Cloud Based Spatial Analysis for the Health Sector: a Case Study of Egypt

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---**ABSTRACT**---
As it is one of the most important and sensitive sectors, decisions related to the health sector are always critical. So it must be built on accurate information in order to weight the positives and negatives of each option and consider all the alternatives to determine which option is the best for that particular situation. The health sector ultimately faces basic challenges of operations, logistics, resource allocation, customers, and management. As it's true that information can help overcome the hurdles, this paper raises the relation between the spatial analyses based on Cloud Computing and the health sector improvement. It presents the vital role of the spatial analysis and the health geography in improving the health sector services. In addition, it presents the significance of the Cloud based GIS. Finally, it presents the usage of the Cloud based GIS for the hospitals distribution in Egypt as a case study.

1. INTRODUCTION

With solving a lot of the common flaws by drawing maps and visualizing spatial distributions to accurately measure distances and areas, here comes the value of the Geospatial Information Systems in improving the health sector services in order to track and control diseases and identify health care shortage areas to map populations at risk to start the process of redistributing the resources according to accurate indicators. The value of the GIS would be more effective by applying the concept of cloud computing that will provide the feature of the location independence access where the GIS can be accessed from anywhere and anytime. Also it provides the application infrastructure and the feature of the resource pooling to all the related partners. This paper is divided to seven sections. Section one gives the introduction. Section two presents the old relation between the spatial analysis and the healthcare. Section three demonstrates the vital role for the health geography in improving the health sector services. Section four explains the significance of the Cloud based GIS and its advantages while section five gives a brief explanation about the proposed cloud platforms for the geo-processing. Section six gives a case study for the hospitals distribution in Egypt using spatial cloud analysis. The last section is the concluded outcomes and the extended future work.

2. SPATIAL ANALYSIS AND HEALTHCARE

How location can influence health is an old concept in medicine. As far back at the time of Hippocrates (3rd century B.C.), physicians discovered that certain diseases tend to occur in some places and not in others. In fact, different locations on Earth are usually associated with different profiles: physical, biological, environmental, economic, social, cultural and sometimes even spiritual profiles that affect and affected by health, disease and healthcare [2].

In 1854, a major cholera outbreak in London had already taken nearly six hundred lives when Dr John Snow, using a hand-drawn map, showed that the source of the disease was a contaminated water pump. By plotting each known cholera case on a street map of Soho district (where the outbreak took place), Snow could see that the cases occurred almost entirely among those who lived near the Broad Street water pump. Snow recommended that the handle of this pump be removed, and this simple action stopped the outbreak and proved his theory that cholera is transmitted through contaminated drinking water. People could also see on this map that cholera deaths were not confined to the area around a cemetery of plague victims and were thus convinced that the infection was not due to vapors coming from it as they first thought [1].
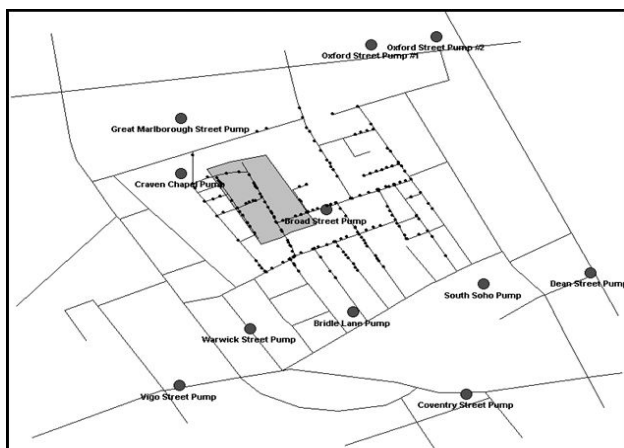
Figure 1: john snow's map of cholera in London

According to "Fig. 1", this map is a digital recreation of Dr Snow's hand-drawn map. The 1854 cholera deaths are displayed as small black circles. The grey polygon represents the former burial plot of plague victims. The Broad Street pump (shown in the centre of the map) proved to be the source of contaminated water, just as Snow had hypothesized. By using a map to examine the geographical (spatial) locations of cholera cases in relation to other features on the map (water pumps and cemetery of plague victims), Snow was actually performing what is now known as spatial analysis [1].

3. HEALTH GEOGRAPHY

Health geography is the application of geographical information, perspectives, and methods to the study of health, disease, and health care. It would be divided to two different types as below:

- Diseases Geography: is the type which covers the exploration, description and modeling of the incidence of diseases and related environmental phenomena, the detection and analysis of disease clusters and patterns.
- Healthcare Systems Geography: is the type which deals with the planning, management and delivery of suitable health services after determining healthcare needs of the target community and service catchment zones.

Health geography plays a vital role in public health surveillance, including the design and monitoring of the implementation of health interventions and disease prevention strategies. Also it includes allocating healthcare staff by region based on actual needs, and assisting in determining the best location and specifications for new healthcare facilities and in planning extensions to existing ones. It can help determining the geographical distribution and variation of diseases and associated factors, analyzing spatial and longitudinal trends, mapping populations at risk and risk factors [4].

The geographic Information can be used in healthcare for [3]:

- Identifying vulnerable population.

- Identifying factors responsible for diseases.
- Identifying health care centers
- Identifying morbidity and mortality rates.
- Identifying water polluting sources

4. CLOUD BASED GIS SIGNIFICANCE

The internet now plays a core function in the operation of most geospatial businesses. Organizations use the internet to communicate with their clients, contractors and employees via email, intranets and social media. Proposals can be delivered, contracts negotiated and results conveyed electronically, shortening up-front processes and producing tighter feedback loops. Cloud solutions build on the internet's foundation of connectivity and interaction. In addition to moving information, remote servers can provide powerful computing capabilities. By tying handheld and desktop computers to cloud services, it's possible to bring sophisticated data processing to more users and locations. As a result, cloud-based geospatial information systems (Cloud GIS) are poised to provide new flexibility in operations.

The Cloud Computing was presented as a solution for the traditional desktop GIS to overcome most of the local desktop GIS defects including [7]:

- The weak computing power when dealing with a large scale of spatial data
- The resources limitation where the computing and the storing of the resources are limited to be accessed only by the local users.
- The waste of money and time when it comes to software upgrading and maintenance was considered also as a defect that would be more cost effective when it comes to the cloud computing technology.

There are now cloud-based platforms of software, data and services to serve the geospatial community. Focused on applications in surveying, engineering and GIS, the solution uses the cloud to support work in geospatial data management, field data collection and transfer, equipment management and spatial data catalogs. By combining cloud services with technologies for positioning, communications and data analysis, companies can leverage point-of-work delivery of information needed by geospatial professionals in the field and office. Data is the cornerstone of any geospatial workflow [5]. By enabling professionals to easily discover access and utilize different types of data, the cloud will soon become an essential part of the daily processes of data collection, processing, modeling and analysis [6].

The main advantages of the Cloud GIS are:

- Results are same with Desktop GIS so there is no quality difference.
- Advantageous in terms of economy, elasticity and accessibility.
- Providing the application infrastructure.
- Supporting the technology infrastructure.
- Using system regardless of installing software makes Cloud GIS accessible.
- All GIS analyzes queries can be done quickly.
- Permission control about self-data makes Cloud GIS more functional, nominate data, map or an application can be open to one person (Private Cloud), a group (Community Cloud) or public.
- Access, edit, query and download controls can be manipulated cloud computing deployment models.
- Cloud GIS brings geospatial working ability for mobile devices. Normally GIS software doesn't run on mobile systems like Android, IOS or Windows Mobile. But Cloud GIS it is usable for mobile devices. Mobile clients can apply GIS analyzes with browsers or small applications but all these works are done on cloud servers.
- Reducing the implementation cost
- The location independent resource pooling
- The data conversion and presentation.

Some providers look at Cloud Computing as a way to provide compute or storage capacity as a service, provisioned from a parallel, on-demand processing platform that leverages economies of scale. Others may equate Cloud Computing with software as a service, a delivery model for making applications available over the Internet. IT analysts view Cloud Computing from the perspective of variable pricing without long-term commitments and massive elastic scaling of services. IT leaders look at cloud as an infrastructure architecture alternative that can reduce costs. End users, the media and financial analysts have still other perspectives on what Cloud Computing represents [10].
For GIS applications the Cloud GIS can prove to be an approach to provide compute or storage capacity as a service, provisioned from a parallel, on-demand processing platform that leverages economies of scale to varied shade of users and organizations requiring GIS application services [9]. Therefore, Cloud GIS is considered as a suitable tool to improve and upgrade traditional GIS applications and provide a broad spectrum to users across the globe [11].

5. GEO-PROCESSING CLOUD PLATFORMS
Geo-processing functions are important for discovering hidden and useful geospatial information, and are widely used in Earth science modeling and applications. The growth of the Web has resulted in the Web-based sharing of large volumes of distributed geospatial data and computational resources. Processing heterogeneous and distributed data into information requires a powerful, scalable, and interoperable information infrastructure. The emergence of Cloud Computing technology brings a new computing Information Technology (IT) infrastructure to general users. Using these Cloud Computing platforms, typical IT resources such as storage, computing utilities, and database are available as services [12].

An implementation of geo-processing service that integrates geo-processing functions and Microsoft Cloud Computing technologies was presented to provide geo-processing capabilities in a distributed environment. The integration combines the conventional powerful geospatial analysis functions with the scalable Cloud Computing technology to provide Web-based geo-processing functionalities [12].

An implementation of geo- processing service that integrates Amazon cloud computing and geo-processing functions was presented to provide geo-processing competence in a distributed web environment. The integration combines the geospatial processing functions with the flexible cloud computing platform to provide Web-based geo-processing functionalities [8].

6. CLOUD SPATIAL ANALYSIS
This section presents an application for the spatial analysis based on cloud computing where the ArcGIS online is used as a cloud based GIS solution. The application deals with the distribution of the hospitals in Egypt – Cairo – Masr Elgdeda.

Table 1: Hospitals within specific Area "Masr El-Gdeda"

FID	Shape *	AREA	A_NAME1
1	Polygon	Masr El-Gdeda	Roxy Hospital
2	Polygon	Masr El-Gdeda	El-Qahera Hospital
3	Polygon	Masr El-Gdeda	Celiopatra Hospital
4	Polygon	Masr El-Gdeda	El-Dorra Hospital
5	Polygon	Masr El-Gdeda	Masr El-Gdeda Hospital
6	Polygon	Masr El-Gdeda	Teriumph Hospital
7	Polygon	Masr El-Gdeda	Heliopolis Hospital
8	Polygon	Masr El-Gdeda	El Hegaz Hospital
9	Polygon	Masr El-Gdeda	Sheraton Hospital
10	Polygon	Masr El-Gdeda	El Nozha Hospital

According to "Table 1", it's a part of a dataset from attribute table for the hospitals within a specific area in Cairo which is "Masr El-Gdeda". Each record in the table has an Id, shape to be represented as, area and name.
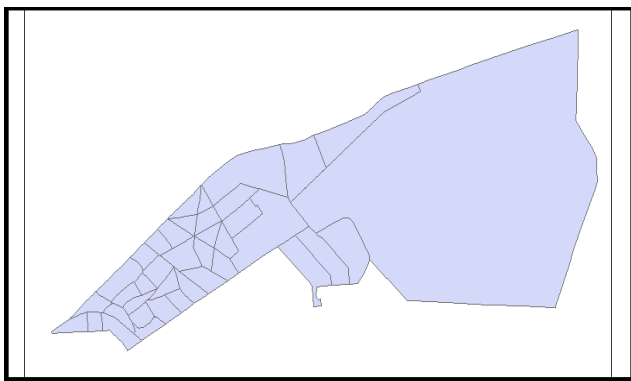
Figure 2: a location map of Masr El-Gdeda

According to figure 2, it's a location map for a specific area in Cairo which is Masr-Elgdeda presented on a Cloud based GIS which is the ArcGIS online. As it's shown on the map, it's an empty map without distribution for any objects on it.

Figure 3: a distribution map for the hospitals in Masr El-Gdeda

According to figure 3, it's a distribution map for the hospitals in Masr-Elgdeda presented on a Cloud based GIS which is the ArcGIS online. As a result for presenting the data in Table 1 on the location map in figure 2, it was the output presented in figure 3 on a cloud based solution. Using such maps with the cloud favor, would help all the related partners in making more accurate decisions and building more integrated strategies.

7. CONCLUSION

This paper presented the strong relation between the spatial analysis and the health sector and the advantages of the cloud based GIS versus the traditional one in improving the health services by giving a various advantages by using the Cloud GIS in the diseases geography and the healthcare system geography. Different proposed geo-processing cloud platforms was proposed and an applied case study for the usage of the Cloud GIS in the health sector was presented in this paper using the ArcGIS online as the Cloud GIS solution for representing the distribution of the hospitals in a specific area in Cairo, Egypt.

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