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GIS AND ASSESSMENT OF THE PERFORMANCE OF THE TRANSPORT SYSTEM AND SECURITY

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Abstract: *Purpose* – The purpose of this research is to develop an analysis ofa systematic approach to generate and utilise GIS capabilities and create layers of combined data bases in order to devise indicators to assess the performance of transport systems.The impacts of various policies on these systemsis evaluated and compared.
Design/methodology/approach – Accident analysis tools were used to calculate rates and severities of accidents before-and-after the implementation of a scheme. Travel demand forecasting models investigated impacts on modal split, route choice and other decision choices.
Findings – The use of such tools can be further extended to investigate the impacts of proposed policies and the impacts of specific variables on the performance of the transport system more efficiently.
Originality/value – Most of the available analysis and modelling tools of transport systems investigate transport problems on a single dimensionor a single data set.

Keywords: *Geographic Information System (GIS), Modelling, Transport sustainability, Accident analysis*

Paper type Research paper

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BACKGROUND

The Geographic Information System (GIS) is a computer-based information system that enables the storing, modelling, manipulation, retrieval, analysis and presentation of geographically referred data (GIS.com, 2008). GIS are very useful tools for landuse planning and data presentation and visualisation (Saxena, 2005). In particular, population is an integral factor when carrying out planning and enhancement of the transport system. With the constant changes in the spatial and temporal behaviour of various population groups in urban areas, there must be continuous investigation into the parameters relevant to population, which need to be furnished by the planners to aid the decision makers.

Evaluation of land use and land cover is a very important activity for contemporary land management. A wide range of literature (Hutton et al., 1983; Turner, 1990; McDonnell and Pickett, 1993) suggests that human landuse practices, including the type and volume of distribution, are the most important factors affecting natural resource management at regional and local levels, and international standards.

It is very important to investigate the patterns and the compatibility of the land use/ land cover after comprehensive overview and research on most populated cities and towns, as well as the facilities available for that particular area. For better planning, knowledge of the past, up-to-date data about population and the history of any building in that area, pattern, environment and facilities available to the government must be considered by the analyst (Lillesand and Kiefer, 1994). GIS provide very powerful tools for the investigation of patterns and to integrate and create various planning scenarios for decision making (Lillesand and Kiefer, 1994).

With the help of GIS tools, it is possible to visually investigate and interpret various scenarios for urbanization and generate required maps for the future. GIS software such as ArcGIS9 can be used for manipulating and changing subsets and/or the digitization of different fields. It is estimated that more than 90 percent of information required for a city's administration contains a spatial component, such as road networks, public transport services, information provision and traffic zonal data. The quality of planning and decision making processes are strongly influenced by data availability and data completeness. Eighty percent of the time and costs occupied in developing GIS is allocated to database acquisition and integration (Thomson and Hardin, 2000).

INTRODUCTION

The most important challenge for any country is to determine territories at any level, such as different natural resources, which are a crucial source in economic development. However, other important specific phases should be consider in border determination processes, such as defining borderlines, finding geodesic points, locating a border pyramid, GPS systems and measurement. Another vital factor is to communicate with local residents while defining borderlines or locating security building positions, because their homes may be left on the other side of the border (Al-Ali and Saleh, 2011).

While locating security buildings, several items are selected as classified into two main factors: physiographic factorsand anthropogeographic factors.The physiographic factors of the terrain are very important while locating security building, including the analysis of high points and different topographical factors (Meha and Selimi, 2010). Anthropogeographic factors are defined as the science of the human species as to geographical distribution and environment. Broadly, this includes industrial, commercial and political geography, and that part of ethnology which deals with distribution and the physical environment. However, this research will focus on the population in the anthropogeographic factor, which can be considered on the base of population density in that particular area.

Centres and border guards were built before the final demarcation of the border with neighbouring countries. The security system of any country is important to the welfare of demarcation process (Meha and Selimi, 2010).It is important to maintain the country's borders and protect it from any attack or infiltration by building centres for border guards and choosing the right place based on certain criteria (Anavberokhai, 2008).

Advanced technology plays an important role in such projects, for example, GIS, which will be used in this research, will contribute to finding appropriate ways and alternative resolutions of border problems and the infiltration of offenders in order to protect the country (Huxhold, 1991).

AIM AND OBJECTIVE

The main aim of this study is to identify the appropriate location for a security department building on the country's borders, and to build GIS

systems in order to determine the best way to maintain the security and integrity of the country and protect it from infiltration and illegal entry through borders with neighbouring countries.

The objectives are:

1. To investigate using GIS for improving border security
2. To recommend new security building location on country border
3. Building GIS system.

CASE STUDY

Borderline area (south of Saudi Arabia)

The study area chosen for this particular research is the borderline of Kingdom of Saudi Arabia with Yemen. The Kingdom of Saudi Arabia contains the Arabian Peninsula with the Red Sea and the Gulf of Arabia to the west and the Persian Gulf to the east. Neighbouring countries are Jordan, Iraq, Kuwait, Qatar and United Arab Emirates. Yemen and Bahrain are connected to Saudi Arabia's mainland by the causeway. Saudi Arabia's land area is approximately 829,995 sq mile, which is equal to 2149690 sq kilometres. Geographically, Saudi Arabia lies 25° N and 45° E, whereas the study area lies from 16° 25' N and 43° 1' E (Geography of Saudi Arabia, 2008). The location of the command area is shown in Figure 2.

ANALYSIS

In this scenario, the length of borderline considered is 8km. This is divided into 4 segments, each 2km long. This creates four different areas

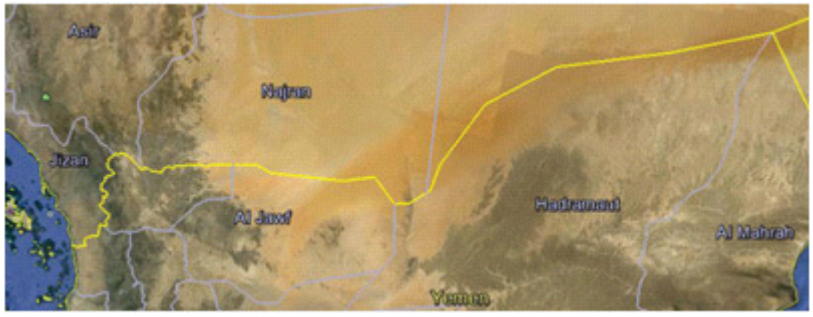

Figure 1. Saudi borderline with Yemen

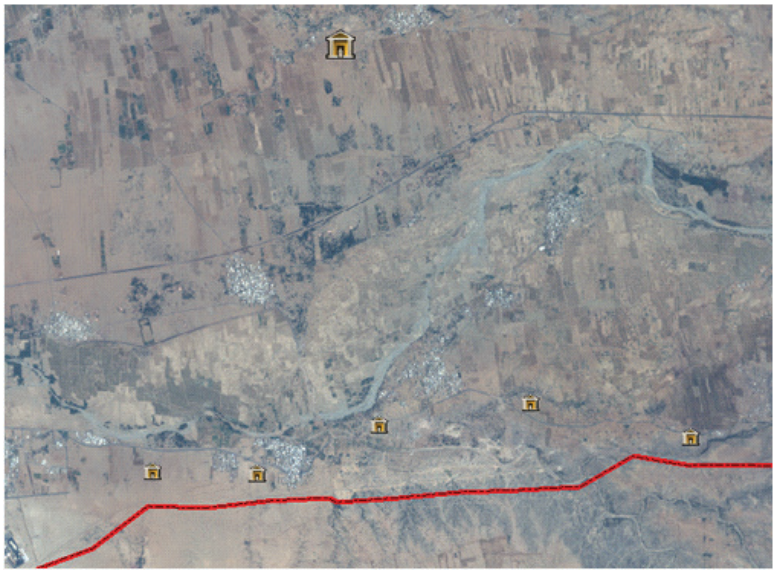

Figure 2.
The new centre guards on the borderline, case study 2 in populated area

(A1– A4), as shown in Figure 1. Data are collected (assumed) for each area, as shown in Table1.

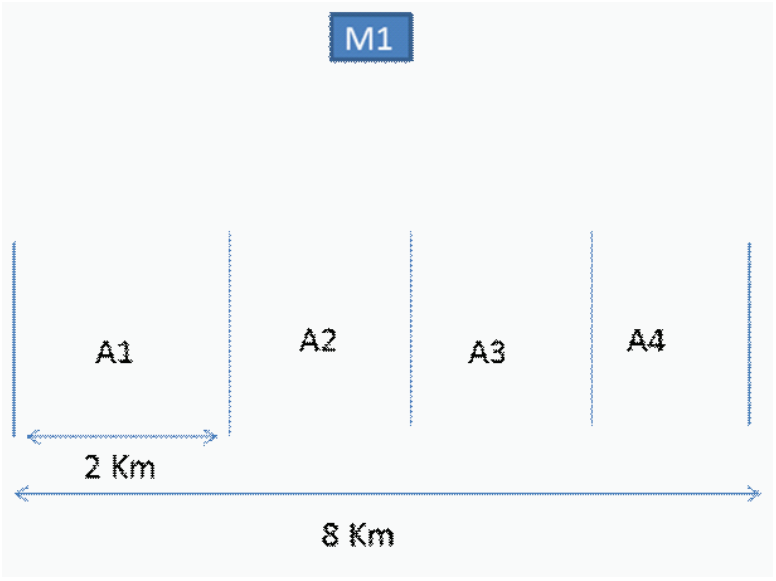

Figure 3.
Borderline is segmented into 4 areas

Area	Distance	Number of arrests per (month per) area	Number of security guards per area	Rate of movement per area	Population
A1	2km	20	8	8	150
A2	2km	10	15	20	450
A3	2km	8	15	22	500
A4	2km	19	8	6	120

Table 1 Parameters with distance for each area

Table 1 includes information for four areas (A1–A4). There are three parameters that can determine performance indicators. These are: Number of arrests (per month) per area; Number of security guards per area; Rate of movement per area. To obtain performance indicators, two criteria are used: Population and Distance. Data in Table 1 show that as population increases, the rate of movement increases, which means more security guards are needed, and as a result the number of arrests decreases.

Table 2 shows six performance indicators: Number of arrests/ Population, Number of security guards/ Population, Rate of movement/ Population, Number of Arrests/ Distance, Number of security guards/ Distance, and Rate of movement/ Distance.

It is assumed that the integrated system that will be developed will make use of different layers in a geo-database as well as the performance indicators represented in Table 2 for the following decisions:

Area	Number of arrests/ Pop	Number of security guards/ Pop	Rate of movement/ Pop (Approx. 5%)	Number of arrests/ Distance	Number of security guards/ Distance	Rate of movement/ Distance
A1	0.133333	0.053333	0.053333	10	4	4
A2	0.022222	0.033333	0.044444	5	7.5	10
A3	0.016	0.03	0.044	4	7.5	11
A4	0.158333	0.066666	0.05	9.5	4	3

Table 2 Performance indicators

1. Choosing the location of security centres.
2. Allocating security areas for each security centre: each security area might be covered by one or more than one security centre. This may also include re-sizing the areas chosen at the beginning.
3. Security equipment required by each centre.
4. The optimum number of security guards for each centre.

For example, as a result of running the integrated systems, the partial information in Table 3 and Figure 2 might be produced.

RESULTS AND DISCUSSION

1. To recommend new security building location on country border

Table 3
Results of running the integrated systems

Security area	Security Centres (involved to cover specific area)	Distance	Number of security guards per area
A1	C1, C2	2.5km	8
A2	C1, C2, C3	2.5km	13
A3	C2, C3, C4	2.5km	15
A4	C3, C4	2.5km	7

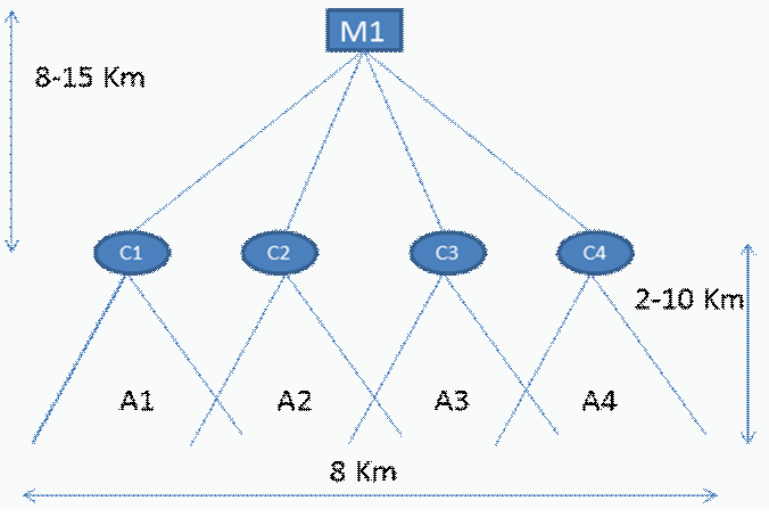

Figure 4.
Results of running the integrated systems

It is important to maintaining the security and integrity of the country by safeguarding the international border, including building centres for border guards and choose the correctlocations. Location choice rests on care over the use of appropriate standards for each state. Choices will vary depending on the nature and seriousness of the land area, and several other factors that fit the area.

For this study, we will implement the following criteria:

1. The security building should be placed 10-13km from populated areas.
2. A GIS should be created for the border and border zone, including a geodatabase, borderline data management, administration and land reform data for the zone, and maintenance of the border zone in technical, legal and security aspects.
3. Sites comprise selected centres of border guards to suit the nature of the security functions of the device, where the following should be observed:
    a) Border posts should be sited in locations adjacent to the border line in order to give border guards early warning of unusual movements on or close to the border. Note that these criteria are presently within the development of modern financial means.
    b) Human resources to the border guards are no longer as important as in the past. All are located in an area 5km from the centre, especially with the approach of the border guards to the building blocks of the border, which is concernedwith administrative units. More centres are required so that the equivalent of manpower and material for three centres combined is available.
    c) In addition, there is currently a project to develop the work of border guards in the areas bordering the neighbouring countries.
4. Due to the volume of smuggling and infiltration in the region, as well as the presence of population and housing, we find that the density of residential areas means that distances between the borders posts should be close for the purposes of security control.
5. Strategic importance is given to the regions where some centres are created in order to promote security and provide a military

presence in areas such as Kalmncat Oil, the official outlets and islands, etc.

6. Employment should be located in order to serve the security aspects.The locations of these centres should correspond to governor control and the exploratory purposes of other bodies should be checked in correspondence to the limits.
7. Site selection should to serve the safety of the building; for example, away from those sites at risk of flooding.

2. Building web-based GIS and document management system for the Ministry of Defence

The idea is to create a web-based GIS that will improve the efficiency of the security departments and provide a security system. The work mainly involves developing their existing layers of data, analysingsuch data and presenting it visually in order to share the data layers with other departments/users, manage their workflow and perform general GIS functionalities.

The system will take data and maintain a document management system for easy data access. The GIS application for the Survey and Land Department must be the prime gateway to register all land parcels within boundaries. All information relating to the land parcels (i.e. owner, deeds, etc) must be archived through the GIS and the Document Management System(DMS) jointly with the GIS as the prime application for transactions within this department.

Several GIS applications should be developed for each different client department. Each security department would have a fully customized application to fit its particular needs, equipped with its own datasets. The different GIS applications should be integrated with the DMS, giving the users an improved security system using geographic attributes for better analysis and understanding of the data.

A. To fulfil the second objective of the study, the following departments should be addressed: 1) Security Department 2) Defence Department
B. A GIS system will be appliedto all of the departments, with several sections underneath them.
C. The main security department requires a customized application for each of the departments in addition to the general GIS in-

tegration with the DMS and the applications of other internal divisions.

D. Customized applications are aimed at helping the departments raise their efficiency levels by facilitating their daily business routines through the use of GIS.

E. These applications should be built as an integral part in the performance of the departments' responsibilities. The application should empower users to plan their work, develop their own layers of data, analyze their data, present it visually, share it with other departments/users, manage their workflow and perform general GIS functionalities.

STUDY AREA

The two areas were selected on the border; the first has apopulation in the border region, and the second is unpopulated.In these two cases, the previously mentioned criteria for the selection of locations for border guardscentres were taken into consideration. The nature of the ground also needs to be considered during site selection, together with factors that may arise in the future.

The centres were divided into two classes, the first category of which is the administration section, which lies about ten kilometres from the second class. The second class is a small offshoot of the main centre or department, as noted earlier, which is close to the areas of responsibility on the borderline.

When the sites were chosen, tests were carried out to ascertain whether or not they were appropriate to act as buffers based on certain spaces following the nearest site boundary line, toensure complete coverage of the region.

CONCLUSIONS

Many factors must be taken into account in order to obtain the best results. Good planning in all areas, pre-design and a commitment to note the problems involved are imperative. GIS, with its advanced technology,is ideally placed to help decision makers in the planning and design work necessary for problem-solving. In this research, GIS will contribute to finding appropriate solutions to the problem of safety and security in some parts of the boundary line between the Kingdom of Saudi Arabia and the Republic of Yemen.

GIS applications evolve rapidly to keep pace with progress. Technologies contribute to the development of planning methods in general, and solve the problems of security and safety in particular. GIS has also contributed to finding solutions, applications and means of security, atborderlines. Planning can be either short- or long-term; quality and efficiency is the main objective of such comprehensive planning, and is appropriate for both cases. In this paper, we report further development of the analysis of a systematic approach which has been developed to generate and utilise GIS capabilities to create layers of combined data bases collected from the southern border of Saudi Arabia.

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Mohammed Al-Ali iscurrently a PhD student at the School of Engineering and the Built Environment at Edinburgh Napier University. This research has been done as part of his PhD work.