

# Using GIS for defining the accessibility to health care facilities in Jeddah city

**Prof. Abdulkader A Murad**

**Department of Urban and Regional Planning,  
Faculty of Environmental Design,  
King Abdulaziz University,  
Jeddah, Saudi Arabia.**



# Contents

- 1- Introduction
- 2- Background
- 3- Methods
- 4-Results & Discussion
- 5-Conclusion



# Introduction

The aim of this paper is to present a GIS application created for defining the level of spatial accessibility to health care facilities in Jeddah city, Saudi Arabia.

# Introduction

The application covers several health care planning issues including:

- A: Defining the spatial distribution of health supply and demand,
- B: Analyzing health facility location, and
- C: Modeling accessibility to health care facilities.

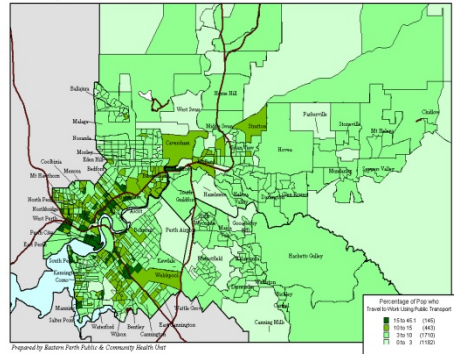
# Location of Jeddah city



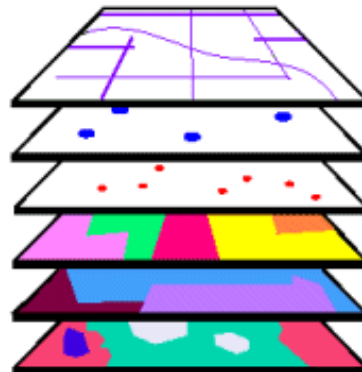
# Introduction

## GIS Software and data

East Metropolitan Area Health Service



	A	B	C	D	E	F	G	H
1	State	Postcode	Control	Number	Result1	Result2	Result3	Result4
2	WA	6000	1	7	5	5	5	4
3	WA	6003	1	3	3	3	3	3
4	WA	6004	1	9	8	8	8	8
5	WA	6005	1	5	4	4	5	5
6	WA	6006	1	36	32	32	32	32
7	WA	6007	1	18	15	15	14	14
8	WA	6008	1	24	20	20	21	21
9	WA	6009	1	31	28	28	28	28
10	WA	6010	1	38	36	36	37	37
11	WA	6011	1	21	18	18	19	19
12	WA	6012	1	18	16	16	17	17
13	WA	6014	1	50	43	42	46	45
14	WA	6015	1	14	8	8	10	10
15	WA	6016	1	26	26	25	27	27
16	WA	6017	1	10	10	10	10	10
17	WA	6018	1	87	73	74	75	73
18	WA	6019	1	44	40	40	41	40
19	WA	6020	1	53	46	46	49	45
20	WA	6021	1	43	42	42	41	41
21	WA	6022	1	7	7	7	7	7
22	WA	6023	1	42	37	37	38	38
23	WA	6024	1	44	42	41	40	41
24	WA	6025	1	112	105	105	108	107
25	WA	6026	1	52	51	51	51	51
26								



- \* Roads
- \* Places
- \* Earthquakes
- \* Census Subdivisions
- \* Soil Landscape Polygons
- \* Ecological Districts

# Introduction

GIS tools for health care:

1. Data Visualisation and Exploration
2. Data Integration
3. Monitoring
4. Geostatistics and Modelling
5. Spatial Interaction and Diffusion
6. Data Sharing and Web Services

# Introduction

Maps of health statistics can be invaluable in understanding local patterns of disease and their geographical associations. They have the advantages of conveying **instant visual information** accessible to non-experts as well as public health professionals though their interpretation.



# Introduction

The potential applications of GIS in health studies are:

- 1: disease mapping and geographical correlation studies,
- 2: patterns of health service use and access,
- 3: environmental hazards and disease clusters, and
- 4: modeling health impacts of environmental hazards

# Introduction

GIS could also be used for

- 1:exposure assessment,
- 2:identification of study populations,
- 3:disease mapping, and
- 4:public health surveillance.

# Background

For example, GIS is used for

- 1: The surveillance and monitoring of vector borne disease,
- 2: Water borne diseases,
- 3: Environmental health,
- 4: Modeling exposure to electromagnetic fields,
- 5: Quantifying lead hazards in a neighborhood,
- 6: Predicting child pedestrian injuries, and
- 7: The analysis of disease policy and planning.

# Background

All of the above applications indicate that GIS has very useful tools and functions for any health care study

# GIS tools for health care planning

- 1- Geo-coding
- This function is used by several applications to create points on a map from a table of addresses

# GIS tools for health care planning

- *2- Overlay Analysis*
- The concept of overlay analysis is one of the major GIS procedures that are used by several studies. It manipulates spatial data organized in different layers to create combined spatial features
- **Union**, **Interact** and **Identity** are the major polygon overlay functions.

# GIS tools for health care planning

- *3- Network Analysis*
- This type of analysis can be used to find the shortest routes or to find the service area of any facilities.
- It uses network data model to produces the analysis outputs.

# METHODS

The data base of this application covers:

Location of health centers at Jeddah city which is created as a point feature and all attribute data about health centers are saved at the attribute table of this file.



# METHODS

The second main GIS data feature is the line feature which has one dimensional shape that represent geographical features too narrow to depict as area.

GIS software store lines as a series of ordered x,y coordinates with relevant attributes. For the presented application, road network of Jeddah city is represented as line feature with attributes about length and type of each road at this city.

# RESULTS & DISCUSSION

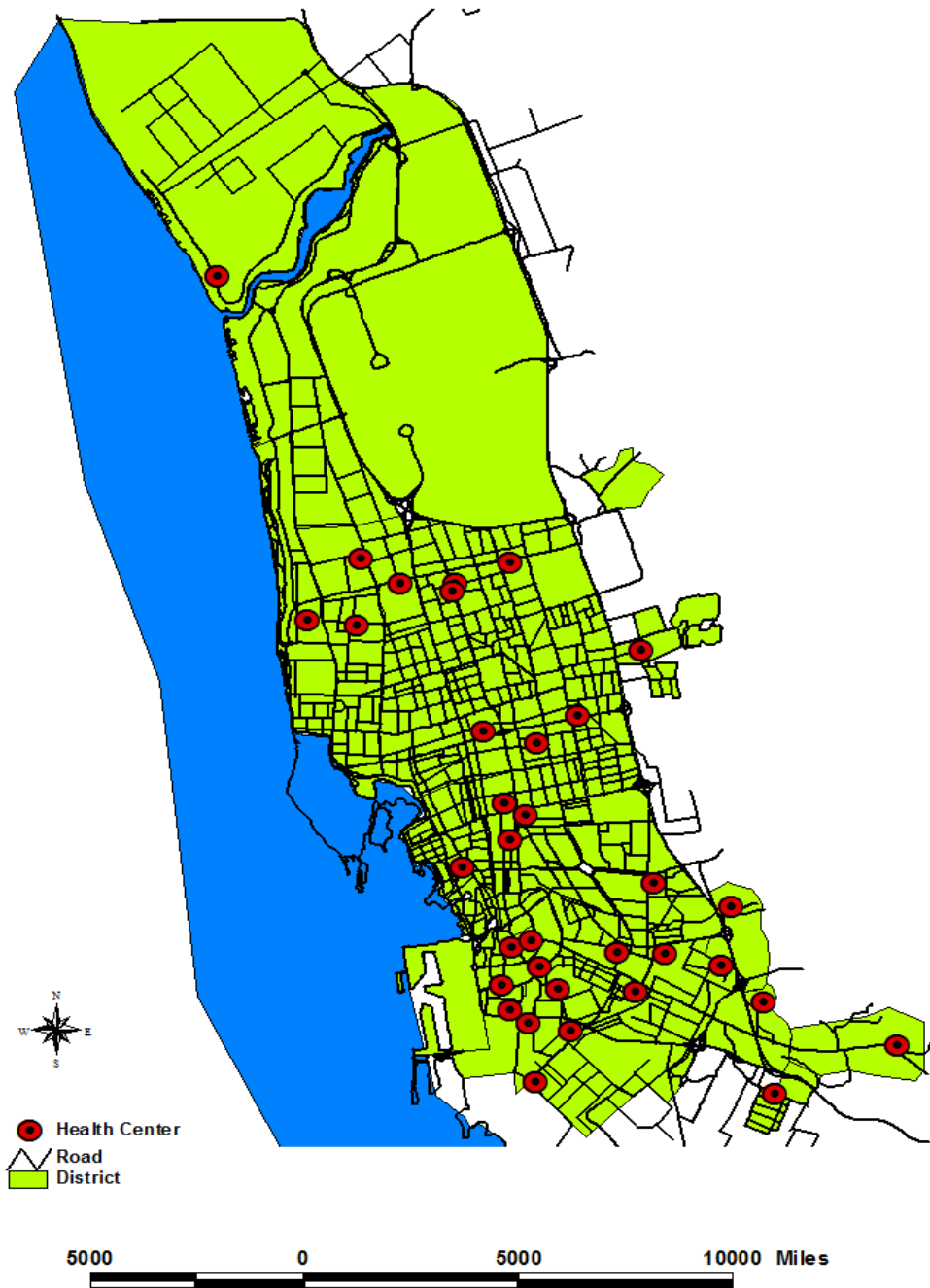
## **Spatial distribution of health services**

**There are 39 health centers distributed at Jeddah city.**

- The health centres in Jeddah city were plotted on GIS as point features map and classified based on their supply or service.
- There are 11 types of health services supply for each centre: 1 - physicians (general practitioners, GPs), 2 - family physicians, 3 - dentists, 4 - nurses, 5 - midwives, 6 - pharmacists (pharmacologists), 7 - laboratory technicians, 8 - x- ray technicians, 9 - administrators, 10 - servants, and 11 - others.

Clinic_nam	district	number_of	doctors	internal	general_do	Specialist	worker	employe
alnuzha	alnuzha	2	14	4	6	4	5	5
algoera clanic	alnuzha	2	12	3	6	4	5	5
alaqsa	alnuzha	2	17	4	8	5	7	6
alshfa	albwade	2	13	4	5	4	6	5
alshfa	aljama	2	12	4	4	4	5	5
plasten	almeowa	2	15	5	5	5	7	6
alslam	alrbowa	2	16	5	7	4	8	6
altaon	albwade	2	2	13	4	4	5	6
alnaem	alnaem	2	12	0	0	12	5	5
altmraz	alrbwa	2	18	7	7	4	9	7
alshle	almrowa	2	10	3	4	3	6	5
hera	alslam	2	10	3	4	3	6	5
alhekma	alslam	2	12	3	6	4	5	5
alflak	alfeysalea	2	13	0	0	13	6	5
almamon	alslama	2	13	4	5	4	6	5
almrzoge	alsafa	2	18	7	4	7	9	7
kaled alnrzoge	alrwda	2	15	6	7	3	7	6
alaber	alshrafea	2	12	3	4	5	5	5
algods	alslama	2	18	6	9	3	6	5
alsada	alsafa	2	16	5	7	4	8	6
yaser	alsafa	2	10	3	4	3	6	5
algrbea	alshrafea	2	15	6	7	3	7	6
al naser	alsafa	2	16	5	7	4	7	6
alrean	alshrfea	2	15	5	5	5	7	6
alwled	alsafa	2	17	4	8	5	7	6
alsamer	alsamer	2	10	3	4	3	6	5
alzezeah	alzezeah	2	13	4	5	4	6	5
alrhab	moshrfa	2	14	4	6	4	5	5
shar	moshrfa	2	15	5	5	5	7	6
algazera	alsulemanea	2	17	4	8	5	7	6
grnada	moshrfa	3	21	8	12	1	7	7
moshrfa	moshrfa	2	13	4	5	4	5	5
albrka	moshrfa	2	13	4	5	4	6	5
saudi amerkan	alrwes	2	2	15	7	3	7	6
ben shel	alshrafea	2	17	6	7	5	8	6
bne malk	bne malk	2	17	4	5	6	6	5
alrashed	alrwes	2	12	0	0	0	0	0
btarge	alkhaldeah	2	12	3	6	4	5	5
bashrahel	alshrafea	2	15	5	5	5	7	6

The spatial  
distribution of  
health centers.

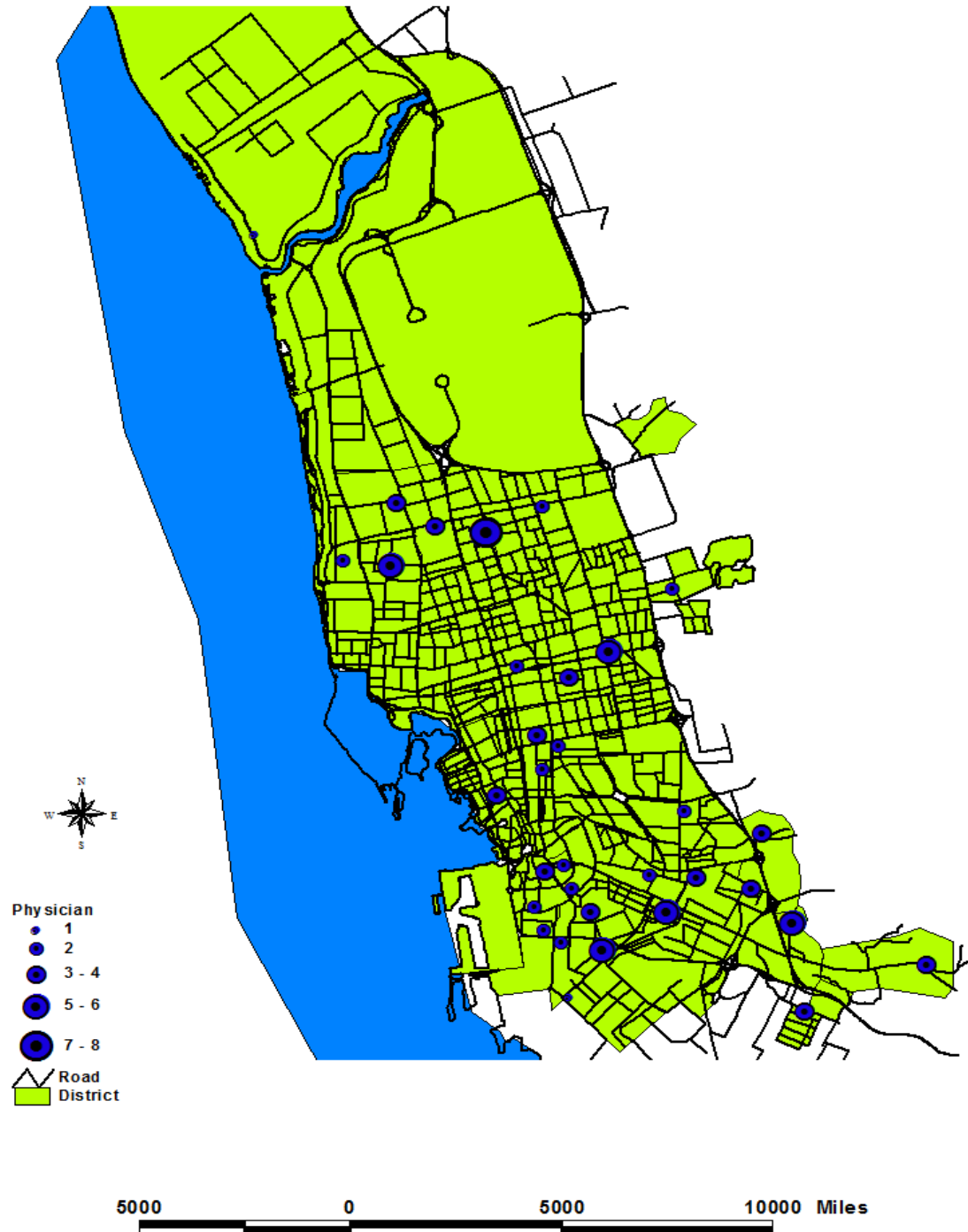


# RESULTS & DISCUSSION

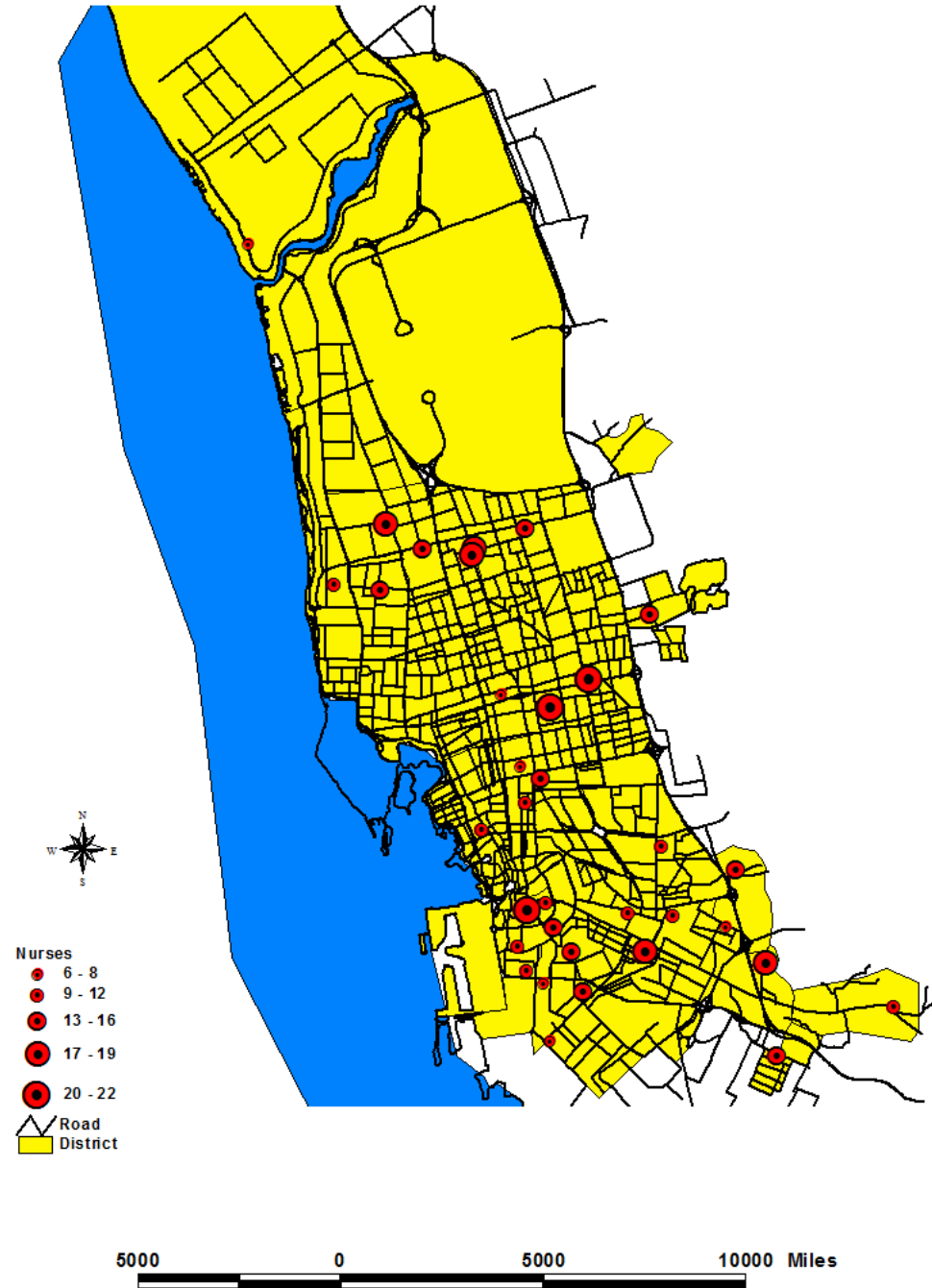
## **Spatial distribution of health services**

- Health centers are identified and classified based on the number of physicians, nurses and x-ray staff.

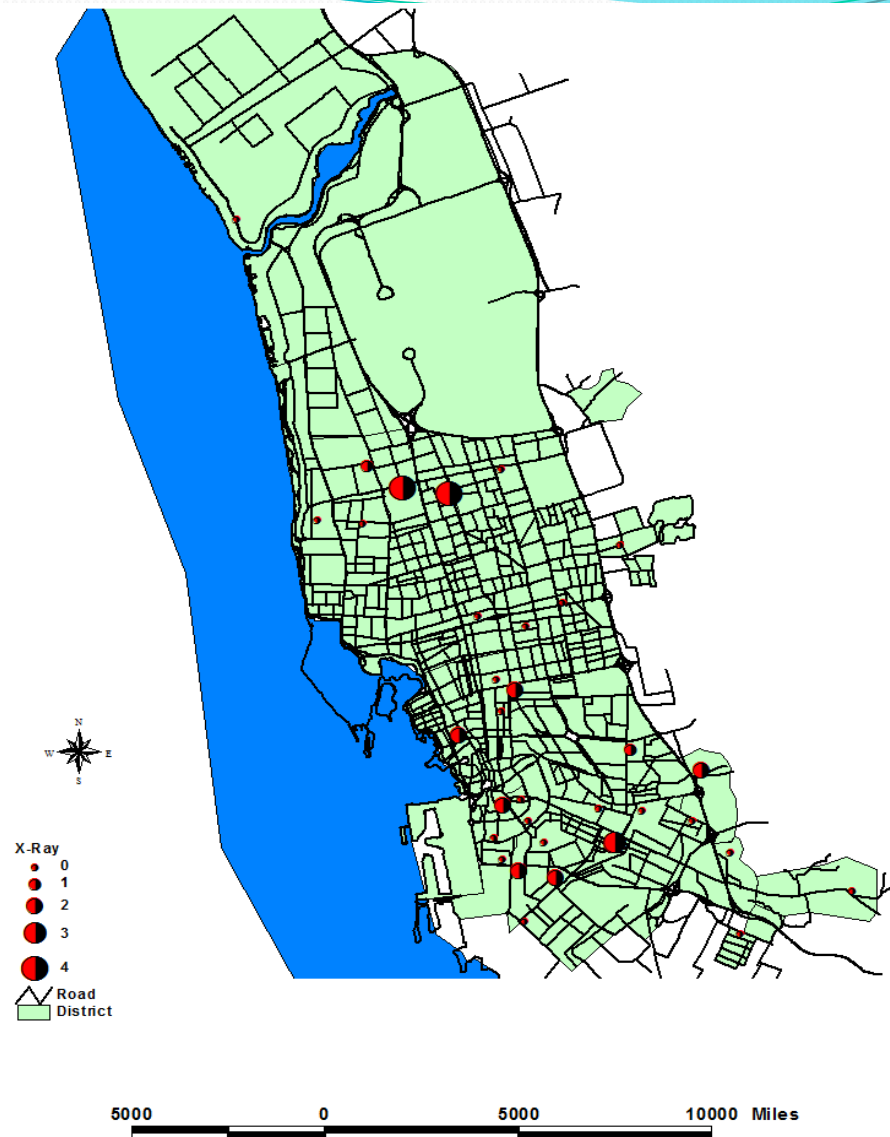
classification of  
health centers  
based number  
of physicians .



Health centers based on  
the number of nurses.

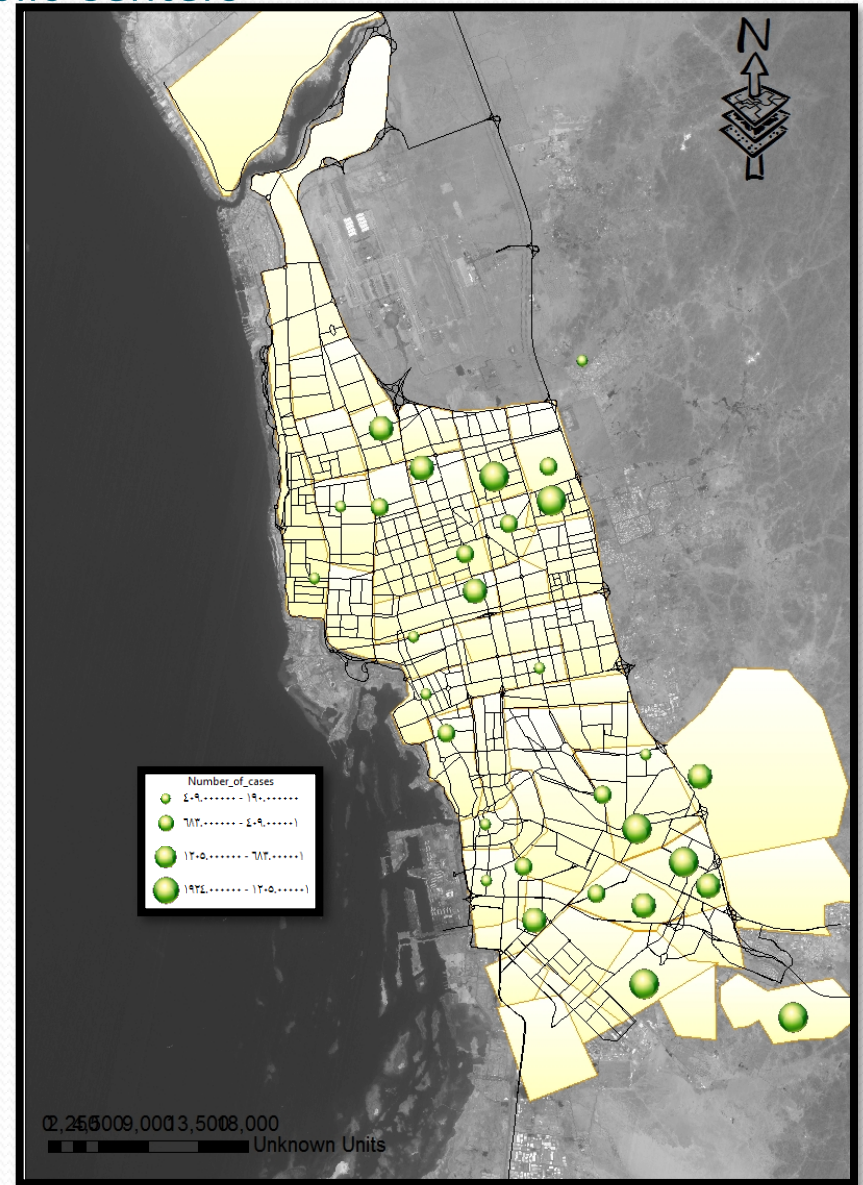
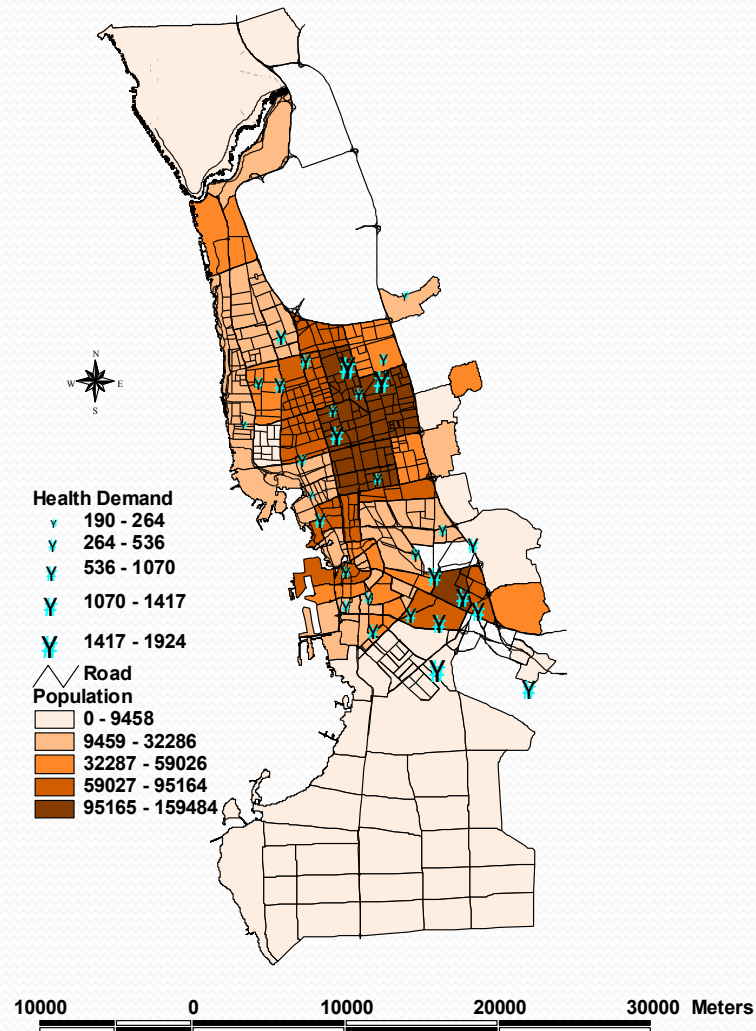


Health centers  
classification based on  
x-ray staff.

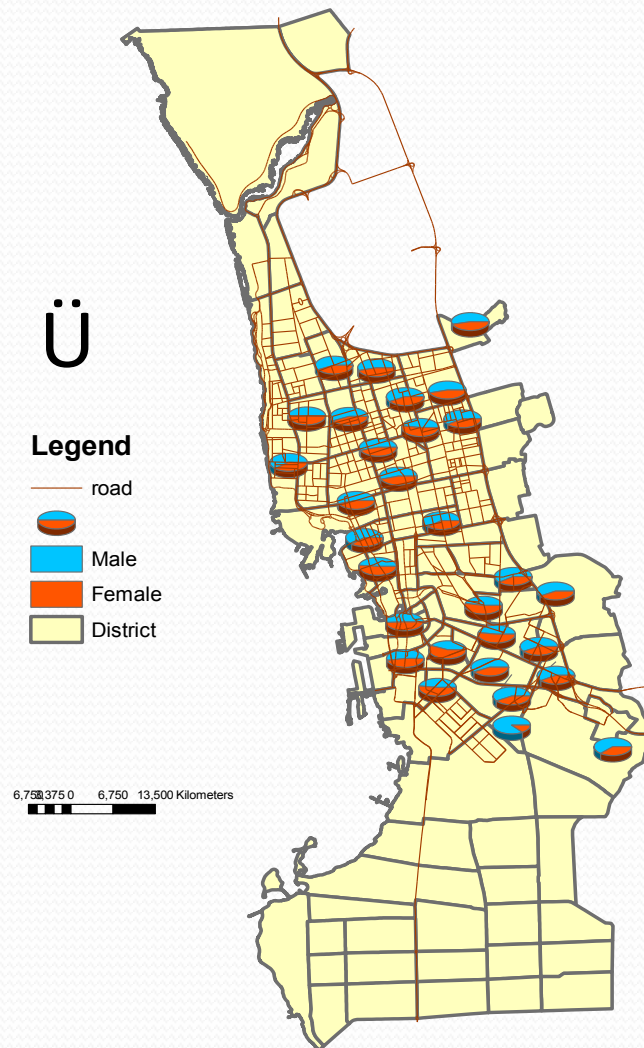




# Health Demand Classification at Public Centers



# Health Demand Classification at Public Centers



# RESULTS & DISCUSSION

- Each health centre has different amount of physicians.
- Alsafa Centre and Gulail Centre engage more physicians than Alsharafia Centre and Althayuar Centre.
- One reason for this difference is related to the size of existing demand.

# RESULTS & DISCUSSION

GIS was applied to classify more types of supply known as multiple data classification, the so-called multiple queries by using logical operations that deal directly with the database and allow the user to identify and select features by a special set of criteria with more than one parameter.

# RESULTS & DISCUSSION

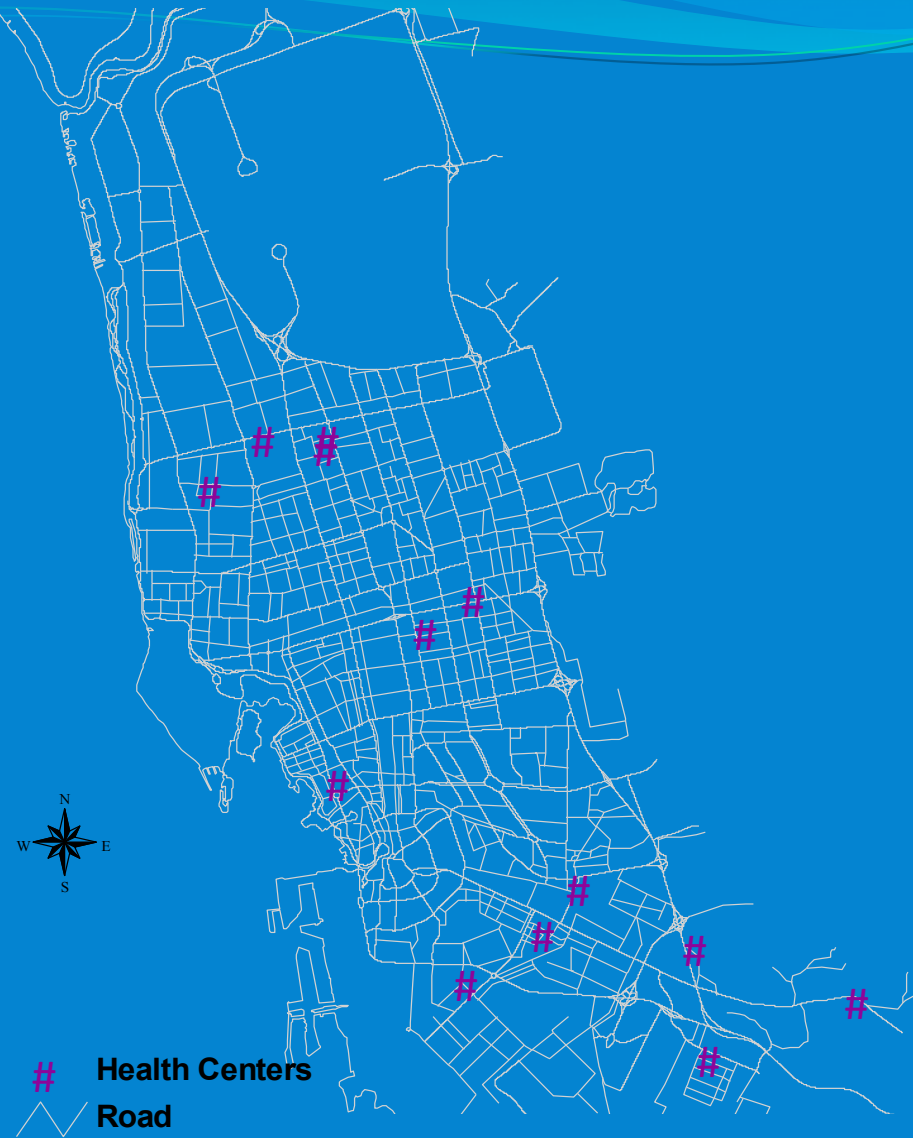
- ❑ One could find out health centres with many physicians but with less nurses.
- ❑ The features were identified and selected from the database and highlighted on the map according to a combination of several conditions.
- ❑ These features can be saved in a new coverage for further analysis.

# RESULTS & DISCUSSION

The presented paper has detected which centres are owned by the health authority and engage more than 3 physicians

Several health centres in Jeddah city are located on rented buildings and engage numerous physicians. e.g. Ghulail and Aljameaa centres are in the southern area while Alzahraa and Alsalamah centres are in the northern area.

# Rented health centers with more than 3 Physicians



10000 0 10000 Meters

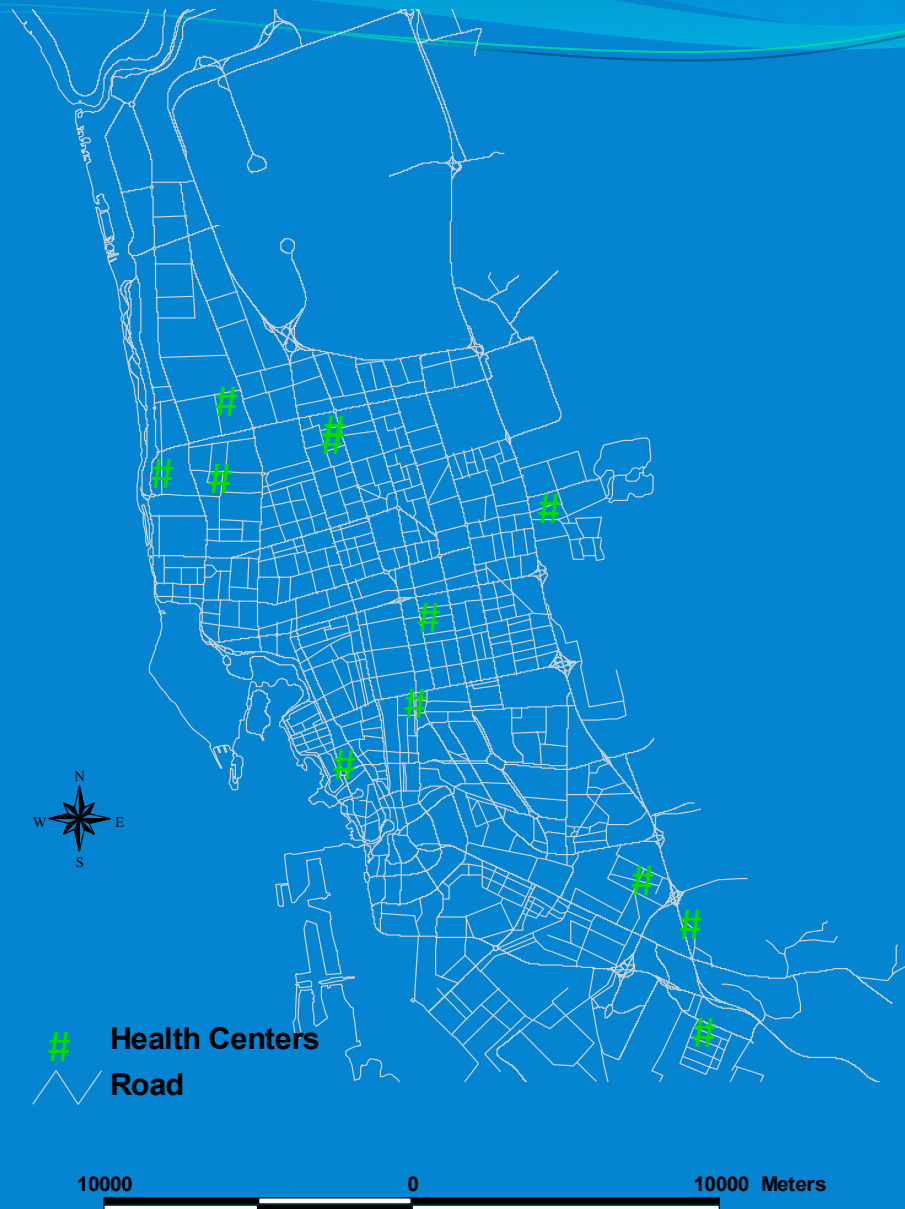


# RESULTS & DISCUSSION

- ❑ Several health centres such as Alrabwa, Alzahra and Alnaeem providing large and various types of health services to the public by family physicians and dentists.
- ❑ Alsafa and Alsohaifa centres, however, do not engage dentists and family physicians at all.
- ❑ The local health authority can therefore use this technique to find quick and clear answers about any issues related to quality and quantity of health services delivered at Jeddah city.



# Health centers with family doctors and dentists



# RESULTS & DISCUSSION

## Modeling health care accessibility

- The presented application has produced two types of health care catchment areas for the purpose of defining accessibility. These are produced based on:
- **Drive time technique**, and based on
- **Straight line allocation technique**.
- The following part of the presentation will illustrate the outputs of these GIS based analysis.

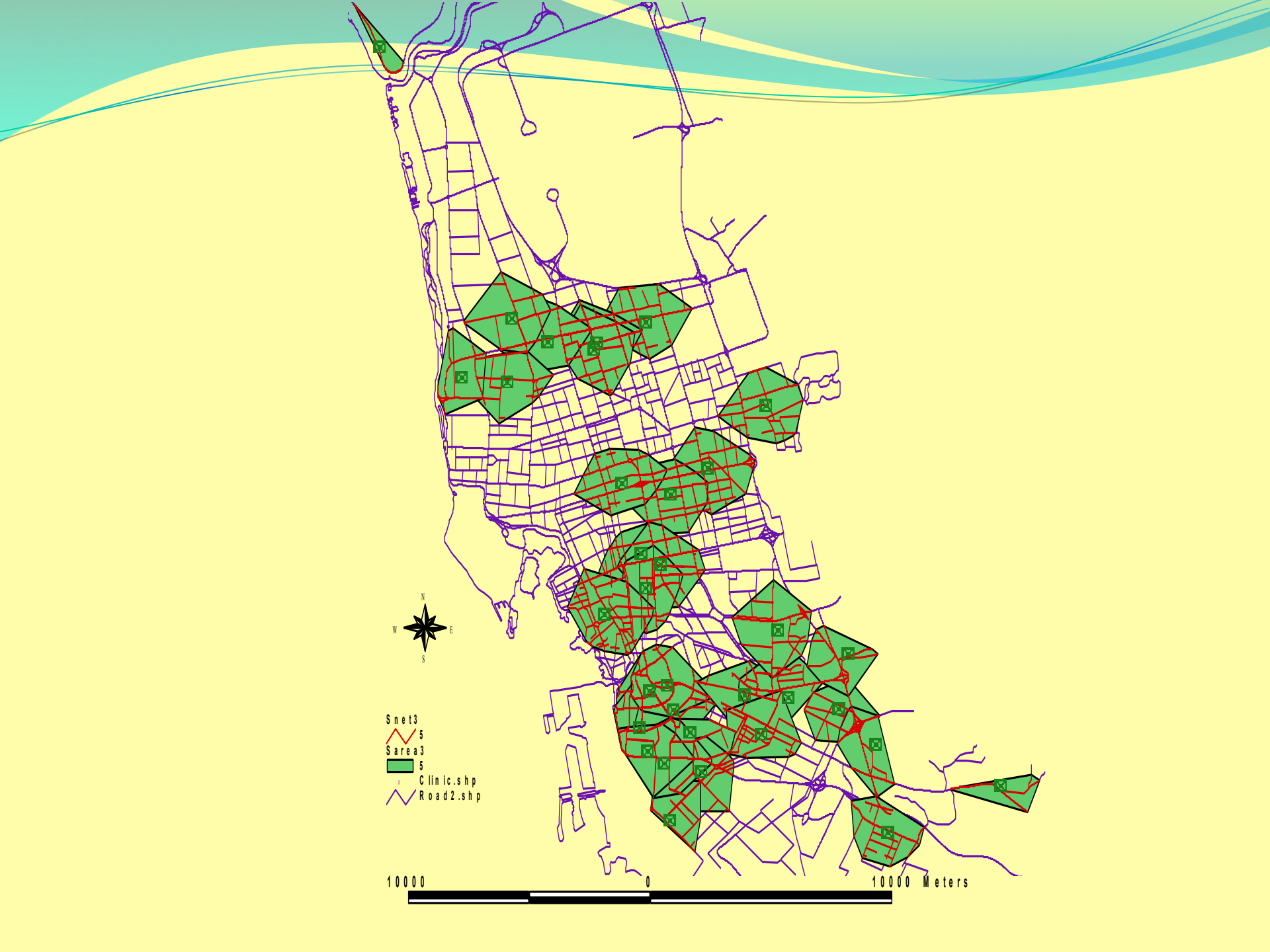
# RESULTS & DISCUSSION

## **Drive time based catchment area**

- The presented application has created drive time service area for health services located in Jeddah.
- Travel time is calculated for all Jeddah roads and used for producing a 5-minutes drive-time catchment area.
- ArcGIS software is used to select all parts of the city that fall within the 5-minutes service area of health services.
- The resulted of this type of analysis can be used to define city districts which need more supply of health services.

# RESULTS & DISCUSSION

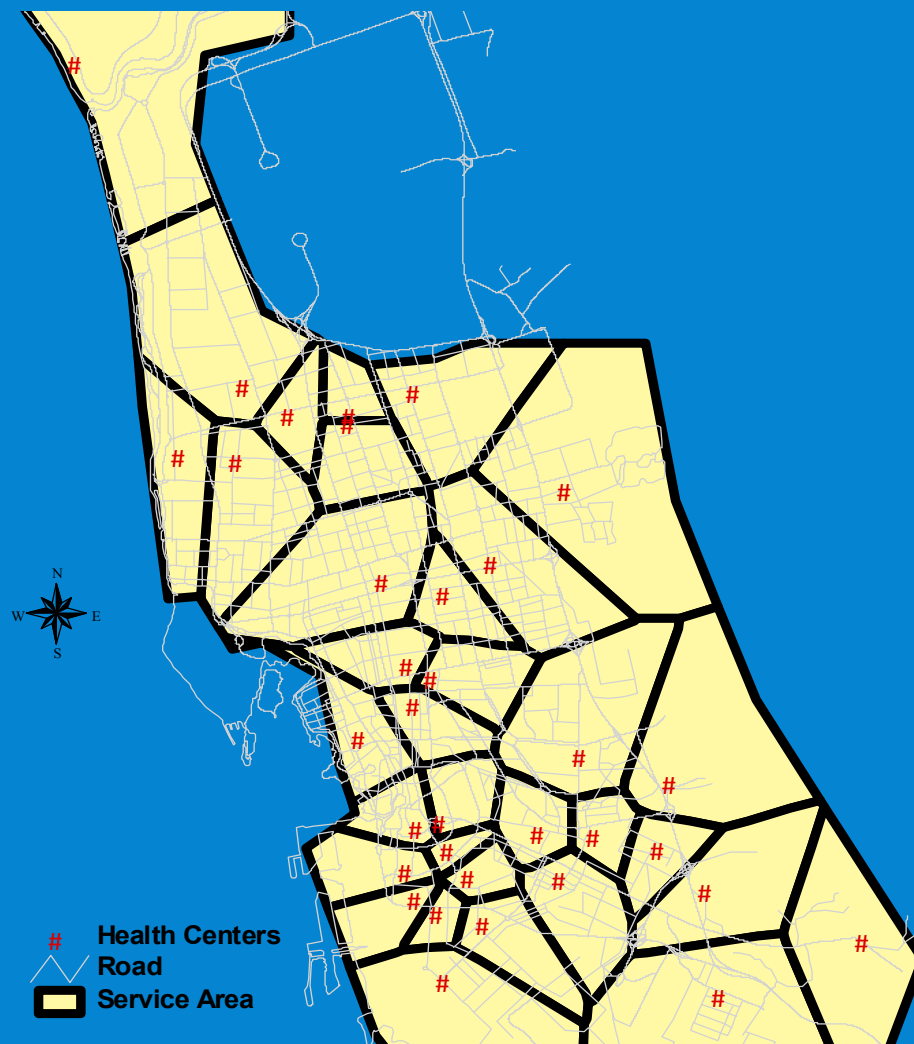
- ❑ There several districts located north of Jeddah that are not well served by health centres.
- ❑ This means that residents of north of Jeddah travel more than 5 minutes in order to reach to their nearest health centre.
- ❑ Accordingly, local health authority of Jeddah city should make plans to introduce additional health centers in these unserved areas.



# RESULTS & DISCUSSION

## **Straight line allocation catchment area**

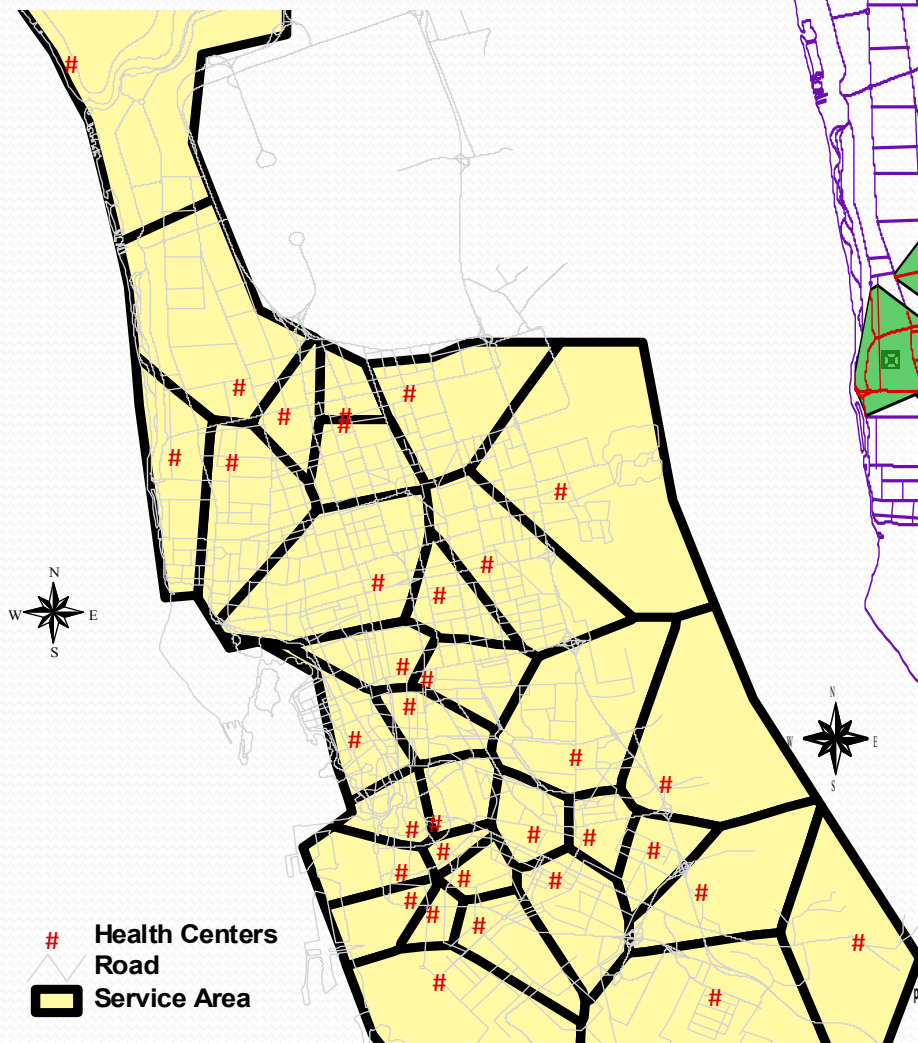
This function is used to define the closest-proximity catchment areas and accordingly, each health centre's location is assigned with the closest area and each service area is closer to its health centre than to any other centre.



# Health Centers  
Road  
Service Area

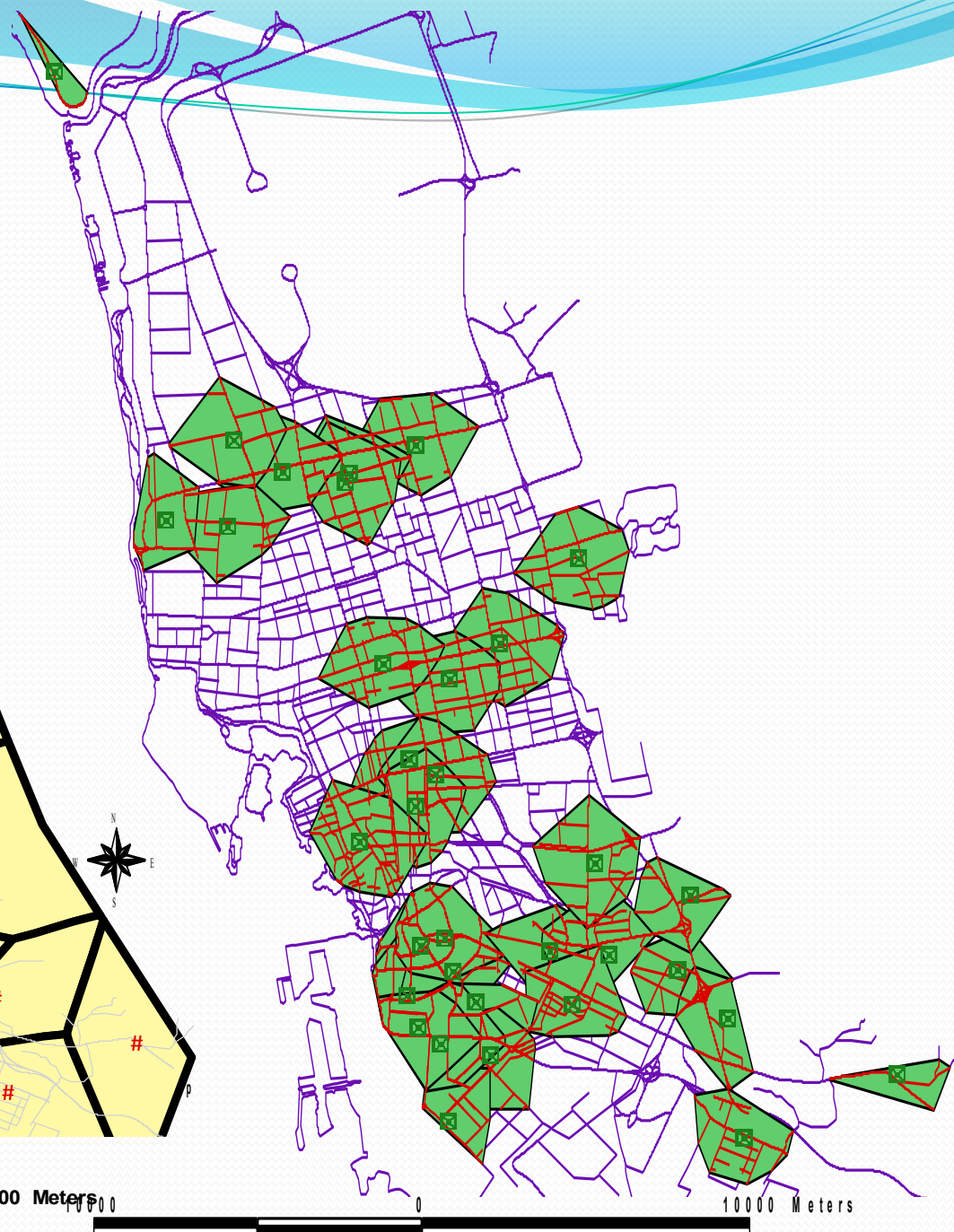
10000 0 10000 Meters






# Health Centers  
Road  
Service Area

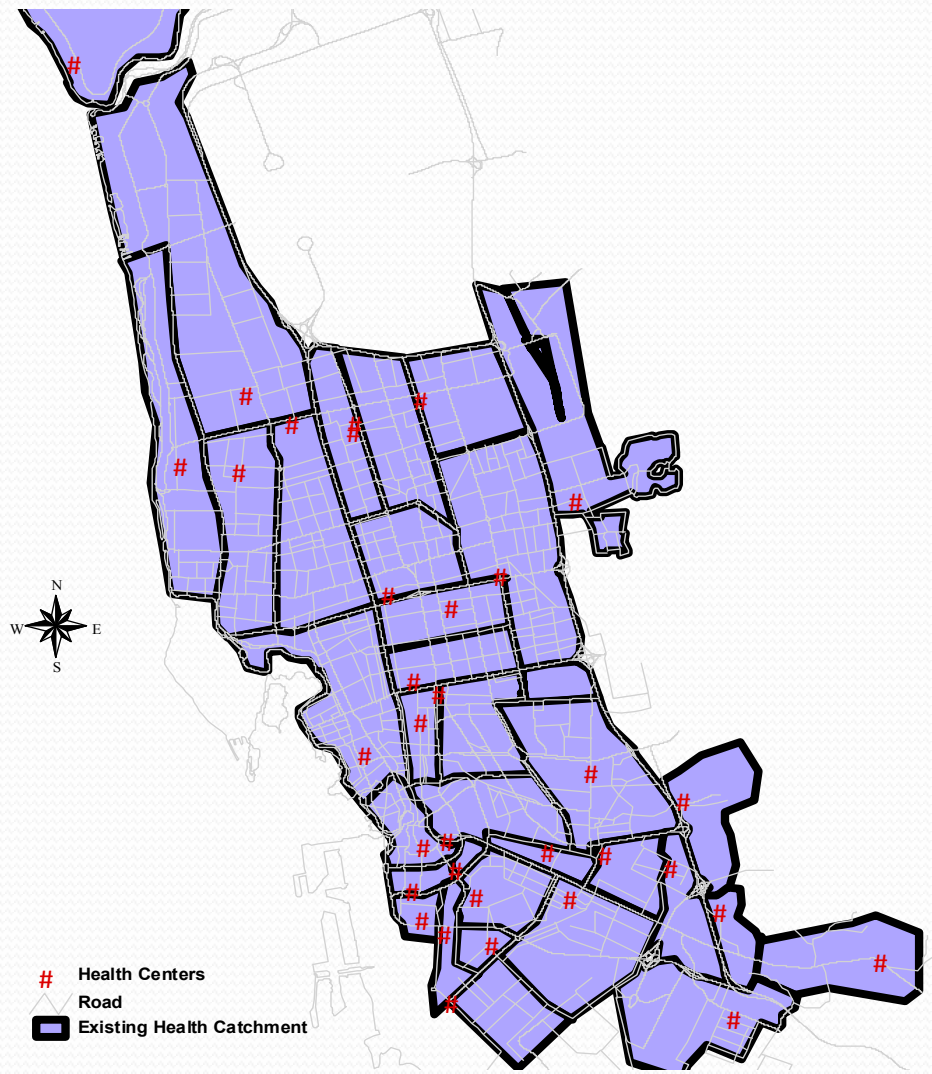
10000 0 10000 Meters




0 10000 Meters

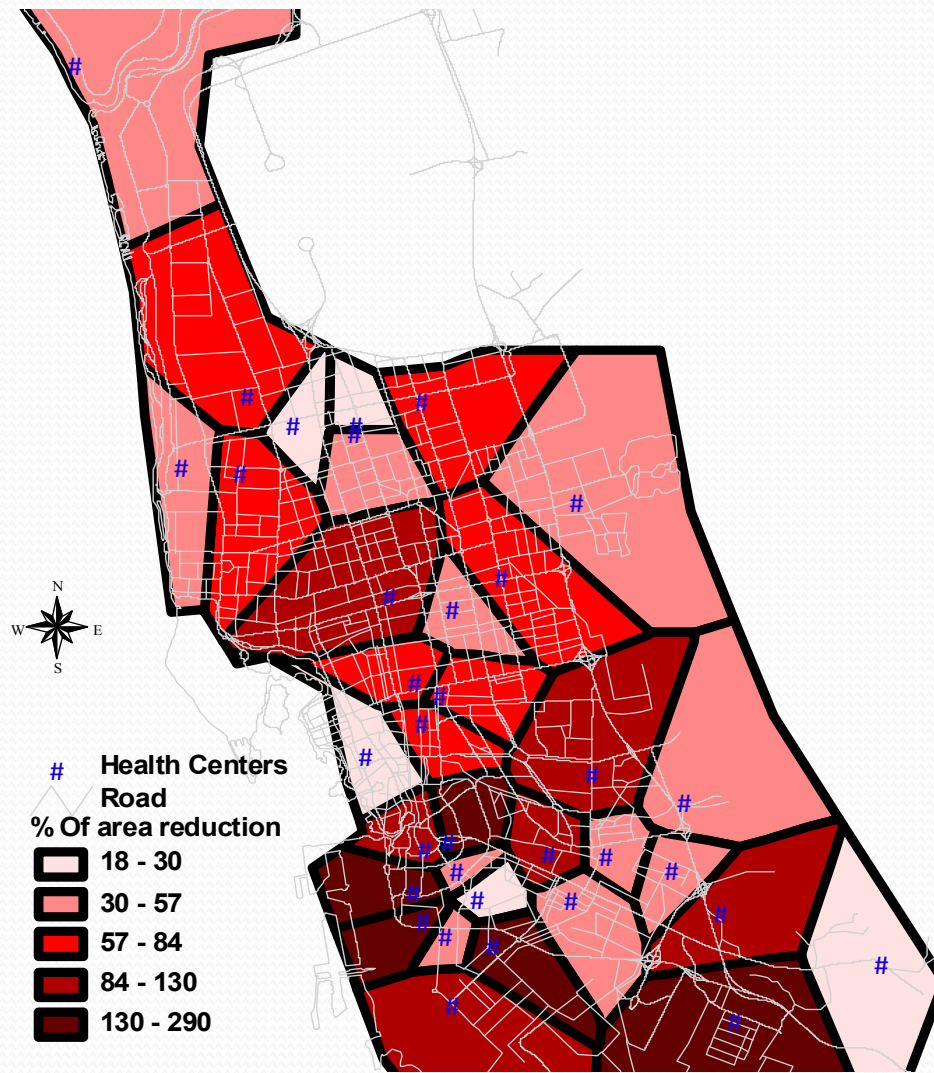


- 
- In order to evaluate this result, existing health catchment areas created by the local health authority were digitized as vector polygons and then transformed into raster for analysis in a spatial analyst extension.
  - Finally, they were compared with the resulted catchment areas in order to identify the percentage of changes that took place in every health catchment area.

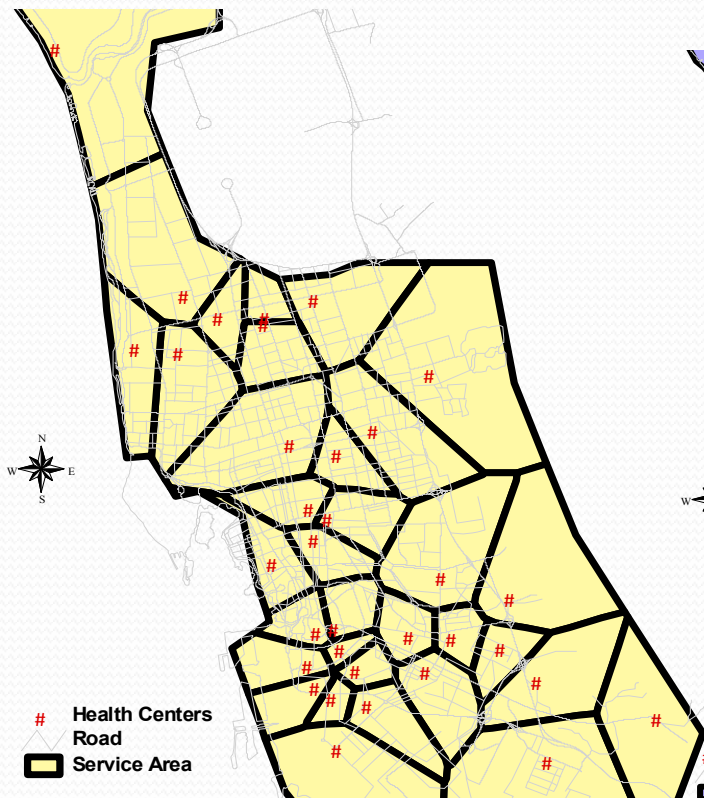


10000 0 10000 Meters

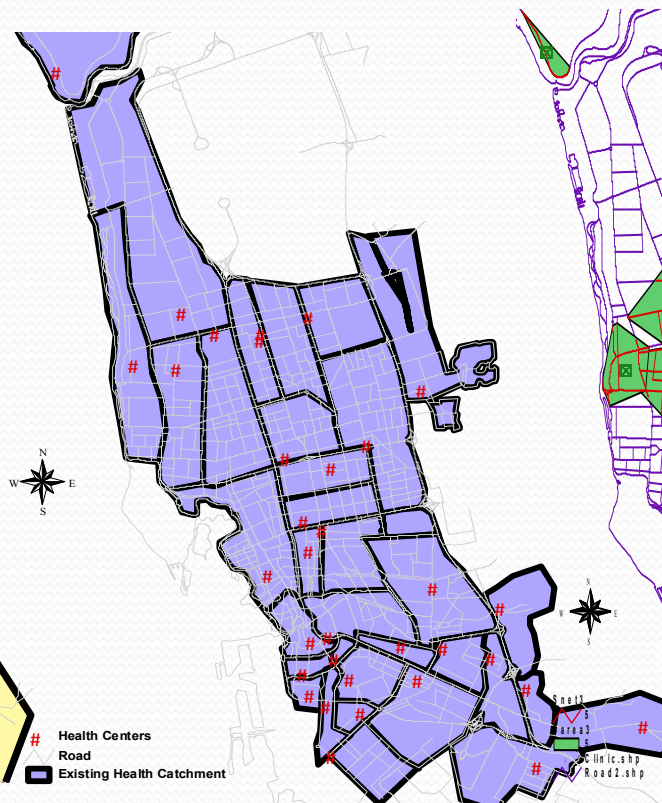
- 
- Total area of every new service area was divided by the local authority catchment area and the results were multiplied by 100 to give an index of change for the health catchment areas in Jeddah city.
  - The results and indicate that almost every existing health catchment area has been reduced to a smaller area and, therefore, better health services can be provided
  - The reduction in size of the catchment areas will lead to a decrease in demand and health services required in every health centre.



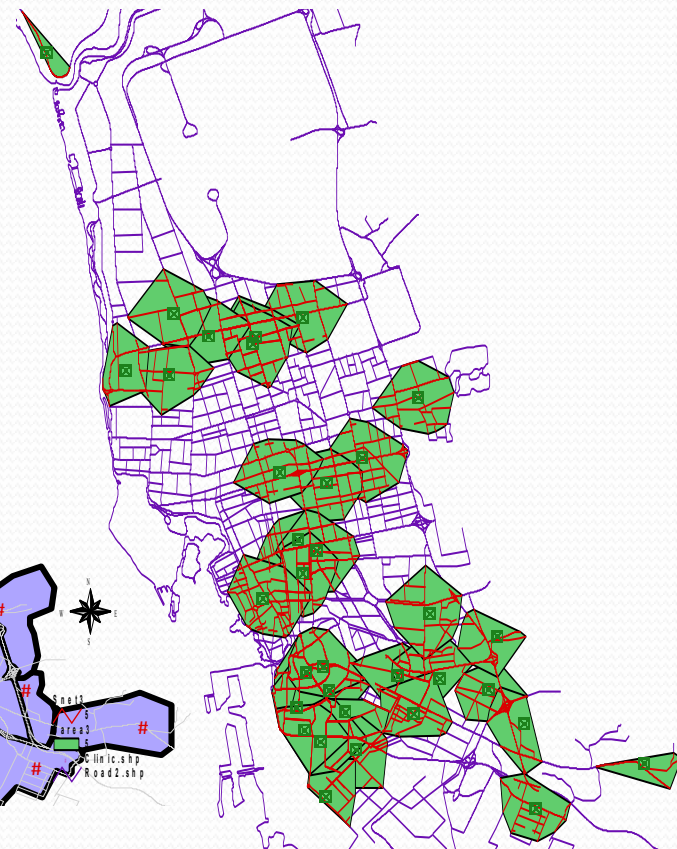
10000 0 10000 Meters



10000 0 10000 Meters



10000 0 10000 Meters



10000 0 10000 Meters

# CONCLUSION

This paper has demonstrated that GIS can be used to explore the patterns of health services in Jeddah city.

- The presented paper has collected points, lines, and polygons data for the purpose of evaluating the location of health centres in Jeddah city. In addition, two types of catchment areas are for health centres in Jeddah city.
- These are produced based on drive time technique and straight lines allocation technique.
- Each one of these catchment area can be used by health planners for improving the existing health services in Jeddah city.



Thank You