

Developing a Web-Based GIS for Hajj Traffic Plan (HajjGIS.Net)

Dr. Nabeel A. Koshak
Hajj Research Institute
Umm Al-Qura University
Makkah, Saudi Arabia
n@cad-gis.com

Abstract

A major challenge facing urban planners and designers in the city of Makkah, Saudi Arabia, is planning the movement of vehicles and mass transit during the period of Hajj (Islamic Pilgrimage) when a huge number of people come from all over the world for religious activities. Every year, local authorities need to provide a traffic awareness plan that can be implemented during Hajj to avoid traffic congestion. A traditional means to distribute awareness of the traffic plan is to publish hard copy maps and distribute them to local authorities and the public before each Hajj season. This method requires extensive time and resources.

This paper demonstrates how the web-based Geographic Information System (GIS) can be utilized to provide broader and easier distribution of the traffic plan. Such a system will facilitate understanding and ease the following of the traffic plan. Awareness of the plan will help implementation and reduce traffic congestion due to unawareness. In addition, urban planners and urban designers can easily access the annual Hajj traffic plans to support research and investigation.

تطوير نظام معلومات جغرافي على شبكة الإنترنت للخطة المروية خلال موسم الحج

ملخص البحث

إن من أهم التحديات التي تواجه المخططين والمصممين العمرانيين بمكة المكرمة والمشاعر المقدسة هو التخطيط لحركة المركبات والمشاة خلال موسم الحج، وذلك عندما يقدم إلى مكة المكرمة أكثر من مليوني حاج كل عام لأداء مناسك الحج التي تتطلب نقل الحجاج بين أماكن مختلفة ذات محددات مكانية وفي خلال فترات زمنية محددة وقصيرة. تقوم الجهات المعنية (إدارة أمن الحج بالأمن العام بالتعاون مع الجهات المختلفة) بوضع خطة مروية لكل عام خلال موسم الحج لتسهيل نقل الحجاج ومحاولة التخفيف من مشاكل الزحام. ولكن الطريقة التقليدية لنشر هذه الخطة هو طباعة هذه الخرائط ورقياً وتوزيعها على الجهات المختلفة ذات العلاقة بعملية نقل الحجاج قبل موسم الحج. هذه الطريقة تحتاج إلى وقت وموارد كثيرة لنشرها كما ينبغي وفي الوقت المطلوب. هذه البحث يستعرض كيف يمكن تسخير تقنية نظم المعلومات الجغرافية على شبكة الإنترنت لتوفير طريقة أفضل لنشر الخطة المروية على نطاق أوسع وبطريقة أدق وأسرع. وإن بناء مثل هذا النظام سيسهل عملية فهم الخطة وقد يسهل عملية إتباع الخطة من خلال الخرائط التفاعلية والمعلومات الوصفية للخطة. إن نشر الوعي بالخطة المروية خلال موسم الحج قد يساعد في تطبيقها وإتباعها. هذا بالإضافة إلى أن توفير الخطة من خلال هذا النظم سوف يجعل الخطة في متناول المخططين والمصممين العمرانيين لإجراء الأبحاث والدراسات في هذا المجال وكذلك تقييم وتطوير الخطة المروية خلال موسم الحج لكل عام.

1 Introduction

Hajj is one of the five pillars (central duties) of Islam. It is a set of acts of worship to be performed in and around Makkah at least once in a lifetime by every Muslim satisfying certain conditions. The nature of today's Hajj (Islamic pilgrimage) requires substantial planning and effort to provide support and infrastructure (Al-Yafi, 1993). Hajj is considered as one of the world's largest mass movements. Over two million pilgrims converge every year at the same time to perform their religious duty (Seliaman, 2001). An important problem facing the city of Makkah during this time is managing the movement of vehicles and mass transit.

The huge number of people (more than two million) and the nature of their activities in Makkah and the Holy Environs (called as Mashaer) further complicate the problem. Local authorities have worked on various solutions to resolve the problems. For example, small cars are not allowed to enter Makkah and the Holy Environs during peak periods. Although some solutions have been implemented and work, with the increasing number of pilgrims more problems continually arise. During the last season of Hajj 1424H (2004), more than thirteen thousand (13,000) buses were used to transfer pilgrims from one place to another. Traffic congestion during Hajj is a phenomenal and serious problem in the city of Makkah and the Mashaer areas (see Figures 1 - 2). The Mashaer areas include Arafat, Muzdalifah, and Muna. Congestion is more severe during two periods: Taseid and Nafrah. Taseid is the movement of pilgrims from Makkah and Muna to Arafat during the 9th day of the twelfth month of the lunar year named Thul Hijjah. Nafrah is defined as the movement of pilgrims from Arafat to Muzdalifah and Muna during the 10th night of Thul Hijjah (Seliaman, 2001).

One approach to solving the problem of congestion during Hajj is to have a careful plan for traffic movement. Different local authorities participate in planning and managing the movement of pilgrims. Part of their duties is to provide awareness of a traffic plan during Hajj in Makkah and Mashaer each year. The more people that are aware about the plan before Hajj, the more easily and effectively the plan can be implemented. Main participants in plan implementation during Hajj should include: Traffic Police (General Security), the Ministry of Hajj, the Ministry of Transportation, Tewafah Establishments, bus drivers, and individual pilgrims.



Figure (1) Traffic congestion at an intersection in Arafat

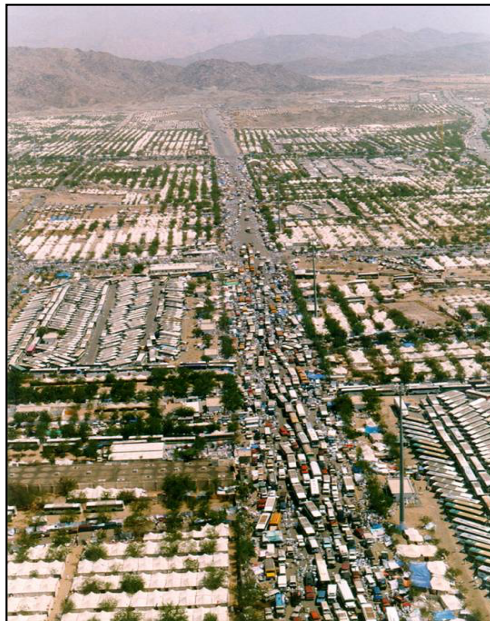


Figure (2) Traffic congestion on a main road in Arafat
(Source: Hajj Research Institute)

A traditional means of providing awareness of the traffic plan is to publish hard copy maps and then distribute them to local authorities and the public before each Hajj season. This method has several problems. First, the plan has to be distributed physically to each public and private entity participating in Hajj, a time consuming process that requires human resources. Second, the plan often changes and requires a reprinting and distributing of the maps when changes do occur. Third, reprinting these maps is a cost for local authorities.

2 Promising Technology

The Internet has not changed the main functions and applications of GIS and the value of spatial information. However, the Internet does make spatial information available for everybody via electronic connections. Every day, millions of people access geographic information via the Internet (Harder, 1998). This new technology offers governmental and private entities the possibility of providing information to a wider base of users. The technology is called "Distributed Geographic Information". It includes software and services that utilize the Internet to allow people to access geographic information in various useful forms, such as maps, photos, and attribute (textual) data (Greene, 2001), (Plewe, 1997) and (Tang, 2003).

This merger of GIS and the Internet provides a viable solution for the different problems related to hard copy traffic plan maps for traffic control during Hajj. In addition, since GIS integrates spatial and attribute data, the Internet adds the possibility of offering integrated maps and data by using a web interface. Any person around the world can access and navigate spatial and attribute data via a web browser without the need for additional software (Peng, 2003).

3 Approach

Given the problems of paper-based maps for traffic plans, web-based GIS can offer a promising means for distributing traffic plan maps. With web-based GIS, the distribution of geographic information becomes wider and easier. Updating information does not require continual reprinting and redistributing maps as is necessary with hard copy maps. Any update on the web server that hosts the geographic information will be reflected immediately on the web browsers of users.

A traffic plan that is web-based using GIS facilitates the distribution of the traffic plan to different participants involved in the traffic movement of pilgrims during Hijj (Figure 3).

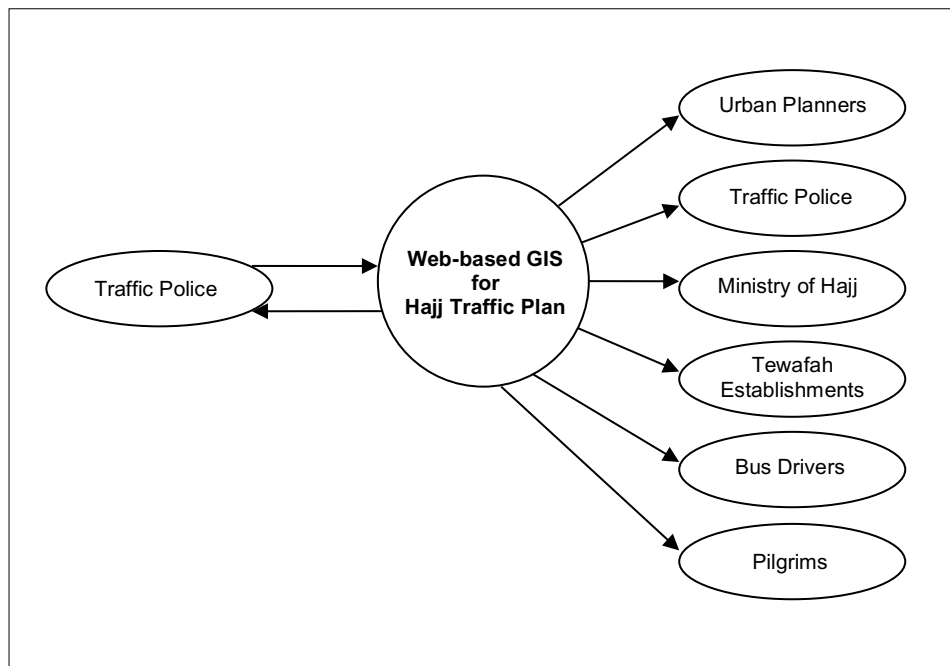


Figure (3) A web-based GIS traffic plan facilitates the distribution of the plan to different participants involved in the movement of pilgrims

4 Prototype Implementation

To implement a web-based GIS of a traffic plan, several steps were followed:

First, a geodatabase has been established to capture the representation of different kinds of traffic network components such as highways, ring roads, primary roads, and pedestrian walkways. Then, using survey CAD files and satellite images were used to draw polygons representing each segment of the traffic network. Attribute data are integrated with each traffic network segment such as street name. The locations and attributes

of main features and land marks are also represented in other layers, such as public services, mountains, hotels, and valleys. On top of these layers, a layer of arrows (see Figure 4) representing allowed traffic direction at each road during two main periods (Taseid and Nafrah) has been drawn.

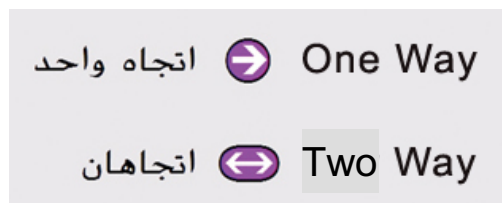


Figure (4) Arrows represent permitted traffic directions

Second, software called HTML Image Mapper was used to convert maps from ArcView to html files. This software transforms ArcView maps and data into interactive maps for use on the internet. It allows for the configuration of the quality and interactions that users should get. Having the maps as HTML files allows the user to navigate thorough the maps without any need to download additional software. The user will only need typical web browser software for access of the data.

Third, a domain name has been reserved for this website. Its address is <www.HajjGIS.net>. A website has also been designed to provide an interface to the traffic plan GIS. Figure (5) shows the main page of the web site. It provides two kinds of maps (described below) of the traffic plan during Hajj in Makkah and Mashaer. In addition, the site provides general information on how to learn about the project and how to contact the project team.



Figure (5) The main page of the Hajj traffic plan GIS web site
<www.HajjGIS.net>

4.1 Static Maps

The first kind of map that the website provides is static maps (offline) available in both JPG and PDF formats (Figure 6). The user can download these maps on a PC and then use them without an Internet connection.



Figure (6). The interface to download the 12 static maps of the traffic plan in JPG or PDF formats from the web site

4.2 Dynamic Maps

The other kind of maps that the website provides is interactive maps (online) that allow the user to interact with maps via the web interface (Figure 7). These maps were generated using HTML Image Mapper software as described above. Through this interface, the user can navigate through maps by zooming in and out (Figure 8) and search the traffic network segment using attribute data such as street names (Figures 9).

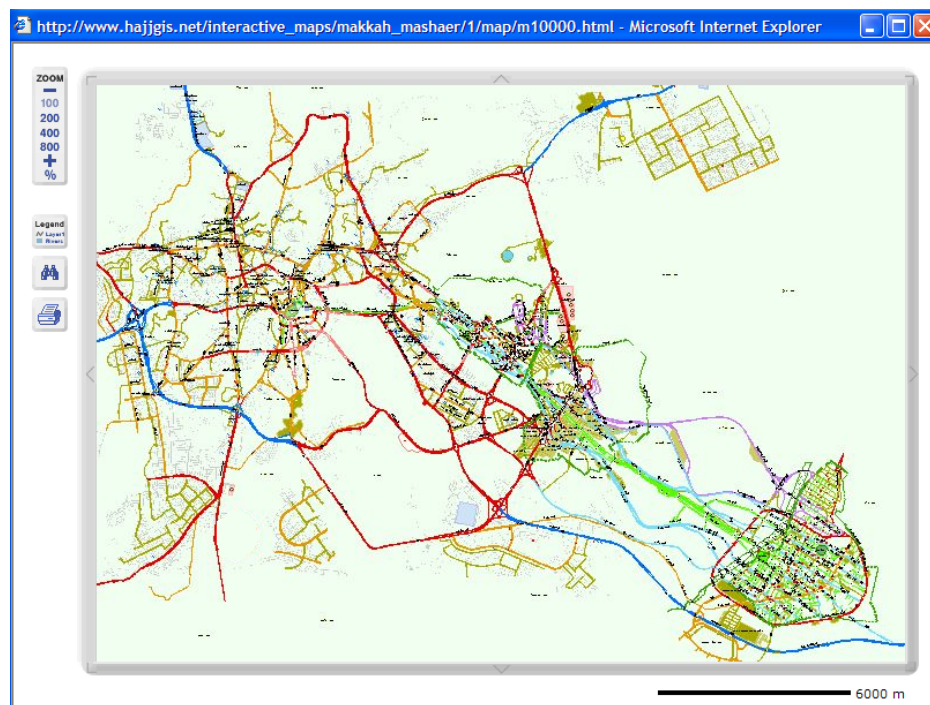


Figure (7) Traffic plan of the city of Makkah and the Holy Environs (Arafat, Muzdalefah, and Muna)

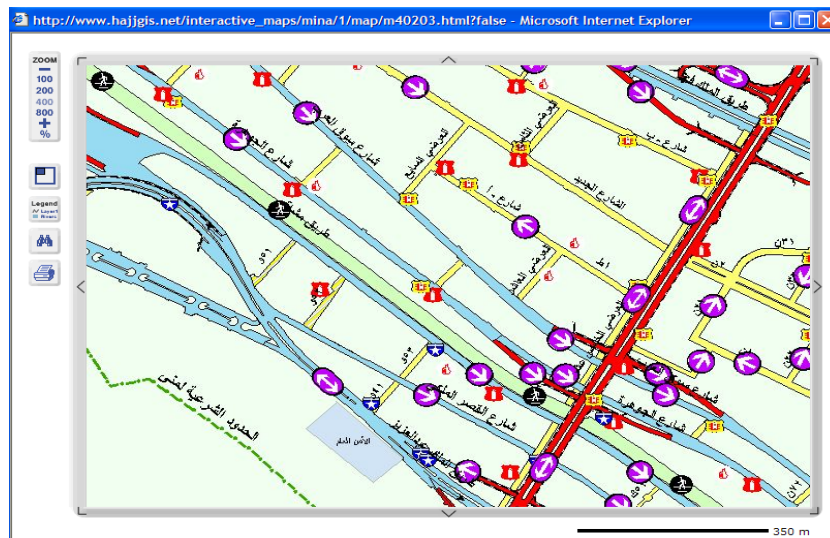


Figure (8) Traffic plan in Muna, allowing the user to zoom in and out and navigate through maps

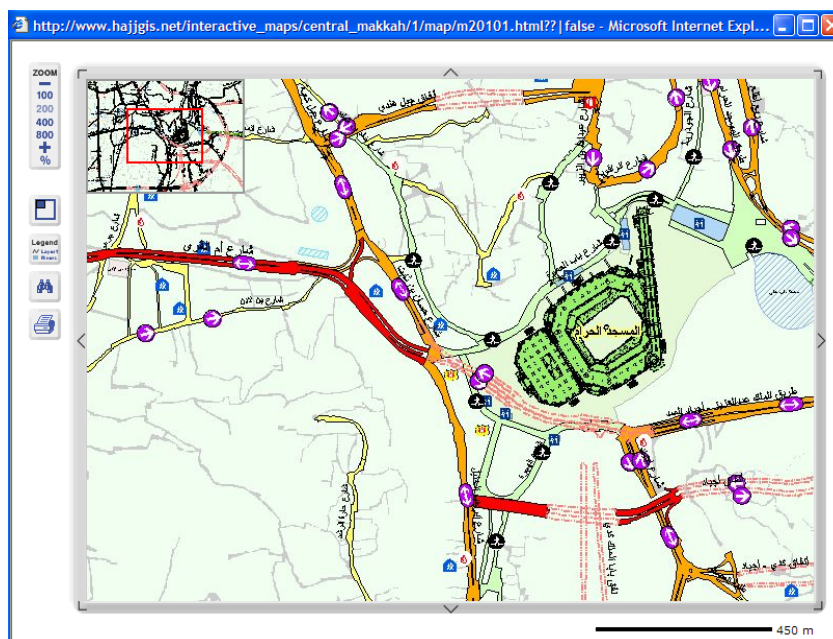


Figure (9) Traffic plan GIS of the central area of the city of Makkah, allowing the user to search for a particular road by name

5 Conclusion

This paper demonstrates how web-based GIS can be utilized to distribute a workable traffic plan during Hajj. Web-based GIS makes the distribution of the plan easier, wider, and cheaper. The web-interface offers both static and dynamic digital maps that can be used by urban planners and designer, different local authorities, and private entities who are participating in managing and operating the movement of pilgrims. Internet interfaces can also help individual pilgrims gain knowledge about the traffic plan from their own countries before even arriving in Saudi Arabia. This access will facilitate understanding and following specific traffic plans. Earlier and more precise awareness of the plan will help in its implementation and reduce further traffic congestion due to unawareness. In addition, urban planners and urban designers can easily access the annual Hajj traffic plans to support research and investigation.

Acknowledgements

My thanks go to Dr. Osamah Al-Bar (Dean of the Hajj Research Institute) and General Mansour Al-Turkey (from Hajj Traffic Police) for their support and supervision of this work. I would like to thank my colleagues Eng. Abullah Foudah and Dr. Ahmad Shehatah for helping me to manage the work of building the geodatabase for the traffic plan. I also would like to thank Akram Noor, Mustafa Sabagh, Aatif Kurdi, and Mazen Milibary for their significant participation in this work.

References

- Al-Yafi, A. (1993). *Management of Hajj Mobility Systems*. Joh. Enschede, Amsterdam, Holland.
- Greene, R. W. (2001). *Open Access: GIS in e-Government*. Environmental Systems Research Institute, Inc., Redlands, CA, USA.
- Harder, Christian. (1998). *Serving Maps on the Internet: Geographic Information on the World Wide Web*. Environmental Systems Research Institute, Inc., Redlands, CA, USA.
- Peng, Zhong-Ren and Tsou, Ming-Hsiang. (2003). *Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks*. John Wiley & Sons, Inc., New Jersey, USA.
- Plewe, Bardon. (1997). *GIS Online: Information Retrieval, Mapping, and the Internet*. On Word Press, Santa Fe, NM, USA.
- Seliaman, Mohamed Elhassan. (2001). *A Simulation Model for the Shuttle Bus Traffic During the Nafrah Period*. Masters thesis submitted to the Department of Systems Engineering, King Fahad University of Petroleum and Minerals.
- Tang, Winnie and Selwood, Jan. (2003). *Connecting Our World: GIS Web Services*. Environmental Systems Research Institute, Inc., Redlands, CA, USA.
- Tomlinson, Roger F. (2003). *Thinking About GIS: Geographic Information System Planning for Managers*. Environmental Systems Research Institute, Inc., Redlands, CA, USA.