# GEO VISUALIZATION OF DISEASE OUTBREAK USING GEOSPATIAL CROWD SOURCING WEB APPLICATION

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**ABSTRACT**
In the outbreak of infectious diseases in the immediate environment, a more rapid notifiable and surveillance system is needed to track pandemics and make rapid decisions thereby reducing the spread of communicable diseases. With systems like Google Earth, providing marvellous geo visualization tools and a wider opportunity to explore complex Geospatial crowd sourcing. These system is now moving towards citizens science (citizens who act as observers), thereby engaging the general public in the trend. Volunteered Geographic Information (VGI) or Geospatial Crowd sourcing is a kind of phenomena whereby the users of the web are generating the healthcare information for the geo web. The aim of this study is to propose a framework based on existing geospatial mashups services to create a crowd sourcing web application service to alert people in disease outbreak situation, help and rescue people in that location. The methodology used in this study makes it possible for the crowd to disseminate and share geospatial communicable disease information by digitizing on the fly. This study presents the results of a geo web application developed for citizens of Johor Bahru, west Malaysiain crowd sourcing for communicable disease outbreak. The results of the prototype is promising and can be used for future study in mobile geospatial crowd source applications.

**Keywords:** *Geospatial Crowd sourcing, Geo visualization, Geospatial Mashups, Disease outbreak.*

## 1. INTRODUCTION

The outbreak of communicable and notifiable diseases normally occur spatially (Boulos, 2003). Undoubtedly, location has long been associated with outbreak of diseases as some disease tends to occur in some places and not in others. Over the years, there had been different approaches related to a rapid disease outbreak information awareness and dissemination to the general public. Currently, most of these dissemination is been done by governmental and private organizations. However in recent years, countries like the United States have employed citizen science in healthcare information dissemination. A concept where citizens or the general public act as observers, gather locational information and share or disseminate these information voluntarily(Goodchild, 2007). This type of information is referred to as volunteered geographic information (VGI) or geospatial crowd-sourced data. These valuable information could be of most relevant in time-critical situations such as outbreak of communicable diseases as presented in this paper (Good child, 2010).

There is a lot of findings going on in the field of VGI; what motivates a citizen to volunteer, quality of the information been shared, or what he or she would prefer to map in the context of this paper. Nevertheless, Brown,*et al*. (2013), points out that the quality of a geographic dataset can have significant implications for the dataset's fitness for purpose. The authors also reported difficulties caused by differences in language and semantics used in labeling volunteered data.

This paper contributes to the advancement of crowd sourcing in the field of public health, a relatively new promising discovery in using the web emergent research field.

## 2. USER-GENERATED GEOSPATIAL CONTENT

Geospatial crowd sourcing was coined as a spatial data that is created voluntarily by millions of people who do not have any expertise in what so ever disciplines related to geography. The public can voluntarily communicate either individually or collectively through web services with geo web gurus to produce latest forms of spatial data (Elwood, 2007). The web has been a big source which contributed in formulating the meaning of geospatial crowd sourcing. These new technologies and practices have result in the improvement of various tools that enable volunteers who are not experts in geospatial related fields or novice users to produce their own geographical data (Good child, 2007).

## 3. MOTIVATING SCENARIO

From John Snow's inaugural public health map of cholera deaths in Victorian London to Health Map. org's geo web 2.0 map of cholera in contemporary Haiti, cartography has persist in playing persuasive responsibility in jointly visualizing health vulnerabilities and organizing responses. Healthcare awareness is gradually waking up to the use of web mapping to listen to the wisdom of the general public. With drastic progress in the concepts of web 2.0, possibility of crowd sourcing and public participatory era of geographic health contents had never been more powerful by the society (Boulos and Burden, 2007, McFedrie, 2007).One example is the work of Lampos and Cristianini (2010), where the rates of flu outbreak in England was determined by text-mining of spatially referenced twitter messages using the open data interface to Twitter. However, the method did not produce the actual rates of flu occurrences, nevertheless the authors justified such an approach "give an early warning in various healthcare situations". Butler, in 2006 stated that, nature has created its own Geo Mashups using Google Earth for tracking flu outbreaks, and Health Map (2013), created by the Children's Hospital Informatics Program in Boston. This brought together various geospatial data within Google Maps to ensure a standard and complete view of the current global state of infectious diseases and their effect on human and animal health. Pablo *et al*. (2012) proposed a framework to create services for guiding people who cannot be found by their families, rescuing injured people, helping people who need to be rescued from their inundated homes, moving people to hospitals or emergency shelters, and other available services near their current location.

## 4. DEVELOPMENT OF THE CROWDSOURCE PROTOTYPE

In this section we describe the process of developing the geospatial crowd source mashups for healthcare geo visualization. This scenario is tailored to central Johor Bahru local authority in south Malaysia. The image from Figure 1 display the map of the study area. The prototype was developed as a simulation by means of both neogeography and VGI as a backing to the residents of Johor in creation and distribution of healthcare information (Gao *et.al*.2009). The most pressing provision of any geospatial health mashups is to provide the ability to both geo visualize and perform analysis of such information.

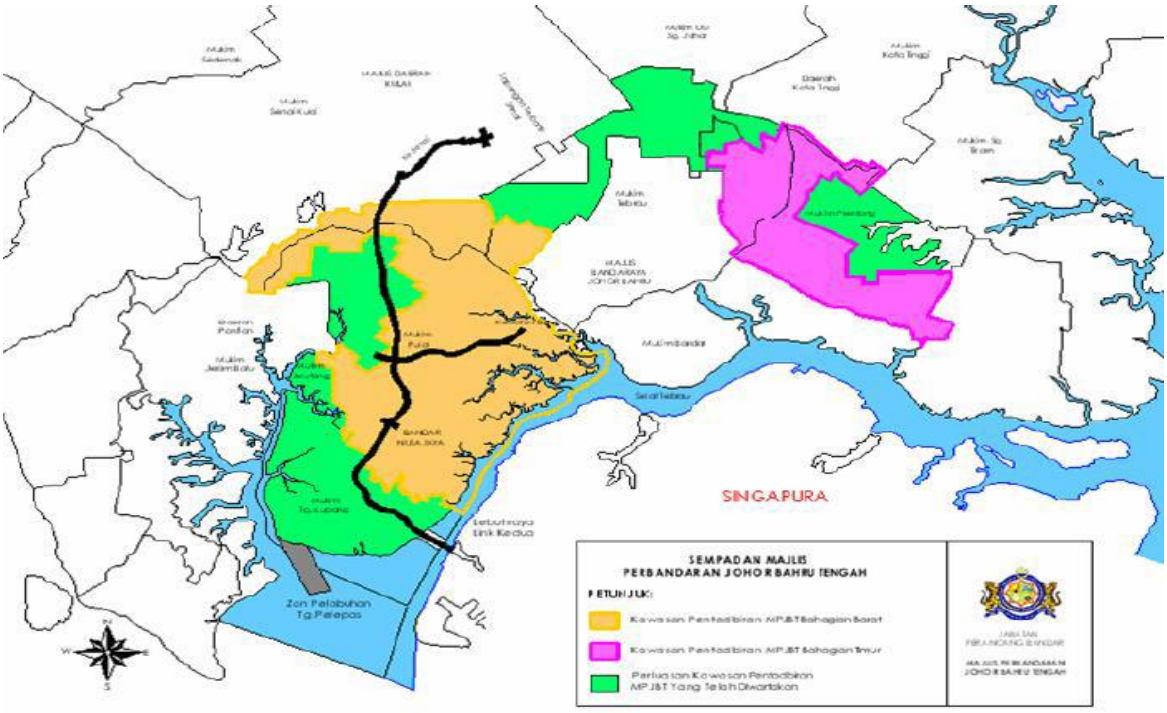


*Figure 1. Central Johor Bahru location.*

### 4.1 Methodology Use

The geovisualization and web mapping of this application is performed by .NET technology based on Google map API implementation and MozillaFirefox web browser as the graphical user interface (GUI), the workflow is shown in

*Geodetic Datum Transformation software (GDTS) v.4.01 was used for projection transformations, it is an innovative geodetic solution developed by Info GeomatikSdn. Bhd.*

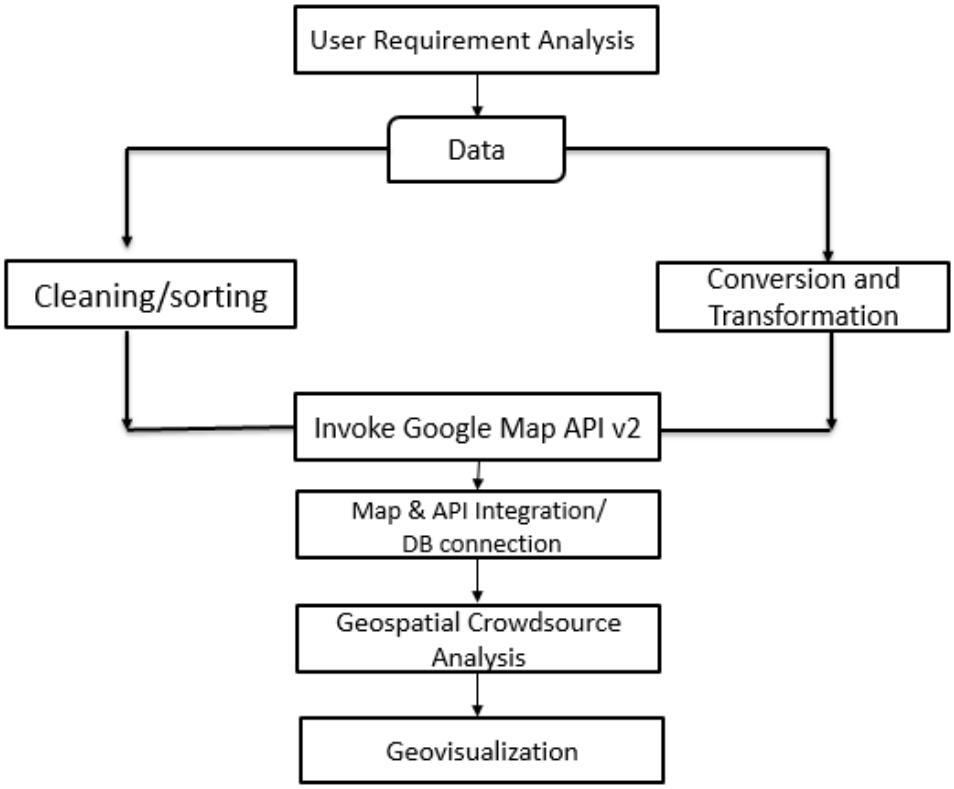


*Figure 2. Workflow for the Geospatial Mashups development.*

**4.2 Planning Stage**

The idea of user requirement gathering was presented by Downton(1991); Whitten and Bentley (2005) with the sole aim of working with users prior to requirement list gathering. This was reported to be a traditional methodology (Haklay, 2010). In brief, Kazman and Chen (2009) stated that the idea of Downton (1991) cease to exist in the era of web 2.0. However, as Queiroz and Ferreira (2009) points out that the only user requirement gathering for spatial application are about mobile device. The development of this Geo Mashup application is motivated to provide opportunities for the citizens of this location to gain access to vital information that can aid in gathering and sharing information based on their local knowledge. User requirement analysis were not collected forthwith, nonetheless it was supported based on literature studies, and the web interface was design to hold a part where the society can willingly add and disseminate information regarding their healthcare centers.

Spatial data sets collected from the field using Ashtech Pro Mark 200 stop-and go post processing method include location of healthcare center in Johor central area. Others data include land use map, Johor Bahru inter-boundary layers, cadastral lots,and Observations – spreadsheet information that reflect location of dengue fever in Johor State for 2009.

West Malaysia is presently using two coordinate system for the purpose of cadastral and mapping: Malaysian Rectified Skewered Orthomorphic (MRSO) and Cassini Soldner. The MRSO system is based on Modified Everest Reference ellipsoid, whereas Cassini Soldner is applies a plane coordinate system for local cadastral system Wan, *et.al* (2000).

Hotine (1947) investigates the relationship between MRSO and the Cassini Solder, alternatively in Richardus and Alber, (1974). Geometric transformations was performed on the land use map by registering four ground control points (GCPs) using AutoCAD Map 3D 2012.

GDTS was used for projection transformation of the land use map from Cassini Soldner to MRSO and finally to the Malayan Revised Triangulation (MRT), which is the local geodetic reference systems in Peninsular Malaysia.

A number of origins have been adopted when establishing local Cassini coordinate system, resulting in each state in west Malaysia using a difference origin. Since geospatial mashups require data in geocentric datum, i.e. WGS84, which will be further converted to kml to be used in Google map API. There is need to transformed these established

local system data to geocentric. The transformation procedure from local datum to global datum (mapping and cadastral system) involves a lengthy computation steps as follows:
CS to MRSO: (E, N) local to (x, y) local
MRSO to MRT: (x, y) local to (ϕ,λ, h)local
MRT to WGS84: (ϕ,λ, h)local to(ϕ,λ, h)global (1)
GS84 to KML: (ϕ,λ, h)global to XML

**4.3 Design Stage**
Presently, geo mashups are mostly accomplish on the client-side (Fu and Sun 2010). Since 2005, there has been a tremendous implementation for client-side mashups due to its rich contents and services such as Java-script, xml and kml widely available across the internet. The land use map in MRT was converted to WGS 84 and KML.
Using Microsoft Access 2010 to store all attribute data in user log-in page. Figure 3, shows the user log-in url. This keep track of number of users to the site. Alternatively a Facebook account can be used to log-in. User name and password is required for authentication using C#.net framework from the user log-in homepage. The security process is ensured by the use of personal identification number. A user is first required to register, a user supplies his preferred username, password via a aspx form, and if the user name number is found from Microsoft Access user table and password confirmation are the same, then it registers the username and password in the user table otherwise it reports error messages.

*Figure 3. User log-in page*

**4.4 Implementation Stage**
The development of a geospatial crowd source mashups requires invoking a map API which consists of a series of map related functions. These functions control the geo visualization of the map, including the scale, position, and any other overlaid information in the form of points, lines or areas. The purpose of these API is to make it possible to incorporate geo spatial maps on websites, and to overlay information from another source. Firstly, we invoke an instance of GMap;(A view which displays a map in our third party website with data obtained from the Google Maps service). Once the G Map instance is generated, other various methods and properties available can be used to manipulate other aspects of the map such as the controls, the display of points of interest, polylines, or polygons. Everything in Google maps flow through an instance of the G map class. The technological developments and the creation of sophisticated computer software reduced not only the costs of map production, but also improved the ways in which we can deliver them. For developers, browser-side APIs have greatly reduced the effort needed to combine multiple web services and datasets. While for web users, browser-side APIs provide rich and responsive interaction that has changed web user‘s expectations of web GIS.

**4.5 Geospatial Mashup**
The home page contain an Interactive web map, from its design a user can make clicks on the map, zoom in and out from specific areas, Java-scripting helped in the development of the home page. From its conceptual design, personalizing map interface was restricted on this page, it was more of a general information page about Johorcentral local authority and its healthcare system. Basically the page embeds Google Map and Google earth. With Google Earth, the user is provided with a certain level of freedom that makes the user feel in control of the application and encourages exploration with no functionality to perform spatial analysis. Nivala *et al.* (2008) carried out a usability evaluation of web mapping sites Google Maps, Multimap, Map Quest and MSN Maps. They explain that people have difficulty finding the map interface as they were confused by maps that looks like links. Also the

same study found that users felt confused by information overload and elements such as advertisements, further reduced the visibility of the map interface and its functionality.

This study developed a digitizer tool based on Google maps Java-script API which consists of a map control with additional radio buttons to change the drawing mode as well as buttons to clear the last point or the entire map. To the right of the map is a text field which logs the clicked coordinate‘s around the study area. The output for this example is in KML; however, the tool could easily be extended to generate other geographical formats. Finally, at the top of the map is a search field which allows the citizens to enter any address around the study area and the tool will locate it geographically, that is geocode it. Figure 4 shows the application interface designed.

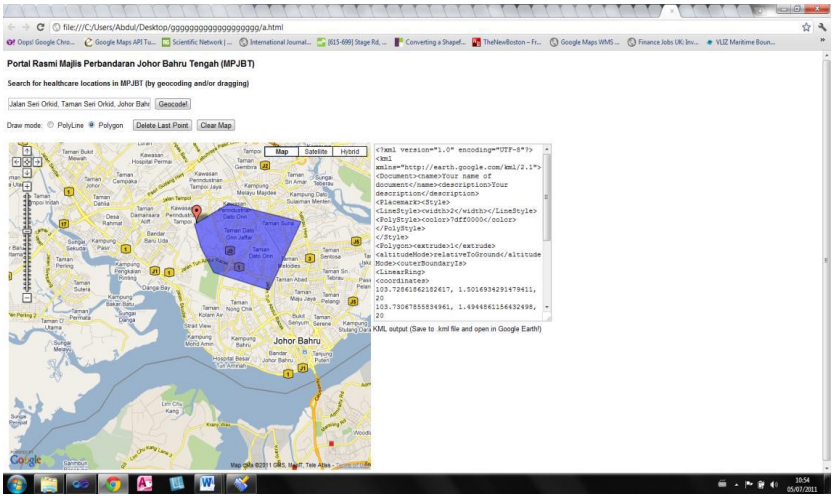


*Figure 4. Interface design*

Digitizing a path is done by simply clicking on the map display. For instance, to trace out a path between two healthcare centers such as from Sultannah Aminah hospital in Johor to Universiti Teknologi Malaysia clinic in skudai, we could digitize to map disease outbreak in the study areas. Once that is done, we can copy the generated KML output path to a single file such as (healthcenterpath.kml) and then open it up in Google Earth to see how it looks. The codes also provide functionality for digitizing polygons. This will further involve the citizens in producing needed data and participating in decision making.

A large map can significantly improve the spatial navigation of the users as more features are available on the screen and at the same time minimizes the use of tools such as panning, which add to the waiting time for each user‘s actions. This study did not provide functionality for back button which lets the user to see the previously accessed map. As a result such functionality should be taken into account.

Thematic Mapping API is a new Java-script library which tends to create thematic maps from our data source. The thematic map used in this study, which represents Johor central boundary, road networks and healthcare centers was firstly converted from dwg, using the AutoCAD tool. Subsequently, kml data was created from shape files and was hosted on a PHP Web server. Using the Java-script library from Google maps an overlay could be made possible as seen in Figure 5. A kml file that has a known URL can also be opened in Google Maps by entering its URL in the Google maps search box. Moving the mouse over this kml layer creates a hover affect. Figure 6 illustrates attribute information of the healthcare center contributed by the public. A click on either of the layers pops out attribute information. Distances could be measured from the analysis. E-Label on the top right corner of the application was created, for switching on and off spatial layers.

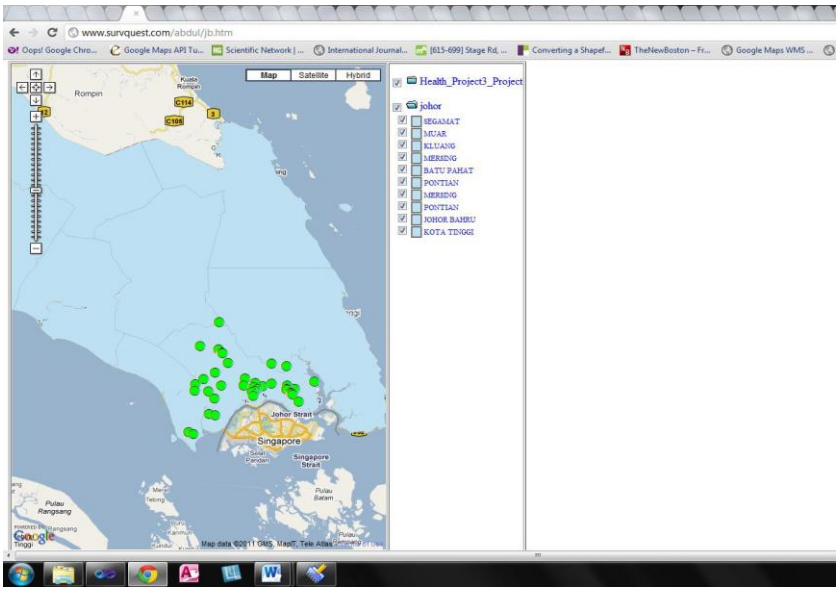


*Figure 5. An overlay of health Care centers and Johor bahru boundary layers embedded in Google Map API*

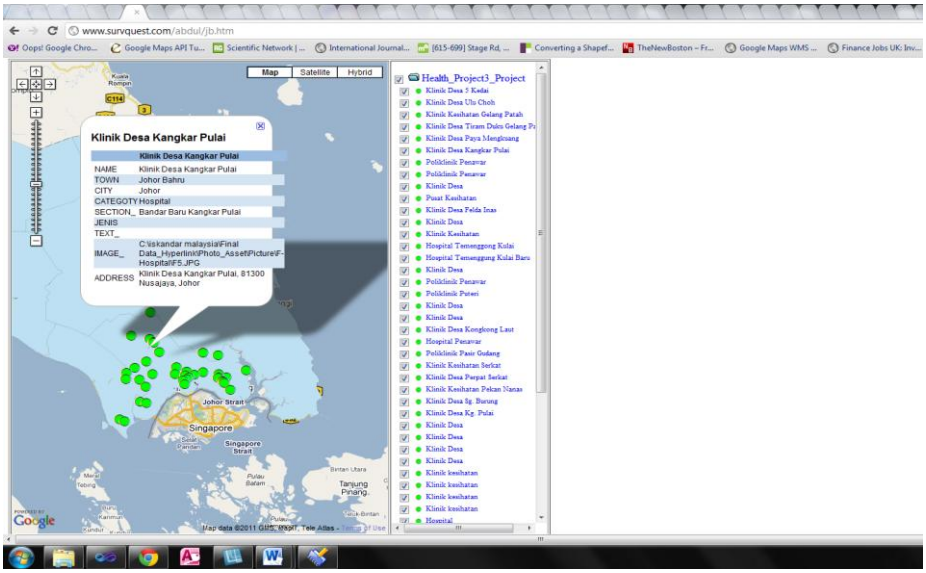


*Figure 6. KML of both spatial and attribute information.*

The most significant job for producing geospatial crowd source mashup for healthcare geo visualization is for the public to generate their own health awareness content for the benefit of others using these platform. Users can add map in communicable disease outbreak locations, add comments using the pop up comment application.

## 5. CONCLUSION AND FUTURE WORK

Presently, the use of geospatial information crowd sourcing in healthcare information dissemination has not been fully explored. Our contribution in this paper is a framework for possibility of designing a geo spatial information system based on web Mashups application to make use of several contents retrieved from volunteered citizens of Johor central in Malaysia and maps to create communicable disease surveillance services for other citizens who are unaware of the outbreak. These awareness system can support in times of new communicable disease outbreak such as the concentrated outbreak of a new strain of a virus that emerged in Saudi Arabia which spread across the Kingdom. Tools for mapping and digitizing of an outbreak of disease was developed based on Google maps API scripts.

The concept of Geo web 2.0 makes crowd source health information available to citizens throughout the day thereby increase awareness and communication.

Anyone can publish contents over the internet, since there is no gatekeeper. Quality can vary enormously, the results of uncertainty or error can be propagated over the internet. This can produce misleading and even wrong information Goodchild *et.al.* (2010).The web resources chosen should be appropriate for the purpose of the mashups application. The next attempt will base on geo visualization on mobile devices.

## 6. ACKNOWLEDGEMENTS

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