جامعة الملك فهد للبترول والمعادن
King Fahd University of Petroleum & Minerals

Final Term Project Report

CRP-514

A GIS Approach to Generating a Dengue Risk Map at Shabwah Governorate

BY

Mohammad Habtoor ID # 200804200

Mohammed AL-Mehdhar ID # 200804340

SUBMITTED TO

Professor: Dr. Baqer Al-Ramadan

May 21, 2012

Table of Contents

Abstract

Since Dengue fever (DF) have become important health concerns worldwide, it is also imperative to develop methods which will help in the analysis of the incidences. The clinical symptoms of this disease range from mild fevers to severe and potentially life threatening hemorrhages. As Dengue fever is a vector borne disease, the best method to cope up with this threat is to eliminate the vector which in this case is two types of mosquitoes (Aedes Aegypti and Aedes Albopictus). To control the population of vector integrated, effective and collaborative management procedures are required which in turn requires DSS (Decision Support System) perform effectively and in a smartly manner. Using ArcGIS it was possible to merge the dengue fever incidence data with the available base map file of the governorate of Shabwah according to corresponding census districts. Shabwah maps were then created using different attributes from which patterns and trends could be used to describe the characteristic of the outbreak with respect to the socio-economic conditions.

1. Introduction

Geographical Information System (GIS) is a system of hardware and software that supports the capture, management, manipulation, analysis, and display of Geographic Information [1]. Nowadays, dengue fever is considered as the most important viral disease transmitted by mosquitoes in the world, which incidence has increased 30 times in the last 50 years. It is estimated that 2.5 billion people are at risk in more than 100 endemic countries; more than 50 million infections occur annually with 500,000 cases of dengue hemorrhagic fever and 22,000 deaths, especially among children.

The word dengue is claimed by some sources to be derived from a Swahili phrase "Ka-dinga pepo" which meant to be the disease caused by evil spirit. It could be a

possibility that the Spanish word dengue originated from the Swahili word dinga meaning fastidious or careful, describing the gait of a person suffering dengue fever (Jose G., 1998). Dengue fever and Dengue Hemorrhagic Fever (DHF) is an acute febrile disease, found commonly in tropical regions and can spread similar to malaria (Teng, 1997). This disease is now endemic in most tropical countries.

Dengue fever cases are growing in number as it also invades widely, in the past few years, there were an alarmingly increased number of confirmed cases of the disease in several locations including Shabwah, Yemen, Jeddah, Saudi Arabia, Rio de Janeiro, Brazil, Taiwan and Singapore.

The reasons for the global reappearance of dengue epidemics are not fully understood, but they are related to demographic and social changes, including the increase in population flow. Growth in population, rural-urban migration, inadequate basic urban infrastructure and exponential growth in consumerism are responsible for the conditions that favor the transmission of dengue fever. In Yemen, the endemic level of dengue fever has already changed morbidity indicators, and the magnitude of these incidences in the last years has surpassed the incidences of all other diseases of compulsory notification.

According to Tran et al (2004), there is no vaccine or specific treatment available for dengue fever, the only way to prevent the disease is to apply vector control strategies that require the identification of high-risk areas and periods. The heterogeneity of dengue fever incidence observed in time and space reflects the complexity of risk factors involved in the disease transmission. Dynamic models of dengue fever may help to understand, on a local scale, the influences of different parameters, and on a larger scale, the emergency mechanisms.

The utilization of geographic information systems (GIS) has currently facilitated mapping of disease cases. In the manner they have been employed, GISs have provided visual display of their occurrence exclusively. Nonetheless, they could be useful to confirm the existence of case clusters and spatial correlation. In addition, Wen et al (2006)[13] state that the exclusive utilization of incidence rates to assess the occurrence of diseases provide limited results, and thus propose a temporal-spatial risk model to map geographic distribution of cases. This model is based on three risk measures in the geographic space – frequency, duration and intensity, and was applied in Taiwan in 2002, where it was considered adequate to identify high-risk areas.

This study describes a solution of using Geographic Information System (GIS) to control Dengue Fever in the case of Shabwah governorate, Careful study of census data with appropriate attributes was made to find out their potential influence on dengue fever incidence in the various regions or census districts. The intention of this study was to propose a suitable method to get DF maps, with proposing and using a suitable data classification method to classify DF data; in order to propose the data dengue fever updating process; to build the Dengue Fever's GeoDatabase, from this making a Dengue Fever Control Software that support to control or prevent DF. This study used the DF data within the years of 2006 and 2012.

2. Problem statement

Dengue fever is a disease and one of the most dangerous diseases in the world. However, there is no map that represents the spread of the disease in Shabwah,

which makes the fight against this disease, very difficult and makes decision-making process not an easy task.

3. Purpose & Motivation

We are motivated by the fact that most of the countries that suffer from dengue fever start by building a map showing the spread of the disease, because of that the purpose of this project is to build the Dengue Fever's GeoDatabase to provide Software that will give a clearer idea and powerful ability to take the best decisions to fight this epidemic.

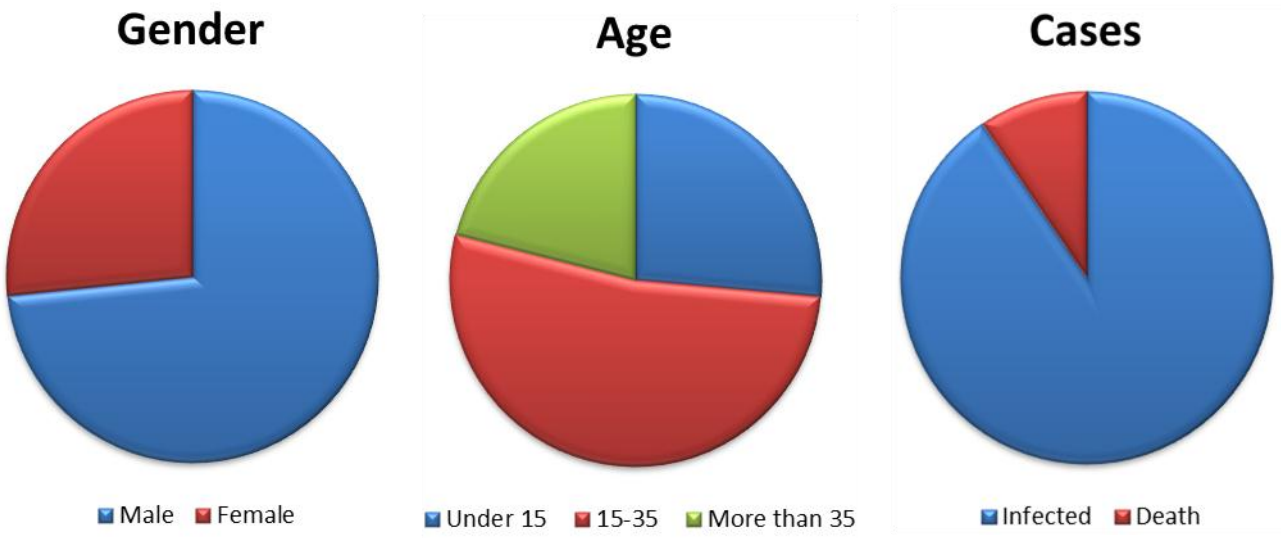
4. Methodology

The governorate of Shabwah is located in Southeastern Yemen. The estimated population in 2004 was 42,548 inhabitants. In Shabwah province, after the first DF/DHF infection in the year 2006 reported by local ministry office in Shabwah, DF/DHF continued to occur and became an epidemic hemorrhagic fever in the years 2008up to 2012.

4.1. Data Collection

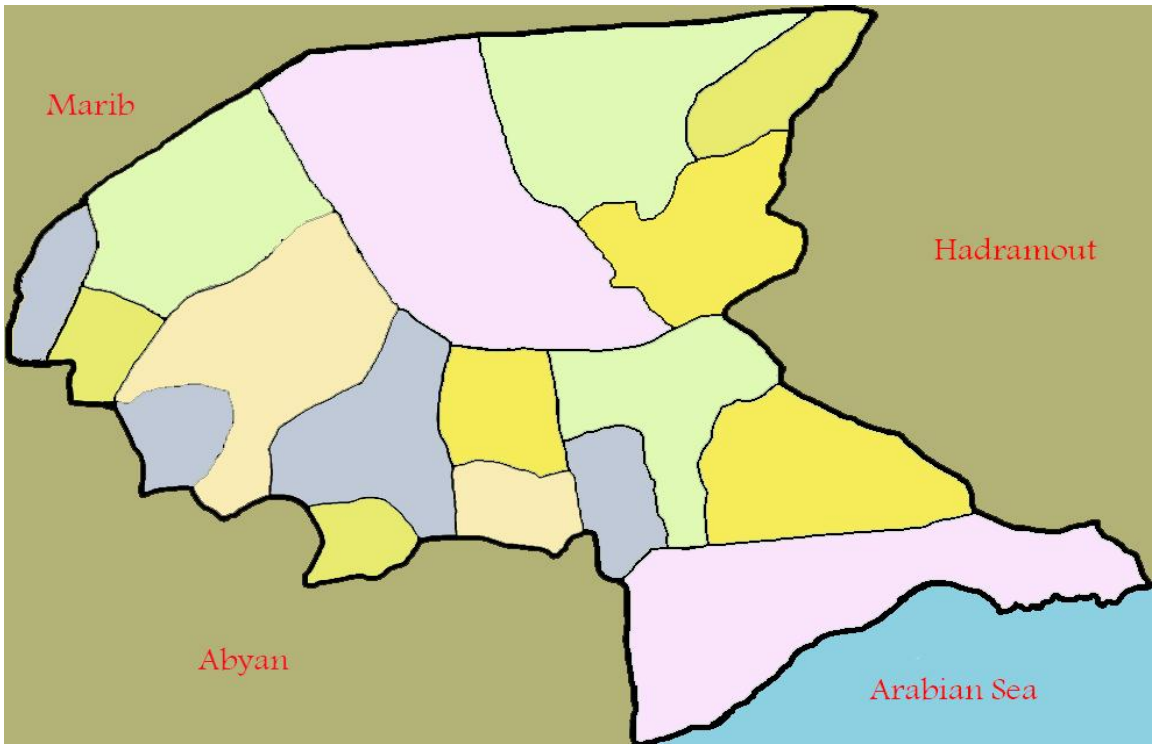
To do this research, we conducted a survey to learn about the situation, the demand of DF management at the study area, collected DF data and built the DF infection geodatabase. From this, we built the software to use DF data effectively. This study used Shabwah general reference map that shows a variety of layers that showed DF cases and health organizations were made from health organizations and DF cases dataset of study area. All of the datasets were collected by health authorities.

By using Microsoft excel, we analyzing the data that we have and we come up with some graphs as follows:



4.2. Build the map

In order to start working on this project, we need a clear map of the province of Shabwah, but unfortunately we could not get any map through the Internet or from printed maps that commensurate with the project we seek to accomplish. For this reason, we draw a map using Adobe Photoshop. The map was produced as shown in the picture 2.



4.3. Digitize the map

When the map became ready to use, we digitized it using ArcMap tool. In order to put our map correct location for the World Map, we had to Georeferencing it. To do so, we need a correct set of latitude and longitude points to the site of Shabwah governorate. We got these points using Google Maps, and then we Georeferencing our map using ArcMap tool.

4.4. Data Entry

Since the map are ready for use and it has been digitized and placed in the correct position on the global map, we immediately start the process of data entry in order to represent the infected cases on the map at the specified location of the infection. We have inserted more than 2150 cases were infected by dengue fever. There are several fields for each case as following: Gender (Male, Female), Age, District (there are 17 district in Shabwah), Address (village), Case (Infected, Death).

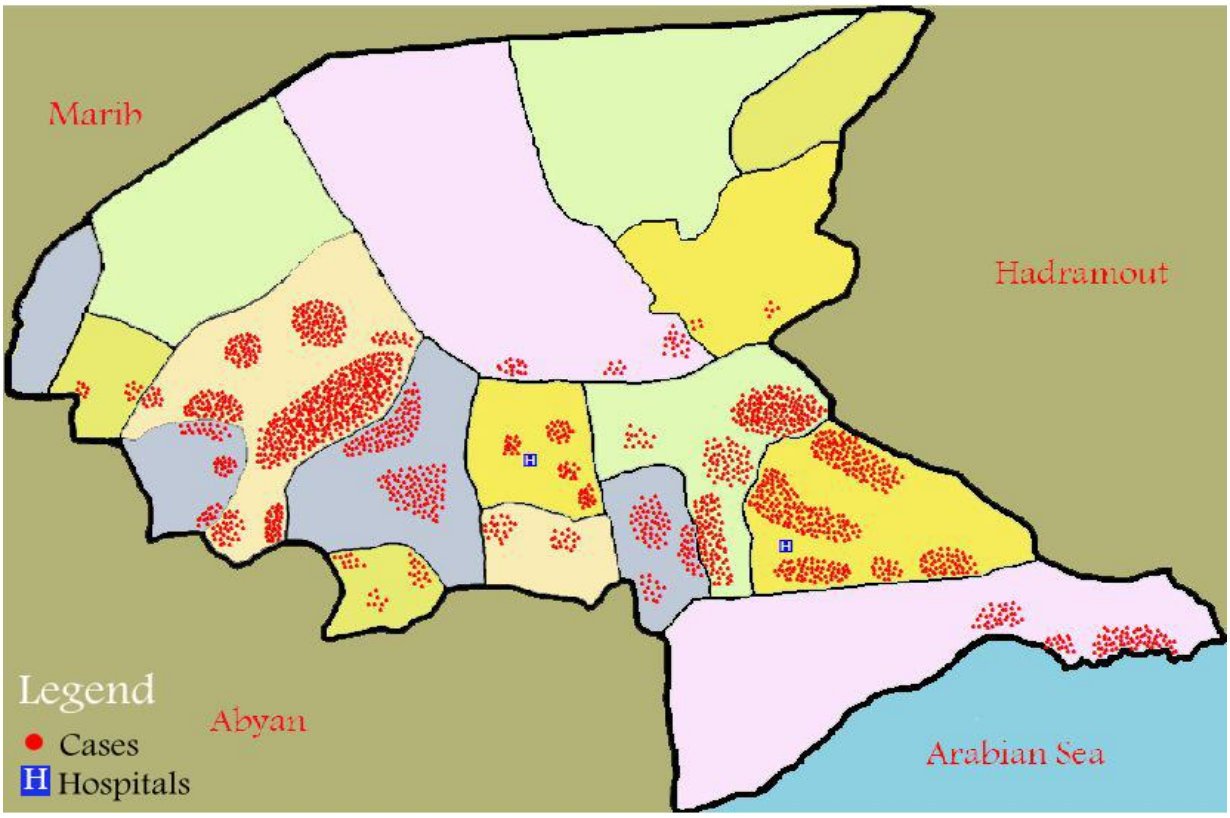
5. Resource and Information

In this project, we use ArcGIS (ArcMap and ArcCatalog) tool to do our project. As well as we used Photoshop and Microsoft Excel. Also, we depend on the internet to get information about how to build and digitize maps using ArcGIS tool.

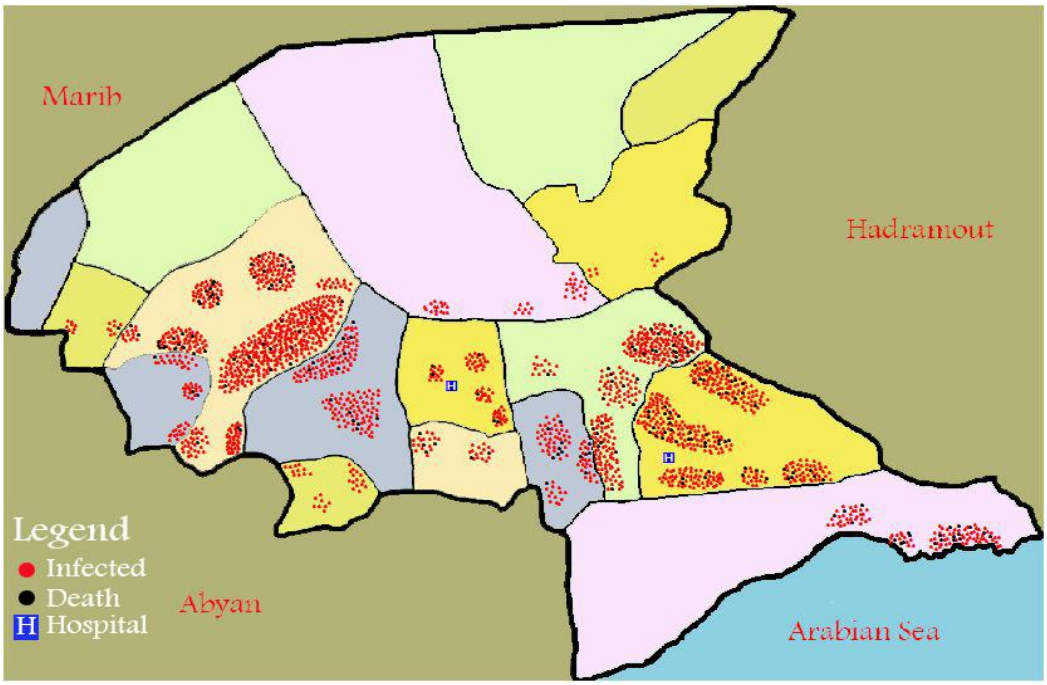
6. Results

As a result of this project, we got a set of maps that represent the spread of the disease in the province of Shabwah as follows:

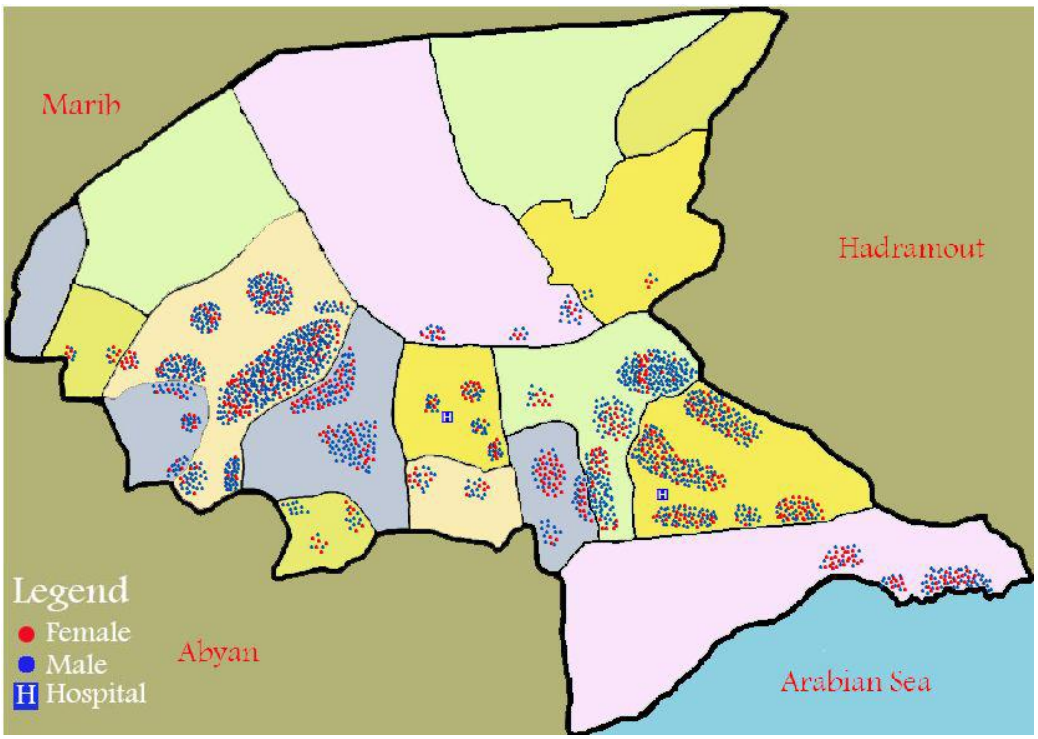
The following map shows all cases that infected with dengue fever as each case represented as red point according to their origin address.



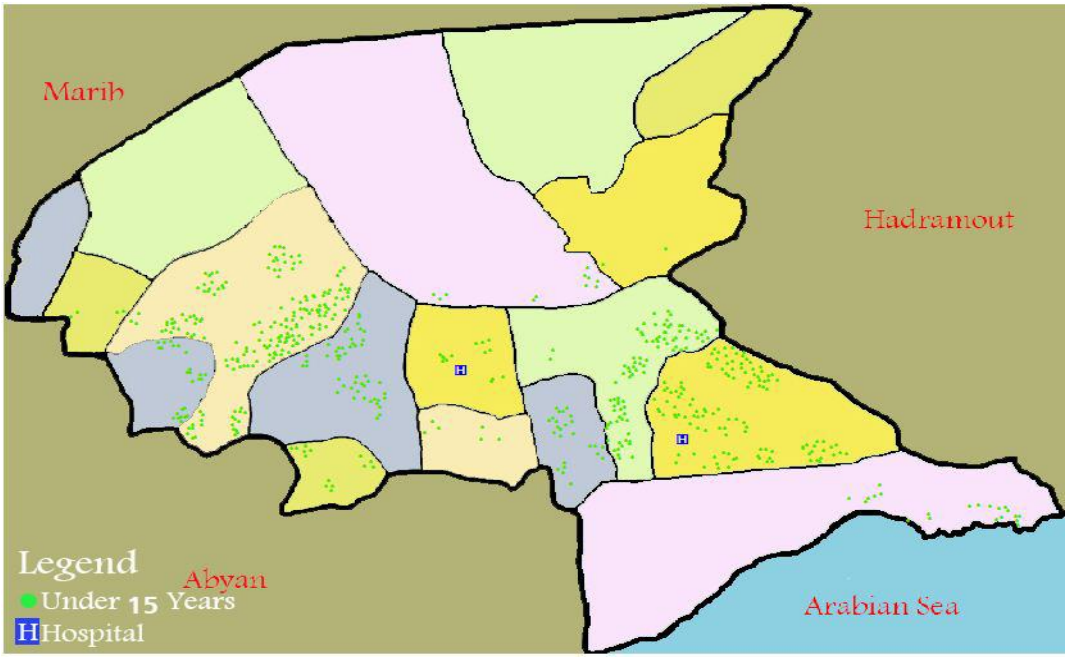
The following map shows all infected cases (red points) and all death cases as each death case represented as black point according to their origin address.



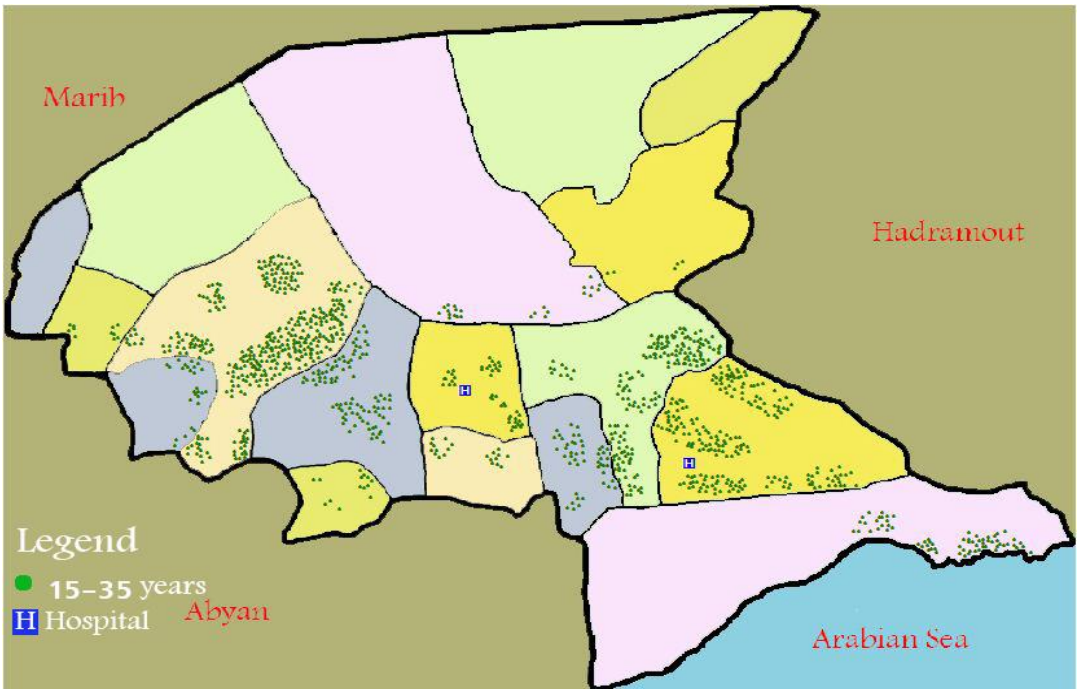
The following map shows all male infected cases (blue points) and all female infected cases (red points) according to their origin address.



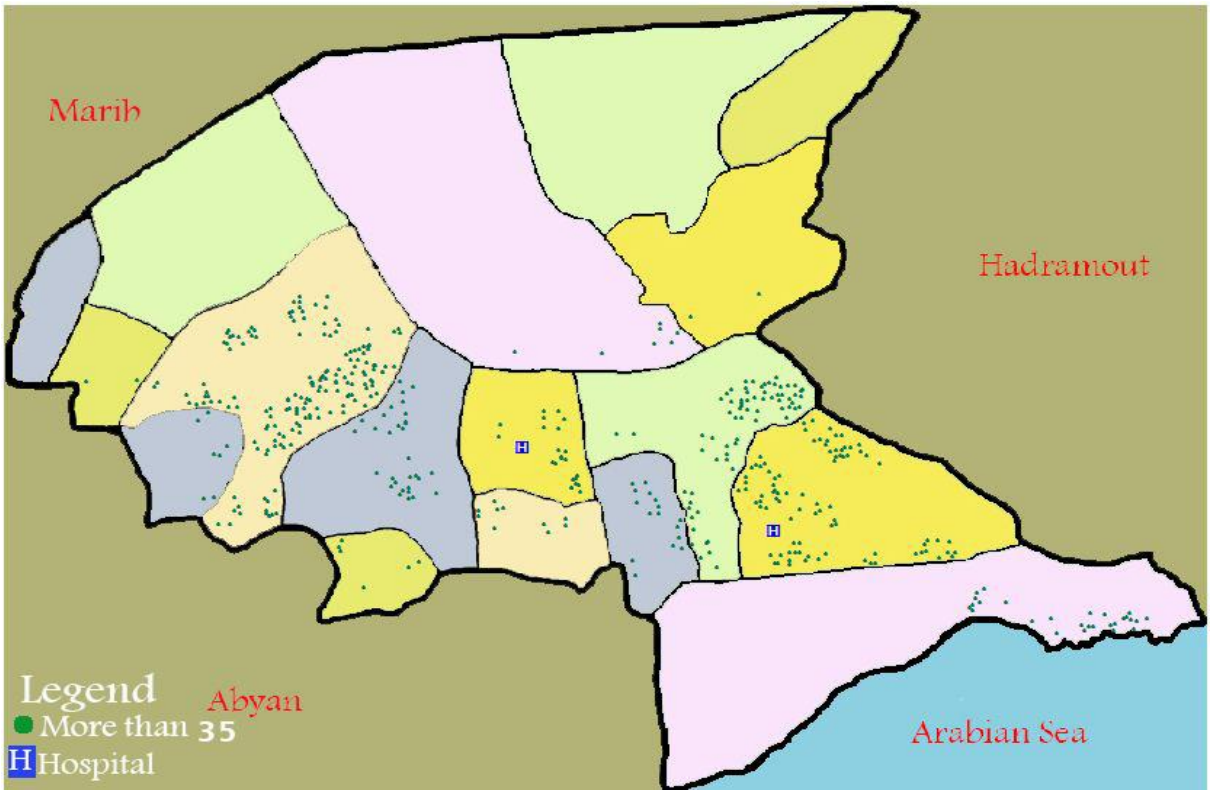
The following map shows all less than 15 years cases that infected with dengue fever as each case represented as light green point according to their origin address.



The following map shows all cases between 15 and 35 years that infected with dengue fever as each case represented as dark green point according to their origin address.



The following map shows all more than 35 years old cases that infected with dengue fever as each case represented as dark green point according to their origin address.



7. Discussion

Generated raster surface, through weighted overlay, confirms the fact that if a densely populated region has dengue fever cases it should be treated as high risk area and to be under constant surveillance. Another finding was observed that agricultural sites are one of the major breeding environments for Aides Aegypti. Consequently, agricultural sites should be under a continuous surveillance and treatment. As well as those areas that were dengue fever cases was detected but not relatively much populated can be occasionally monitored for mosquito density.

This way the most resources can be allocated to high risk regions, hence efficient usage is obvious.

8. Conclusion

When considering the factors as population, dengue cases and mosquito population resulted in dynamic positioning of surveillance points. This positioning can be change at any time depending upon the factors. High risk areas can be used to enforce precautionary measures before the start of epidemic cycle. Distributing surveillance points on spatial basis not only control the mosquito population but it also reduce the cost than in treating region haphazardly. Precautionary spraying and treatment can be concentrated on historically high risk for dengue fever regions. Since the factors used in this spatial distribution are very common among any urban area, other factors might be included based on the characteristics of the region or surrounded environment.

9. Acknowledgment

The authors would like to acknowledge the health ministry office team at Shabwah governorate for their helpful, discussions and comments. Also we would like to thank our professor Dr. Baqer Al-Ramadan for his valuable help and instructions.

10. References

- B. Al-ramadan. "Introduction to GIS technology and its application," GIS@development, Middle East, 2005
- Alharthy, Abdulatif, "Role of GIS in Dengue Control Management Strategy at Jeddah Municipality" ,Retrieved on 20\4\2012
- Gubler DJ, 1998, "Dengue and dengue hemorrhagic fever" Clinical microbiology reviews, pp. 480-96.
- Jose Rigau-Perez, 1998, "The Early Use of Break-Bone Fever (Quebranta Huesos, 1771) And dengue (1801) in Spanish", The American Society of Tropical Medicine and Hygiene, 59(2), 1998, pp. 272-274.
- Mazen Fakeeh and Ali Zaki, 2001, "Virologic and Serologic Surveillance for Dengue Fever in Jeddah, Saudi Arabia, 1994–1999", The American Society of Tropical Medicine and Hygiene, 59(2), 2001, pp. 764-767.
- Muhammad Ayyub, Adel M Khazindar, Eman H Lubbad, Shahid Barlas, Adnaan Y Alfi and Sawasan Al-Ukayli, 2006, "Characteristics of Dengue Fever in a Large Public Hospital, Jeddah, Saudi Arabia " Journal of Ayub Medical College, 2006, 18(2), pp. 9-13.
- Ten Boon Teng, 1997, "Control of Dengue Fever/Dengue Haemorrhagic Fever in Singapore" Dengue Bulletin, vol 21.
- Esri understanding our world ,"GIS for Higher Education" , Retrieved from http://www.esri.com/industries/university/business/administration.html