allow all kinds of analysis by governorate to clarify and reflect their strong and weak points, needs. This will help in defining indicators for development and planning. ArcGIS software is used in our work for capturing, organizing, analyzing, mapping, and presenting spatial information.

Our main Objectives are to: (a) create a global digital data for the country by governorate, (b) allow the usage of endless capabilities of GIS analysis and (c) offer the possibilities of web posting and e-government utilization.

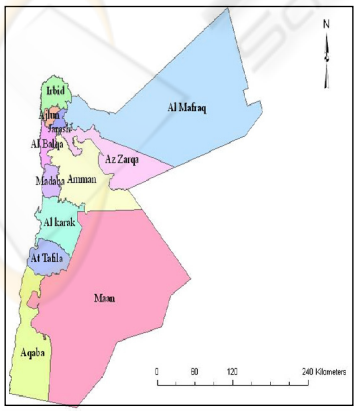

Figure 1: Jordan Governorates.

2 METHODOLOGY

GIS Data Model: GIS systems handle two types of data, raster and vector data. Raster data from scanned or remotely sensed images are poor at representing points, lines and areas, but good at surfaces. Vector data model uses points stored by their real coordinates, sequence of these points build lines and areas. The spatial data we used in building our GIS includes: Jordan Map (scale 1:1,000,000) and a Spot Satellite Image for Jordan. Global Positioning System (GPS) is used to collect the coordinates of important points to enrich our GIS such as: Universities (8 points), Hotels (58 points), Hospitals (29 points), Police Stations (44 points), Water Companies (11 points), Civil Status and Passport department (11 points), Municipalities (12 points), Airports (3 points). All points were taken according to Google Earth Map.

Attribute data give more information about features in tabular form. Attribute Statistical Data for Jordan for the years (1990 - 2005) were used to create the GIS database. All kinds of data such as: population count, population density, urban population, rural population, population by gender, number of births, deaths, marriages, and divorces, crimes, rain fall, water supply for domestic purposes, fuel distribution, number of new telephone subscribers, pharma- cies, registered engineers, post office mail boxes, post offices, road accidents, hotels, registered lawyers, charitable societies, bookshops, hospitals, health centers, dental clinics, schools etc. Available and field collected data were included in the work.

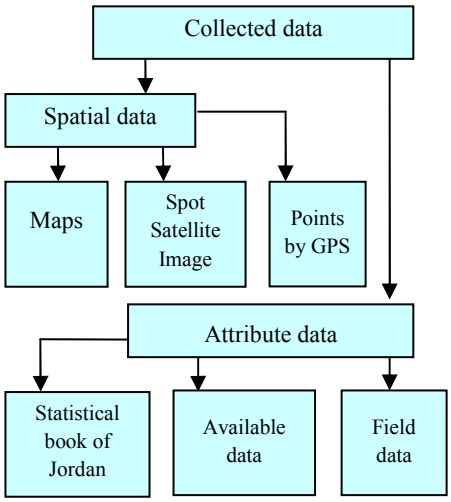

Figure 2: Collected data flowchart.

Data Processing: spatial and attribute data, maps and images were processed as follows: (a) scanning the map of Jordan to convert it to digital format, (b) defining the coordinate system; (Universal Transverse Mercator: UTM) and the Ellipsoid, (c) registering the scanned map (image) in the coordinate system using ground control points (points of known coordinates), and (d) creating the layers by digitizing the map (Fig.3).
Many layers were created using GIS. The output layers included: Jordan by Governorate map, cities, sea, water companies, Police stations, Municipalities, Hotels, airports, border stations, Civil status and passport departments, roads networks, universities, Governorate buildings, etc.

3 ANALYSIS AND RESULTS

GIS analysis is finding geographic patterns in the database and the relationships between features. The analysis methods can be very simple such as making a map (Fig.1) or more complex, involving models that imitate the reality of the situation, or by combining many data layers. The tabular data allows different analysis techniques such as classification, buffering and statistical analysis. The analysis achieved is in clear presentations and real interaction with the needed information.

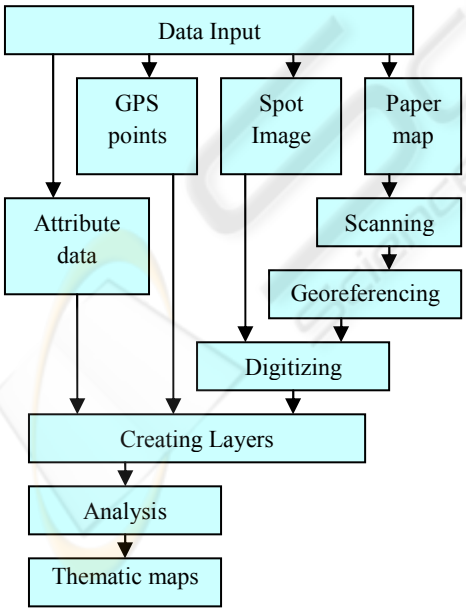

Figure 3: The Methodology.

Spatial Analysis: Queries offer a method of data retrieval from the data base, or on a new data produced as a result of the data analysis. There are many methods of querying Data, which include: Identify, Find, Hyperlink, Query data by attribute, Query data by location.
Identify is the fastest tool for getting information about features by clicking on the feature, then all attribute data will appear in a tabular from. Find data is used to locate the position of such feature on the map in different layers upon the need, for example, to locate an airport or university on the map. Hyperlink data Hyperlink is a tool to obtain more information attached to features such as Photo or text (Fig.4).

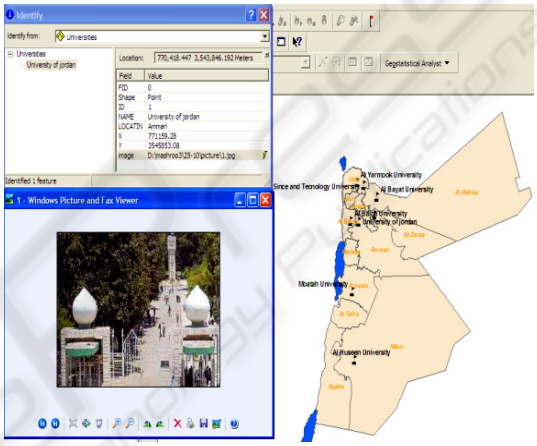

Figure 4: Hyperlink; the University of Jordan.

Query data by attribute. The features could be selected using the Standard Query Language (SQL), such as: Querying about the location of Universities in the northern city of Irbid (Fig.5).

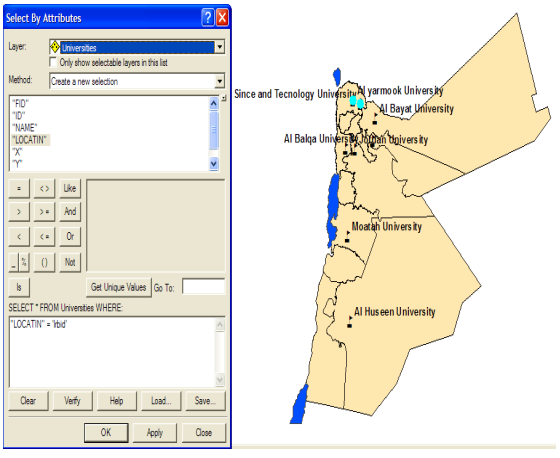

Figure 5: Universities in Irbid.

Figure 6 presents another type of queries such as Querying about the Highways in Jordan which are more than 75Km long.

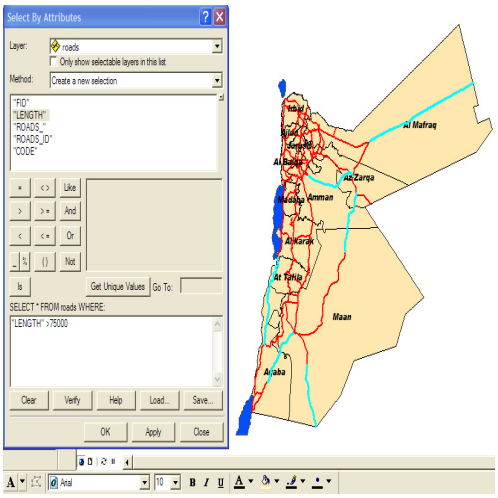

Figure 6: Highways more than 75Km long in Jordan.

Query data by location Selecting features by location is a function that lets you select features from one or more layers based on where they are located in relation to the features in another layer such as: how many "Police station" within (5km) from the Hotels (Fig.7)? Hotels within (50km) from the Airports (Fig.8)? and so on.

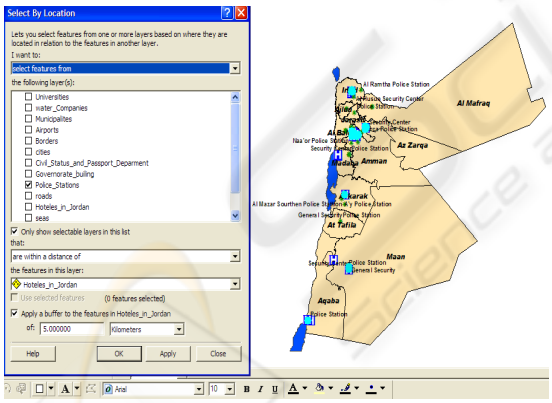

Figure 7: Police Stations within 5km from hotels.

Connectivity Analysis is done between points, lines, and polygons in terms of distance such as: travel time, optimum paths etc. Using the distance tool, we can measure the distance between any two features on the map. Figure 9 for example shows the distance between Queen Alia airport and Aqaba airport.

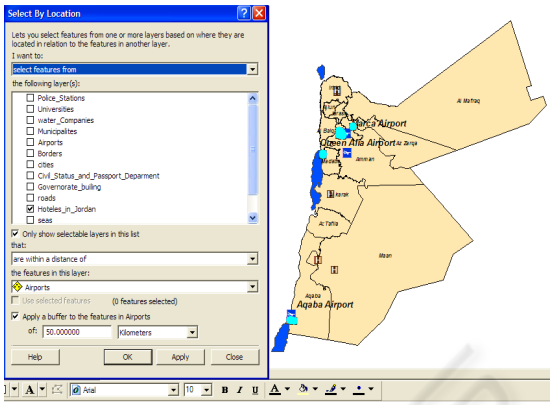

Figure 8: Hotels within 50 km from the Airports.

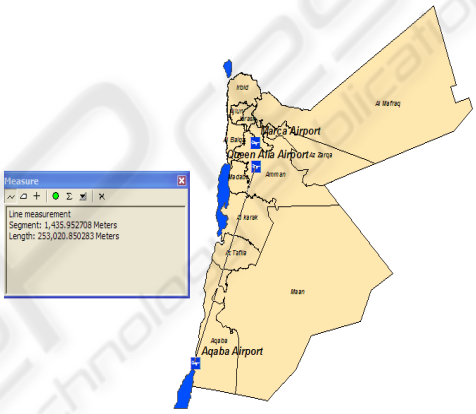

Figure 9: The distance between Queen Alia and Aqaba Airports.

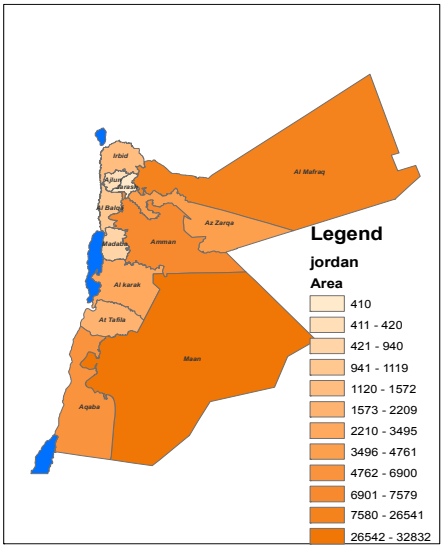

Figure 10: The Jordanian Governorates Areas in km2.

The Arc GIS software enables the conversion of a shape file into a feature class, which includes the area as an attribute file. Then, these areas could be used in statistical and spatial analysis. Figure 10 presents the areas of the governorates in km2 using classification technique.

Statistical Analysis entails the representation of the numerical data of the layers into graphical forms; a lot of mathematical functions are used to help in making engineering decisions.

Classification is used when we need to symbolize quantities, or want to see where attribute values lie in relation to one another on a continuous scale. Classification is an easy way for comparison in order to find or clarify any change in a situation or setting. It could reflect more than a result according to what is included in the classification process. Examples are many in city planning and in monitoring the results of the planning process in general. Figure 11 presents a comparison of the Population (number) for the years of 1990 & 2005 in a pie form. Figure 11 shows an increase in the population in all governorates. The pie plot is good only to show if there is an increase or decrease in each governorate, but it doesn't show the value of this increase in comparison between governorates as when using the histogram plot (Fig. 12).

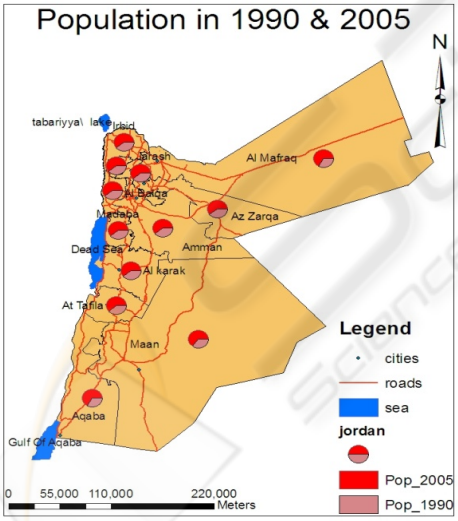

Figure 11: Population by governorate in the years 1990 & 2005.

Classification of population density for the years 2000 and 2005 (Fig.12) shows that Irbid Governorate has the most population density. Mean while, in Figure 13, we compare the population for the same years 2000 and 2005 and the results reflect that Amman has the largest population and not Irbid governorate.

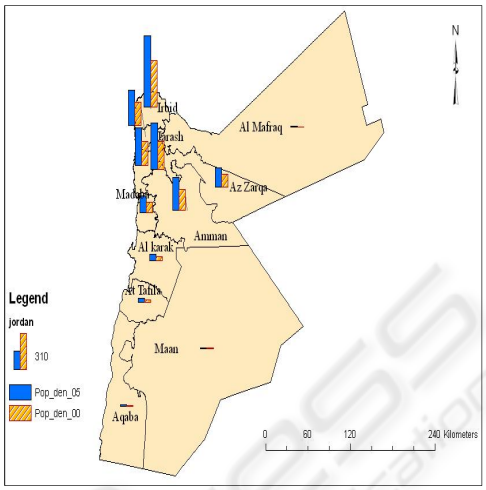

Figure 12: Population density by governorate in the years 2000 & 2005.

From a closer look to the population (number) by Rural and urban for the years 2005 and 2003, we can see clearly that the urban population in Jordan (blue color) is more important than the rural one.

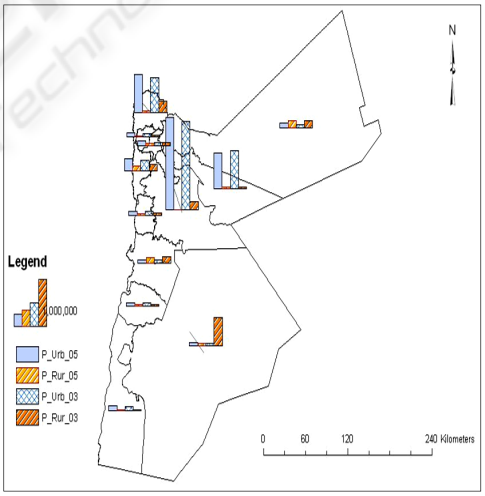

Figure 13: Population in 2005 & 2003 of the Urban and Rural.

Figure 13 shows that in year 2005 the rural population decreased alertly in the Maan governorate (2005). This may be explained as the incline in the agricultural area in the desert due to the lack of rain and water in general. In a previous study that we conducted using remote sensing, we found out the same results in Maan area. Another Classification

method of population density in 2005 could be used to clarify other relations.

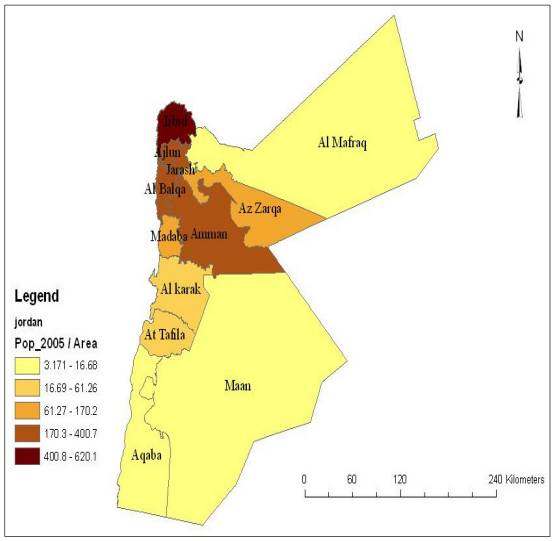

Figure 14: Population density (2005).

Figure 14 shows that the governorate of Irbid has the most population density in the country as it is the mainly agricultural governorate with the most rural population. The second in line is Amman, AlBalqa, Ajlun and Jerash as they all contain big cities and the least populated are the desert governorates with the least population density and resources. In this classification method we used the colors to join the governorates which have the same density. Another mode of presentation is the population density using dot representation (Fig.15).

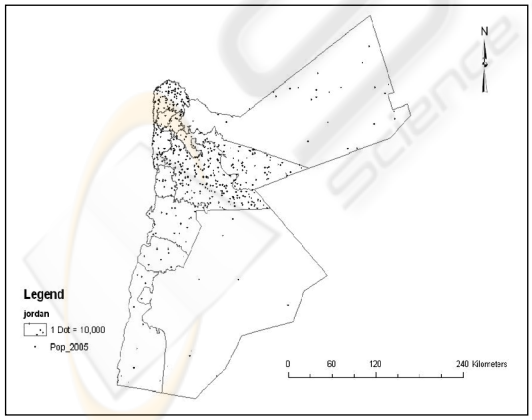

Figure 15: Population density in year 2005).

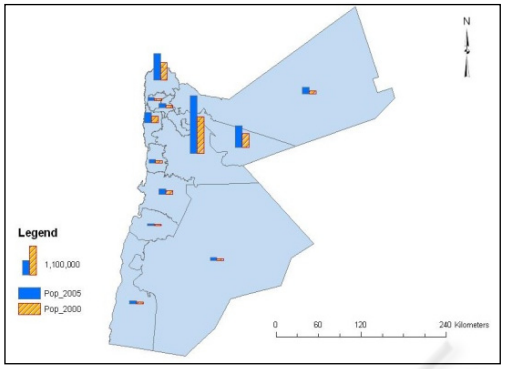

Figure 16: Population by gender in year 2005.

Figure 16 presents the Population in year 2005 by gender, 17 and 18 present other examples to be used in environmental (e.g, rain fall) and emergency analysis and planning. Endless possibilities and outcomes are offered using the created GIS system.

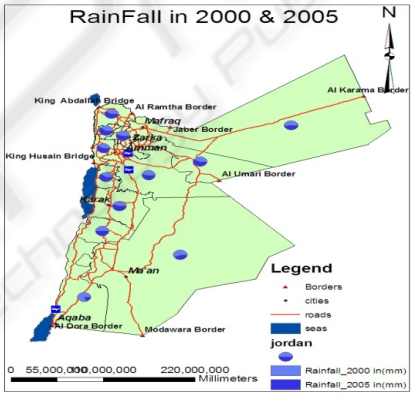

Figure 17: Rainfall in the years 2000 & 2005.

In Figure 18, we see that the highest General number of Crimes in 2005 is in the big cities. Again we can better understand reality of the statistics if we used percentages (crime/pop) or a histograms representation.

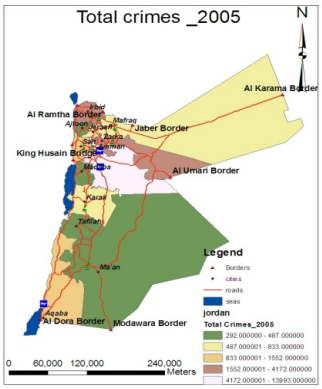

Figure 18: Numbers of General Crimes in year 2005.

4 CONCLUSIONS

To conclude, a GIS system is created for The Department of General Statistics in Jordan for all purposes especially in optimal and informed decision making and planning. The created digital database is easy to use. We can manipulate, maintain and update info effectively. In addition the data is presented in an easy to understand and act upon it. Finally, the ability of international information sharing through a web-site creation, collaborative environment and e-government development is possible with such a system.

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