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Abstract

Geographical Information Systems (GIS) have been used widely in many countries to map health-related events and the results are used for planning of health services and in assessing clusters of health facilities. This project demonstrates the application of GIS in the mapping of health facilities in Addis Ababa particularly Gulele sub-city; the ArcGIS 9.3 software was used to map and evaluate the spatial clustering of health facilities in the study area. The study was conducted using primary and secondary data collected from various areas with GPS technology. The results suggest that new health facilities should be built in the woredas of Gulele sub-city. The method of analysis employed point pattern analysis used to evaluate the physical distribution of point events and test whether there is a significant clustering of points in a particular area and also ratio. The project has been developed for all participating service agencies to give an overview ?map? of the health service sector. The project is designed to assist the participating health services in developing a good understanding of the community in the recovery context, enabling strategic planning and coordination of services to the increased need of the population of the subcity in the area of health facilities.

Index terms— GIS; health facility; mapping.

1 Introduction

e live in an age of information, and spatial information is one of the most critical elements underpinning decision making for a range of disciplines **??**Rajabifard and Williamson, 2001). Health, wealth and population distributions are all examples of spatial information commonly attached to administrative polygons. In fact, there are few areas of the economy and environment that do not rely either directly or indirectly on the integration of data attached to administrative boundaries for planning, maintaining or rationalizing activities (Eagleson et al., 2001).

GIS has the ability to examine the complex behavior of geographically referenced data. Today, with increased spatial and network analysis capabilities, GIS are designed to predict and understand the interactions between entities and phenomena throughout space and over time (Tomlinson, 2002). Since the 1980s the benefits of geographic data and GIS for analysis and modeling have been realized. As a result, virtually all people, property and infrastructure have the ability to be referenced by location (Openshaw, 2000). With geographic data readily collected and GIS technology now available at a relatively low cost, it should be possible to build a digital representation of virtually any phenomena of interest. Related technical issues such as data exchange, differences in geographic boundary design and data integration present serious limitations, however, and must be addressed if geographic data is to be used to its full potential.

Health is vital for all of us and understanding the determinants of a disease, its spread from person to person and community to community has become increasingly global (ESRI, 1999). As expressed by (Scholten and De Lepper, 1991), "health and ill-health are affected by a variety of life-style and environmental factors, including where people live". There are various factors such as climate, environment, water quality and management, education, air pollution, natural disasters, social and many others which are the reasons for the emergence of

diseases. The characteristics of these locations (including socio-demographic and environmental exposure) offer a valuable source for epidemiological research studies on health and the environment. Epidemiological research ranges from outbreak investigation, data collection, design and analysis including the development of statistical models. Since health is a geographical phenomenon and various factors attributing to the health diagnostics and planning are geography dependent, as such, GIS (Geographic Information System) for health studies serves as an important tool. Therefore, this project focuses on mapping health facilities and to show their spatial distribution in Gulele sub-city and finds gaps on which woreda health service provision is needed. This project utilizes different methods of data collection, and the sources of information were both primary and secondary data. The primary data collected through Garmin 76 GPS were, the spatial distribution of health facilities (pharmacies, hospitals, clinics and health posts). Secondary data were population data from the Central Statistical Agency (CSA), these data were combined to form a database for this project.

2 a) Data Sources and Methodology of the Study

3 c) Data Collection

During the present study, both spatial and non spatial data were gathered, from primary and secondary sources. Primary data were generated from the analysis of field visits. A field survey was undertaken to record the geographic coordinates of all health facilities (government hospitals, private hospitals, government clinics, private clinics, government pharmacies, health centers, private pharmacies and government health centers) were recorded. The addresses of these facilities were obtained from the Ministry of Health and their spatial locations were gathered using GPS. In addition, the major primary data required for the study has been extracted from various road category net works were also generated from 1:50,000 scale topographic maps of Addis Ababa obtained from Ethiopian Mapping Agency through digitizing and the sub-city layer was obtained from Ethio-GIS. ? Field Visit Presenting the results using thematic maps and table

addresses of the health facilities were generalized to maintain the confidentiality, it was often difficult to record the precise location. Various approaches were used to identify the location as close as possible to the actual location. These included checking the addresses by using Google Earth software prior to undertaking the fieldwork, Field visits were the major data collection mechanisms. Preliminary field visit was carried out to get an overall overview of the study area, to identify health facilities and to collect using Garmin 76 GPS readings of the various health facilities readings of the study area.

4 d) Data Analysis

The data that was collected using Garmin 76 GPS, after recording these locations using GPS and data obtained from GPS were loaded into the ArcView 3.2 GIS software and later converted into the ArcGIS 9.3 format. All data were in ArcGIS 9.3 format.

The data entered with were provided in Microsoft Excel format, then export to SPSS version 20.0 to change DBF format, after changing to DBF format, ArcGIS capable with this format, then with this software changed to shapefile. Since the data handled is large and diverse i.e. from different sources, the database is organized in a series of tables so that it can be shared. Each table is called a relation and it consists of a number of rows and columns.

The method of analysis employed in this project was subjected to different softwares depending on the objective of analysis. For analysis, GIS data was vertically organized into layers or themes. Using database query, these basically involve basic retrieval of what is already in the database. In addition, point pattern analysis was conducted to evaluate the distribution of health facilities in the sub-city. Nearest neighbor statistics was calculated for the evaluation of the pattern of the distribution of the cases. Nearest neighbor ratio (R) calculates the distance between one point to its nearest points. It was calculated using equation (**??**) below (Robinson, 1998).?? = ???????? ???????? (1)

Where, R = nearest neighbor ratio ???????? = observed average distance between nearest neighbor ???????? = expected average for a hypothetical random distribution This index gives a systematic measure of the pattern within a specific region. R values range from 0 to 2.1491, where an R ratio value less than 1 indicates that the point pattern distribution is more clustered than random, the value of R is greater than 1 indicates that the point pattern distribution is more dispersed than random (Robinson, 1998). This analysis was undertaken with the ArcGIS9.3 software.

5 II.

6 Results and Discussion

7 a) Physical and Socio-Economic Background of Addis Ababa

Addis Ababa, the capital of Ethiopia, which is by far the largest in the country located in the central part of Ethiopia and belongs to the Western highlands. All sides of the capital city is bordered by Oromiya Regional state, and covers an area of 530 square kilometers (53,000 ha) and a total population of 3,041,002 million persons **??**CSA, 2011). Addis Ababa has a history of 125 years. Thus, one can say with certainty that it had its earliest

beginnings in the mid 1880s and had evolved to be the capital of Ethiopia around 1886/87 City Council of Addis ??baba, 1986 ??Johnson, 1974). Then after that changed the name to Addis Ababa City Municipality and also in 2005 called as Addis Ababa City Administration.

Astronomically, Addis Ababa is located at 09 0 02' N Latitude and 38 0 44' E Longitude. It is situated on the foot of escarpment of Mt. Entoto in the North which rises to 2900 meters to the south with an average altitude of 2400 meters. This varying topography of the city has affected its spatial expansion favoring the relatively flat landscape in the south as a major factor contributing to the "unsafe housing" condition in the city, as cited in Hadgu ??1988). Thus, males comprise 48 % and females 52 % of the total population of the sub-city. The sex ratio for Gulele sub-city equals 94 %. It is calculated as the number of males over the number of females. When the ratio is greater than hundred it indicates a higher number of males than females. Ratio closer or equal to hundred shows balanced number of males and females in a given woreda.

The female population exceeds the number of male population by 8832 persons on average at woreda level. Higher number of females are recorded at woreda 09. Sex ratios greater than hundred are observed in woreda 06. The highest sex ratio, that is, 118%, is recorded in woreda 06. This map on Figure ?? shows the spatial location of all health facilities in the sub-city. Based on the spatial distribution of health facilities illustrated on the map, woreda 09 have consisted all health facilities (i.e., pharmacies, hospital, clinics and health center). But, woreda 04 have consisted only one clinic. The rest woredas of the sub-city health facilities have less sparsely distributed. The North West, north and north east part have outskirts of the sub-city have no health facilities, because these parts of the sub-city have steep slope and covered with forests.

ii. Point pattern analysis of the Health Facilities Figure ?? : Results of point pattern analysis Point pattern analysis is used to evaluate the physical distribution of point events and test whether there is a significant clustering of points in a particular area. Health facilities distribution in Gulele sub-city were clustered, because, the ratio obtained was 0.76 (which is <1). Z score = -3.64 standard deviations; whereas the P-Value is 0.0000274. Thus, in Gulele sub-city health facilities were concentrated only in some woredas, for example, in woreda 09 all facilities are found. But, there were many cases have seen no built up of health facilities in the sub-city.

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9 (B)

f) Gulele sub-city Pharmacies Figure ?? : Gulele sub-city pharmacies Gulele sub-city has a total population of 267,624; this map on Figure ?? represents the spatial location of pharmacies in the sub-city. According to the spatial location of pharmacies, there are 16 pharmacies in the Sub-City. The distribution of pharmacies is not equitable because all of them except one are privately owned pharmacies and the owners opened the pharmacies on downtown where more market is available. The pharmacies mostly concentrated on woreda 09 but no pharmacies opened on woreda 04, 05 and 06. The above table 1 shows that, for each woreda the ratio shows how many people share a pharmacy on average. It is calculated as the number of people divided by the number of pharmacies. There is still a need for constructing new pharmacies for showing zero population sharing for the pharmacy.

The average population of the sub-city is 26762 whereas at sub-city level average number of pharmacies is 1.6 thus for on average for 16726 people needs nearly 2 pharmacies. But, the distribution of pharmacies in the sub-city is not on the above proportion. On woreda 09 there is more concentration of pharmacies, that is 7 pharmacies.

10 g) Gulele sub-city Hospitals

Figure ?? : Gulele sub-city hospitals Gulele sub-city has a total population of 267,624; this map shows that the spatial location of hospitals in the sub-city. In this sub-city there are two specialized government hospitals and one general private hospital. The first specialized hospital (Kidus Petros TV Center) is found in woreda 01. In addition, the other specialized hospital (Poulos hospital) is found in woreda 09. The private general hospital (Cure hospital) is found in woreda 02. The hospitals found in Gulele sub-city serve not only to Gulele sub-city but also for the country as a whole.

Out of six specialized hospitals found in Addis Ababa city Administration two of them are found in Gulele sub-city. The proportion of population expected to serve in specialized hospital is 1:5,000,000 population means that 1 specialized hospital expected to serve for 5,000,000 people. Whereas, for general hospital is 1:1,000,000 population means that 1 general hospital expected to serve for 1,000,000 people. Thus, it is enough general and hospitals found in The above table 2 shows distribution of clinics in the ten woredas and one clinic supposed gives services. Accordingly, the average population of the sub-city is 26762 and clinics are 4, thus, averagely 6690 people share 4 pharmacies. But the distribution is very sparse in woreda 02, 04, 06, 07 and 08. The above table 3 shows that, for each woreda how many people share a health center. According to Ministry of Health on Health Sector Development Program IV (2011-2015), the proportion of health center is 1:25,000 population means that 1 health center expected to serve 25,000 people. But, the reality seen on the sub-city is different. Based on the spatial distribution, woreda 03 is only 1 health center for 28,124 people, woreda 06 is 1 health center for 26,123 people and woreda 09 is also 1 health center for 32,704 people.

On the rest woredas there is not a health center. From this we conclude that in woredas where no health center, there is a need for built additional health center.

11 III.

12 Conclusions and Recommendations

GIS is designed to predict and understand the interactions between entities and phenomena Health Facilities Distribution Mapping in Addis Ababa, Ethiopia throughout space and over time. This project mapped the distribution of health facilities. A field survey was undertaken to record the geographic coordinates of all health facilities and their spatial locations were gathered using GPS. The results showed that health facilities are sparsely distributed in most of the woredas. Planners and concerned government officials should be built extra health facilities based on the population ratio in Gulele sub-city. The necessary extra pharmacies, clinics and health centers should be built timely in order to solve the health facility problem which prevails in the study area. Analyses provide essential information for health practitioners to understand the problem and help them plan for additional health facilities distributed equally in the sub-city.

IV. [1]

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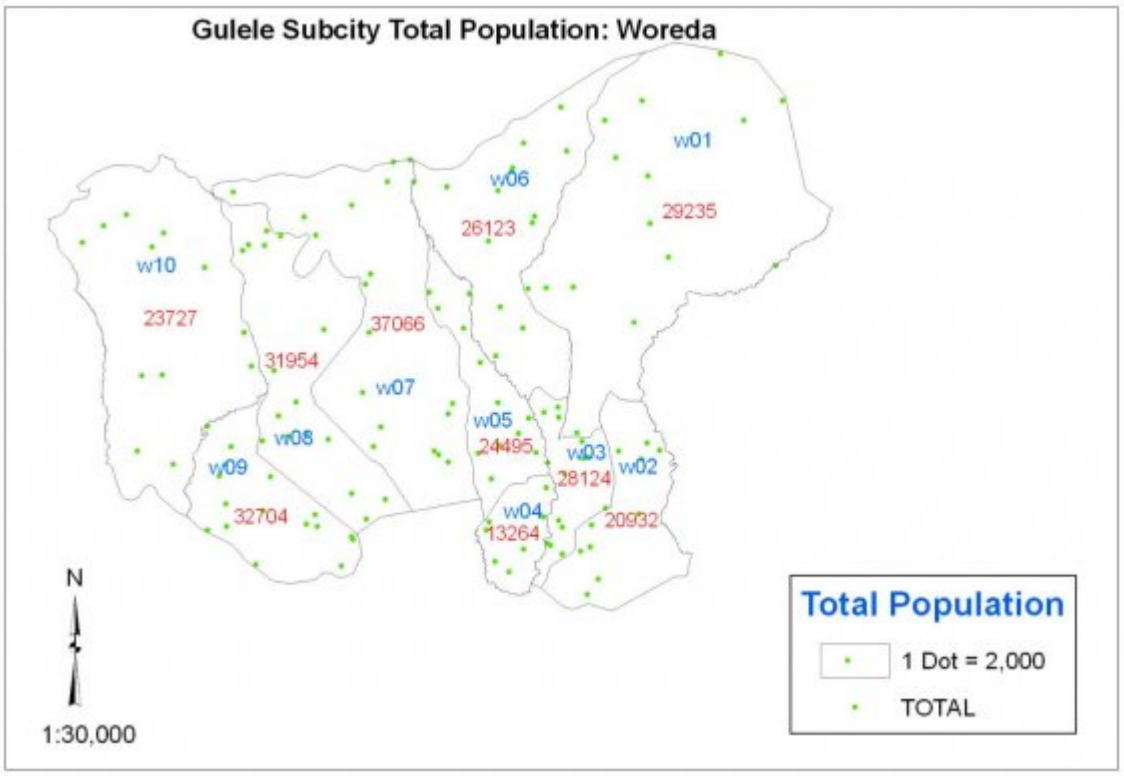
Figure 1: Figure 1 :

[1] © 2016 Global Journals Inc. (US)Health Facilities Distribution Mapping in Addis Ababa, Ethiopia



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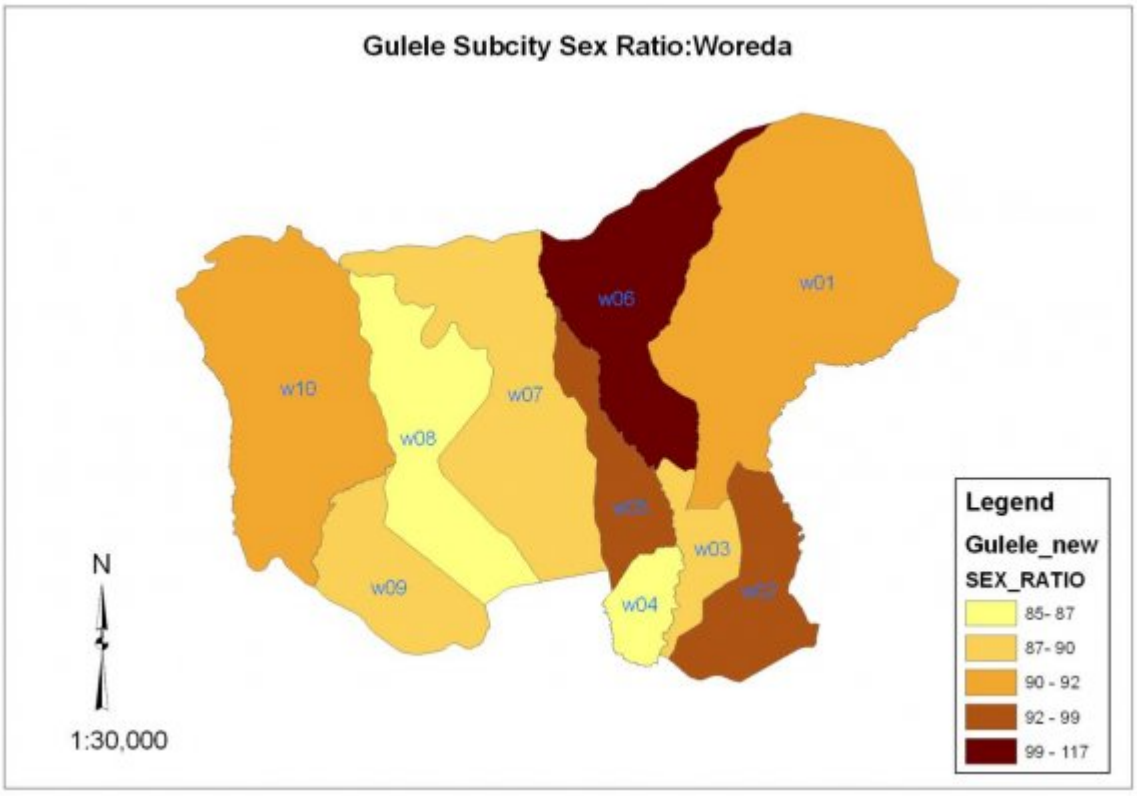

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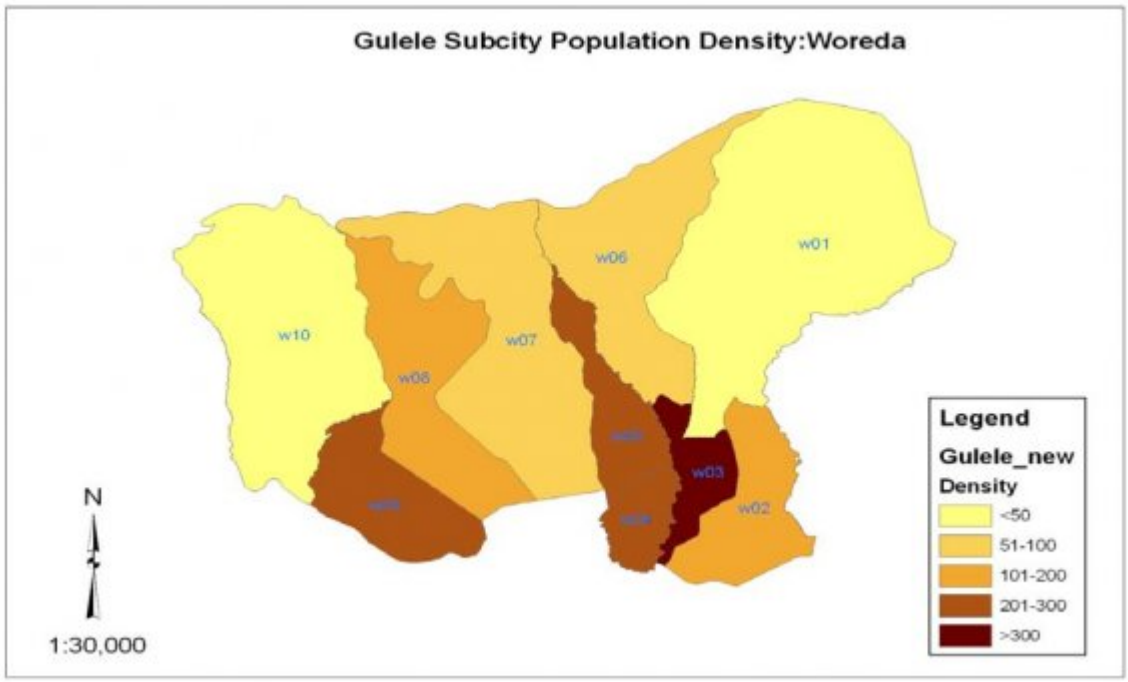

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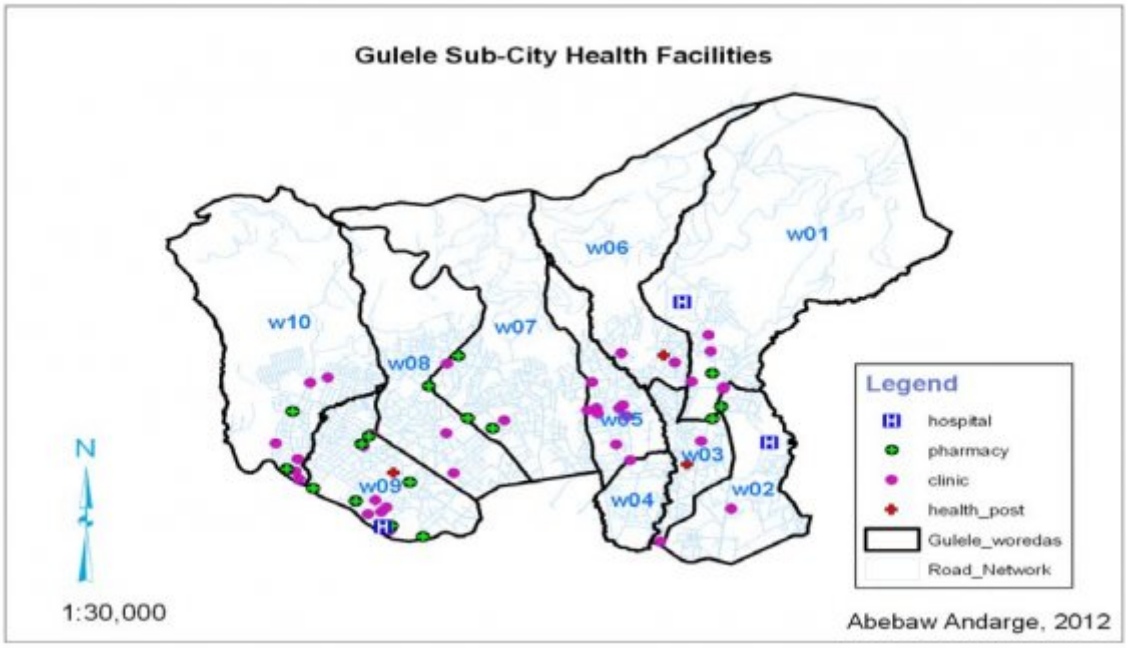

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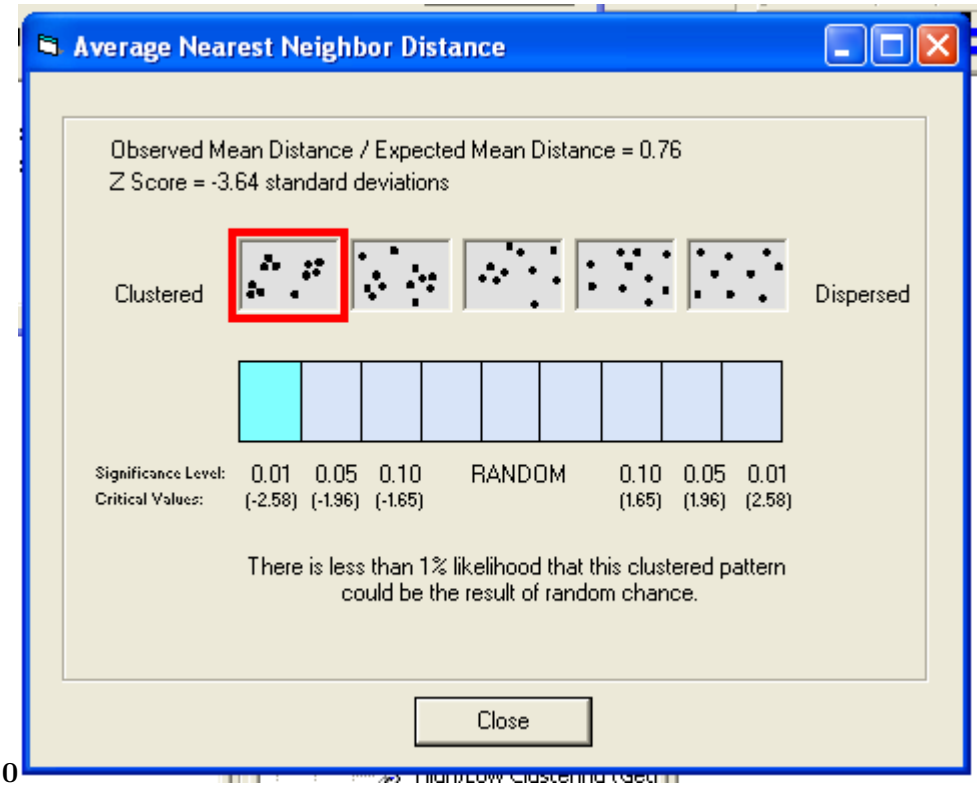

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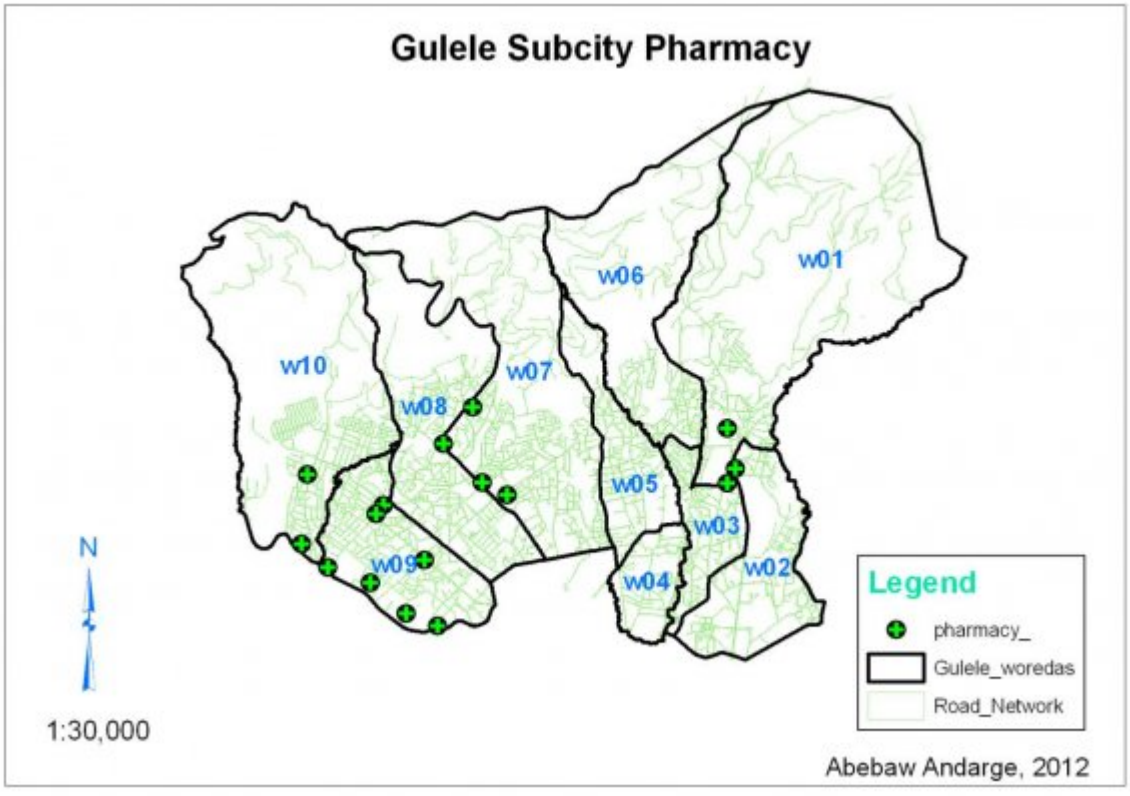

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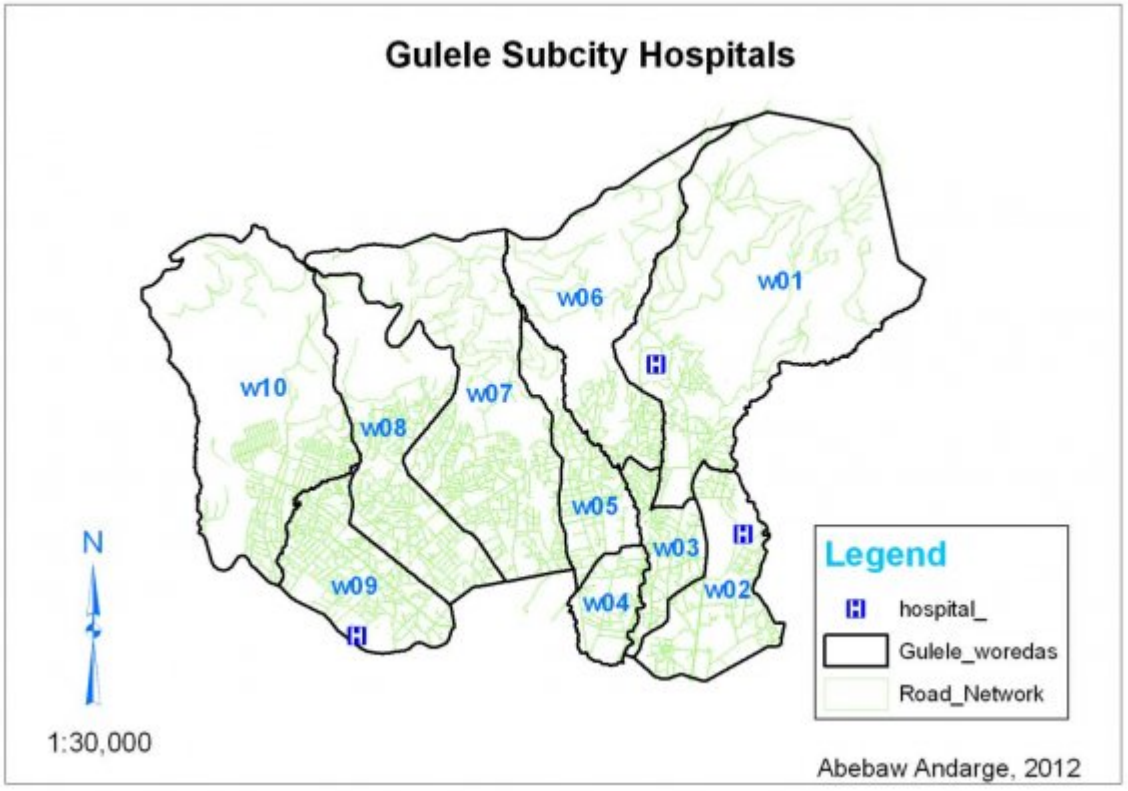

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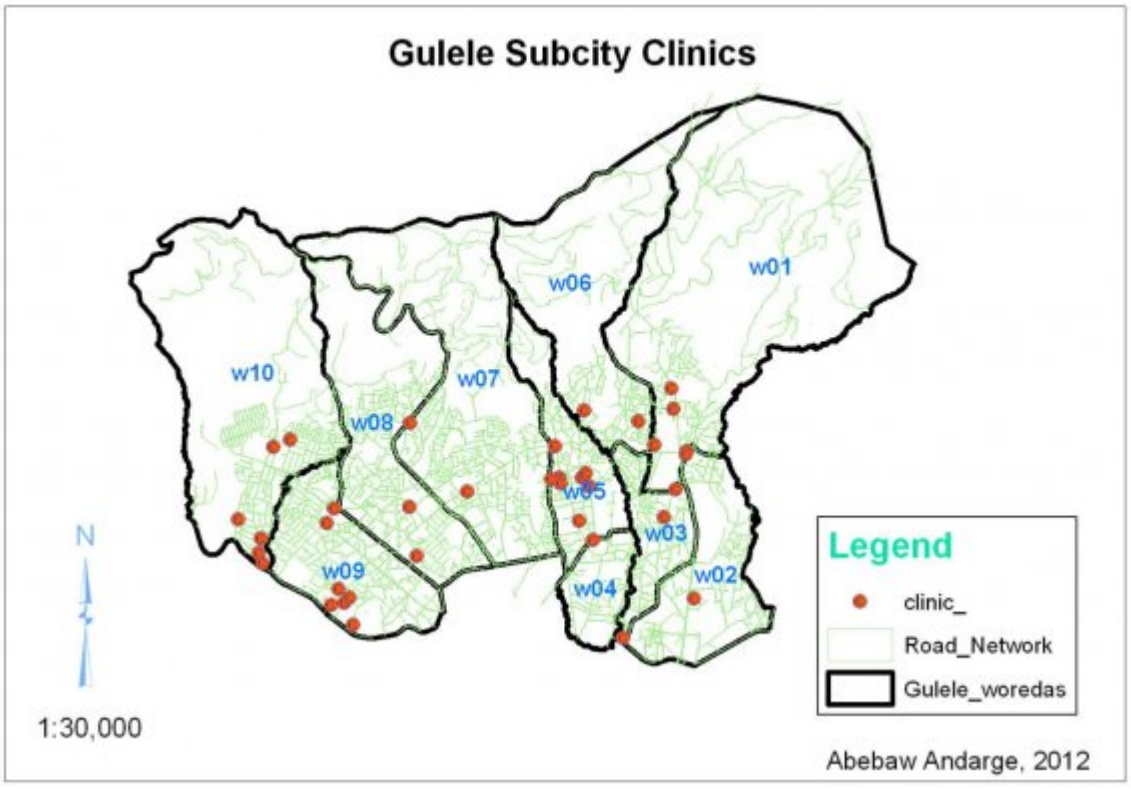

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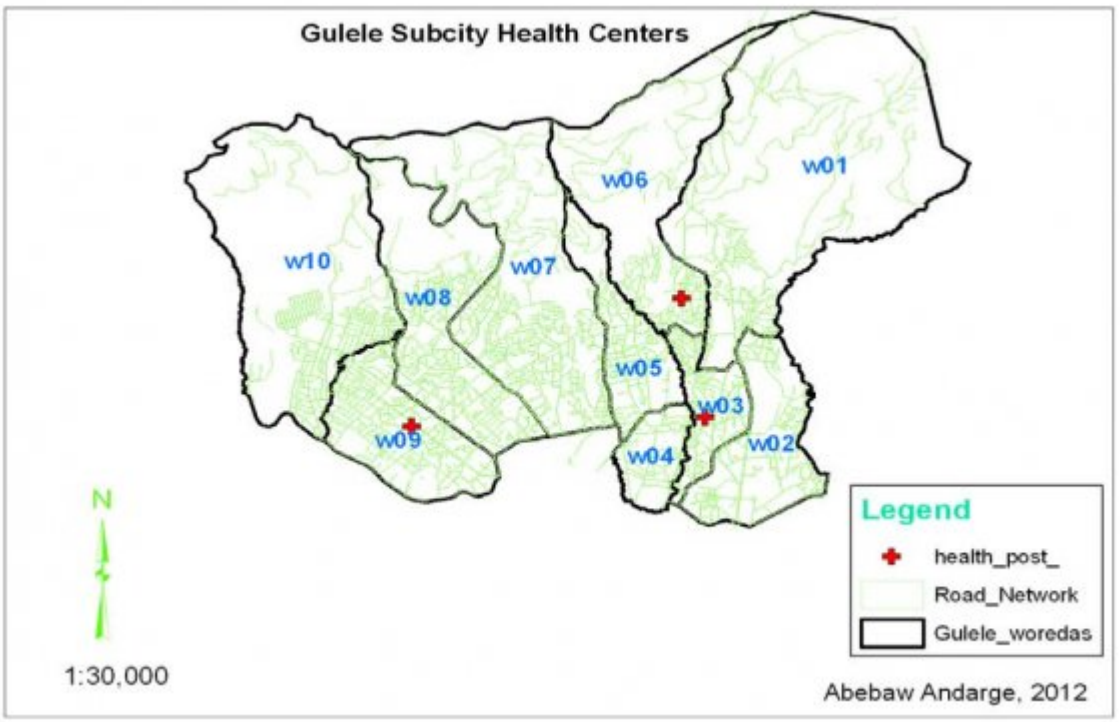

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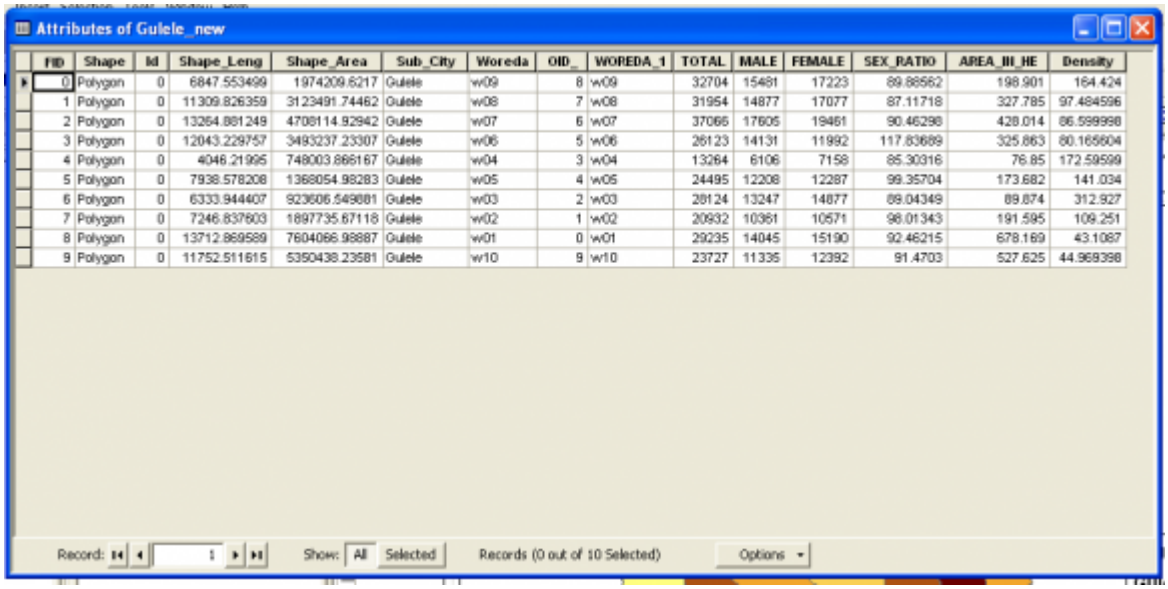

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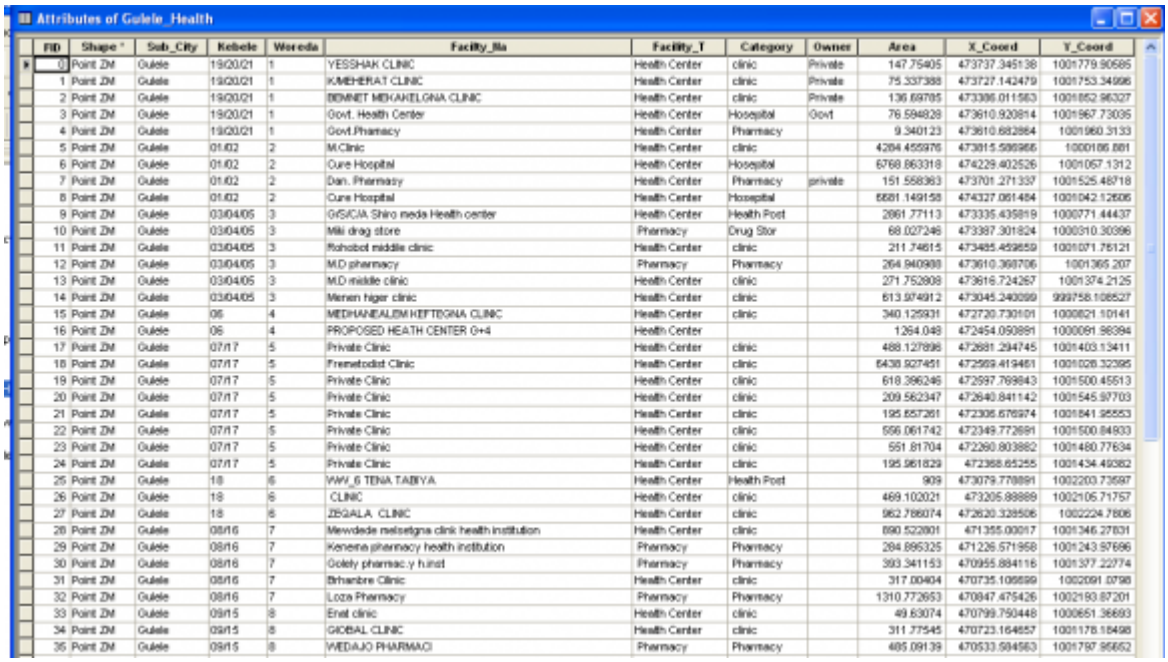

Attributes of Gulele_Health

FID	Shape *	Sub_City	Kebele	Woreda	Facility_Na	Facility_T	Category	Owner	Area	X_Coord	Y_Coord
0	Point ZM	Gulele	19/20/21	1	YESSHAK CLINIC	Health Center	clinic	Private	147.76405	473737.345138	1001779.90585
1	Point ZM	Gulele	19/20/21	1	KMEHERAT CLINIC	Health Center	clinic	Private	75.337388	473727.142479	1001753.34996
2	Point ZM	Gulele	19/20/21	1	BEMNET MEKAKELGNA CLINIC	Health Center	clinic	Private	136.69785	473386.011563	1001852.96327
3	Point ZM	Gulele	19/20/21	1	Govt. Health Center	Health Center	Hosepital	Govt	76.594828	473610.920814	1001967.73035
4	Point ZM	Gulele	19/20/21	1	Govt.Pharmacy	Health Center	Pharmacy		9.340123	473610.682884	1001960.3133
5	Point ZM	Gulele	01/02	2	M.Clinic	Health Center	clinic		4284.455976	473815.599966	1000186.881
6	Point ZM	Gulele	01/02	2	Cure Hospital	Health Center	Hosepital		6768.863318	474229.402526	1001057.1312
7	Point ZM	Gulele	01/02	2	Dan. Pharmacy	Health Center	Pharmacy	private	151.558383	473701.271337	1001525.48718
8	Point ZM	Gulele	01/02	2	Cure Hospital	Health Center	Hosepital		6681.149158	474327.061484	1001042.12606
9	Point ZM	Gulele	03/04/05	3	GrS/CIA Shiro meda Health center	Health Center	Health Post		2861.77113	473335.435819	1000771.44437
10	Point ZM	Gulele	03/04/05	3	Miki drag store	Pharmacy	Drug Stor		68.027246	473387.301824	1000310.30396
11	Point ZM	Gulele	03/04/05	3	Rohobot middle clinic	Health Center	clinic		211.74615	473485.459659	1001071.76121
12	Point ZM	Gulele	03/04/05	3	M.D pharmacy	Pharmacy	Pharmacy		264.940988	473610.369706	1001365.207
13	Point ZM	Gulele	03/04/05	3	M.D middle clinic	Health Center	clinic		271.752808	473616.724267	1001374.2125
14	Point ZM	Gulele	03/04/05	3	Menen higer clinic	Health Center	clinic		613.974912	473045.240099	999758.108527
15	Point ZM	Gulele	06	4	MEDHANEALEM KEFTEGNA CLINIC	Health Center	clinic		340.125931	472720.730101	1000821.10141
16	Point ZM	Gulele	06	4	PROPOSED HEATH CENTER 0+4	Health Center			1264.048	472454.050891	1000091.98394
17	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		488.127898	472681.294745	1001403.13411
18	Point ZM	Gulele	07/17	5	Freewtodist Clinic	Health Center	clinic		6438.927451	472569.413461	1001026.32395
19	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		618.396246	472597.769843	1001500.45513
20	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		209.562347	472640.841142	1001545.97703
21	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		195.657261	472305.676974	1001841.95553
22	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		596.061742	472349.772691	1001500.84933
23	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		551.81704	472260.803882	1001480.77634
24	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		195.961829	472368.65255	1001434.49382
25	Point ZM	Gulele	18	6	WW_6 TENA TABIYA	Health Center	Health Post		909	473079.778891	1002203.73597
26	Point ZM	Gulele	18	6	CLINIC	Health Center	clinic		469.102021	473205.88889	1002105.71757
27	Point ZM	Gulele	18	6	ZEGALA CLINIC	Health Center	clinic		962.786074	472620.328506	1002224.7606
28	Point ZM	Gulele	08/16	7	Mewdede melsetgna clinic health institution	Health Center	clinic		890.522801	471355.03017	1001346.27831
29	Point ZM	Gulele	08/16	7	Kenenna pharmacy health institution	Pharmacy	Pharmacy		284.895325	471226.571958	1001243.97696
30	Point ZM	Gulele	08/16	7	Golely pharmac.y h.inst	Pharmacy	Pharmacy		393.341153	470955.884116	1001377.22774
31	Point ZM	Gulele	08/16	7	Birhanbre Clinic	Health Center	clinic		317.00404	470735.106599	1002091.0798
32	Point ZM	Gulele	08/16	7	Loza Pharmacy	Pharmacy	Pharmacy		1310.772653	470847.475426	1002193.87201
33	Point ZM	Gulele	09/15	8	Enat clinic	Health Center	clinic		49.63074	470799.750448	1000651.36693
34	Point ZM	Gulele	09/15	8	GIOBAL CLINIC	Health Center	clinic		311.77545	470723.164657	1001178.18498
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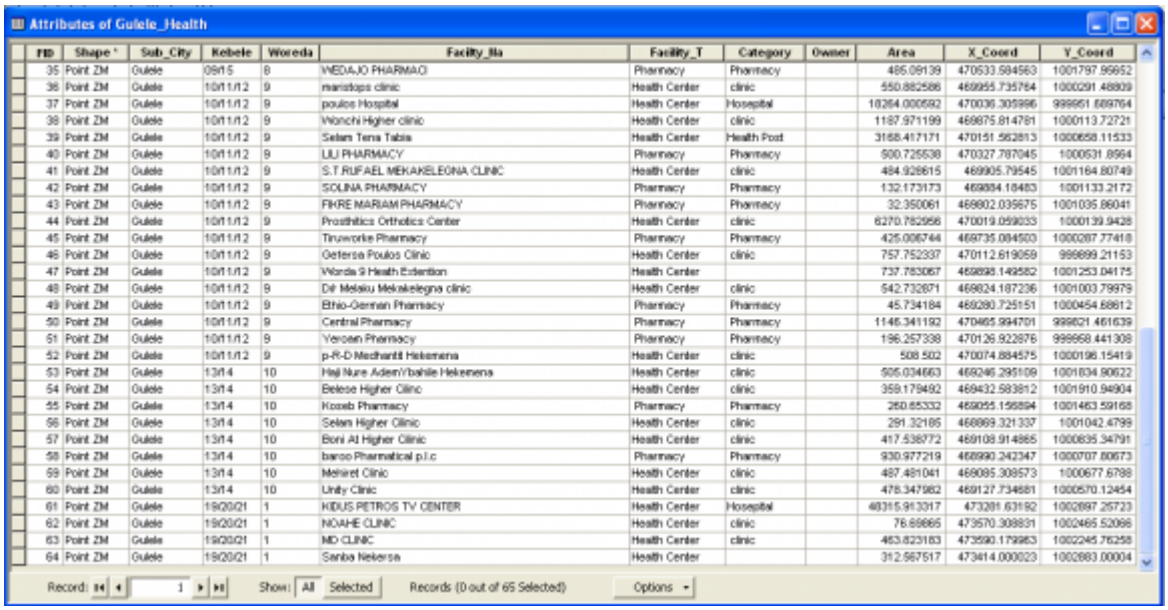
Figure 12:



Attributes of Gulele_Health

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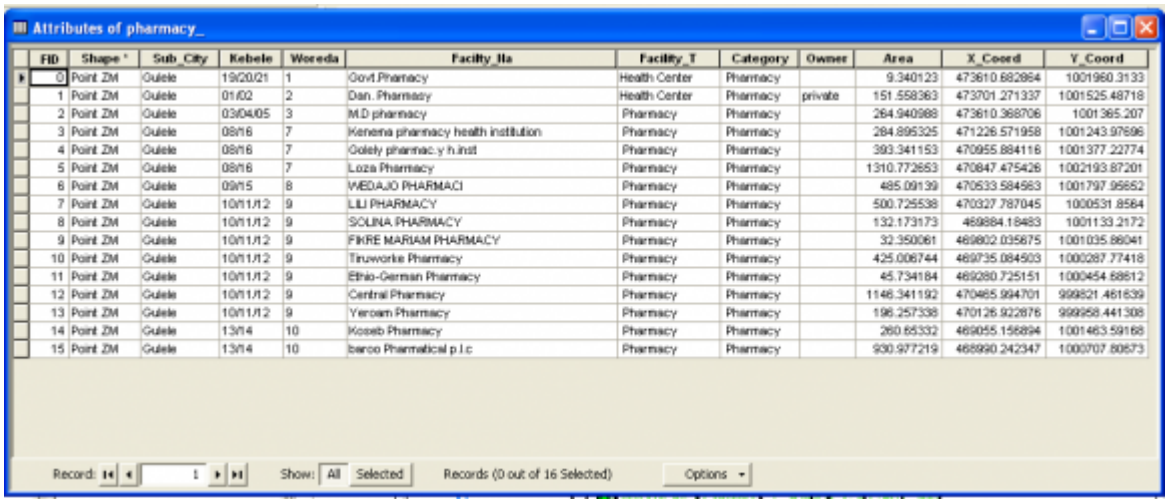
36	Point ZM	Gulele	10/11/12	9	mariotops clinic	Health Center	clinic		550.882586	469955.735784	1000291.48809
37	Point ZM	Gulele	10/11/12	9	poulos Hospital	Health Center	Hosepital		18264.000592	470036.305996	999951.689764
38	Point ZM	Gulele	10/11/12	9	Wonchi Higher clinic	Health Center	clinic		1187.971199	469875.814781	1000113.72721
39	Point ZM	Gulele	10/11/12	9	Selam Tena Tabia	Health Center	Health Post		3168.417171	470151.562813	1000858.11533
40	Point ZM	Gulele	10/11/12	9	LILI PHARMACY	Pharmacy	Pharmacy		500.725538	470327.787045	1000531.8564
41	Point ZM	Gulele	10/11/12	9	S.T.RUFAEL MEKAKELEGNA CLINIC	Health Center	clinic		484.928615	469905.79545	1001164.80749
42	Point ZM	Gulele	10/11/12	9	SOLINA PHARMACY	Pharmacy	Pharmacy		132.173173	469934.18483	1001133.2172
43	Point ZM	Gulele	10/11/12	9	FIKRE MARIAM PHARMACY	Pharmacy	Pharmacy		32.350061	469802.035675	1001035.86041
44	Point ZM	Gulele	10/11/12	9	Prosthitics Orthotics Center	Health Center	clinic		6270.782956	470019.059033	1000139.9428
45	Point ZM	Gulele	10/11/12	9	Tiruworke Pharmacy	Pharmacy	Pharmacy		425.006744	469735.084503	1000287.77418
46	Point ZM	Gulele	10/11/12	9	Geterse Poulos Clinic	Health Center	clinic		757.752337	470112.619059	999899.21153
47	Point ZM	Gulele	10/11/12	9	Wonda Si Heath Extention	Health Center			737.783067	469898.149582	1001253.04175
48	Point ZM	Gulele	10/11/12	9	Dil Meleliu Mekakelegna clinic	Health Center	clinic		542.732871	469824.187236	1001003.79979
49	Point ZM	Gulele	10/11/12	9	Ethio-German Pharmacy	Pharmacy	Pharmacy		45.734184	469280.725151	1000454.68812
50	Point ZM	Gulele	10/11/12	9	Central Pharmacy	Pharmacy	Pharmacy		1145.341192	470465.934701	999821.461639
51	Point ZM	Gulele	10/11/12	9	Yercaen Pharmacy	Pharmacy	Pharmacy		196.257338	470126.922876	999868.441308
52	Point ZM	Gulele	10/11/12	9	p-R-D Medhanitt Hekemena	Health Center	clinic		508.502	470074.884575	1000198.15419
53	Point ZM	Gulele	13/14	10	Haji Nure Adem/Ybahile Hekenena	Health Center	clinic		505.034663	469246.295109	1001834.90622
54	Point ZM	Gulele	13/14	10	Belese Higher Clinic	Health Center	clinic		359.179492	469432.583812	1001910.94904
55	Point ZM	Gulele	13/14	10	Kozeb Pharmacy	Pharmacy	Pharmacy		260.65332	469055.156894	1001463.59168
56	Point ZM	Gulele	13/14	10	Selam Higher Clinic	Health Center	clinic		291.32185	468869.321337	1001042.4799
57	Point ZM	Gulele	13/14	10	Boni Al Higher Clinic	Health Center	clinic		417.538772	469108.914885	1000835.34791
58	Point ZM	Gulele	13/14	10	baroo Pharmatical p.l.c	Pharmacy	Pharmacy		930.977219	468990.242347	1000707.80673
59	Point ZM	Gulele	13/14	10	Mehiret Clinic	Health Center	clinic		487.481041	469085.308573	1000677.6798
60	Point ZM	Gulele	13/14	10	Unity Clinic	Health Center	clinic		478.347982	469127.734681	1000570.12454
61	Point ZM	Gulele	19/20/21	1	KIDUS PETROS TV CENTER	Health Center	Hosepital		48315.913017	473201.63192	1002697.25723
62	Point ZM	Gulele	19/20/21	1	NOAHE CLINIC	Health Center	clinic		76.69865	473570.308831	1002465.52096
63	Point ZM	Gulele	19/20/21	1	MD CLINIC	Health Center	clinic		463.823183	473590.179963	1002245.76258
64	Point ZM	Gulele	19/20/21	1	Saniba Nekersa	Health Center			312.567517	473414.000023	1002883.00004

Record: 1 Show: All Selected Records (0 out of 65 Selected) Options

Figure 13:

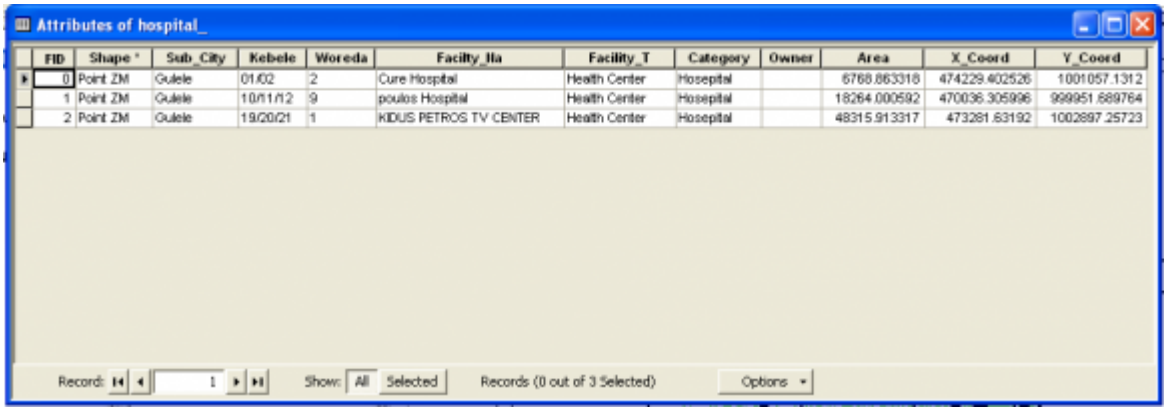


Attributes of pharmacy_

FID	Shape *	Sub_City	Kebele	Woreda	Facilty_Ha	Facility_T	Category	Owner	Area	X_Coord	Y_Coord
0	Point ZM	Gulele	19/20/21	1	Govt.Pharmacy	Health Center	Pharmacy		9.340123	473610.682864	1001960.3133
1	Point ZM	Gulele	01/02	2	Dan. Pharmacy	Health Center	Pharmacy	private	151.558363	473701.271337	1001525.48718
2	Point ZM	Gulele	03/04/05	3	M.D pharmacy	Pharmacy	Pharmacy		264.940988	473610.368706	1001365.207
3	Point ZM	Gulele	08/16	7	Kenema pharmacy health institution	Pharmacy	Pharmacy		284.895325	471226.571958	1001243.97696
4	Point ZM	Gulele	08/16	7	Golely pharmac.y h.inst	Pharmacy	Pharmacy		393.341153	470955.884116	1001377.22774
5	Point ZM	Gulele	08/16	7	Loza Pharmacy	Pharmacy	Pharmacy		1310.772653	470847.475426	1002193.87201
6	Point ZM	Gulele	09/15	8	WEDAJO PHARMACI	Pharmacy	Pharmacy		485.09139	470533.584563	1001797.95652
7	Point ZM	Gulele	10/11/12	9	LILI PHARMACY	Pharmacy	Pharmacy		500.725538	470327.787045	1000531.8564
8	Point ZM	Gulele	10/11/12	9	SOLINA PHARMACY	Pharmacy	Pharmacy		132.173173	469884.18483	1001133.2172
9	Point ZM	Gulele	10/11/12	9	FIKRE MARIAM PHARMACY	Pharmacy	Pharmacy		32.350061	469802.035875	1001035.88041
10	Point ZM	Gulele	10/11/12	9	Tiruworke Pharmacy	Pharmacy	Pharmacy		425.006744	469735.084503	1000287.77418
11	Point ZM	Gulele	10/11/12	9	Ethio-German Pharmacy	Pharmacy	Pharmacy		45.734184	469280.725151	1000454.68612
12	Point ZM	Gulele	10/11/12	9	Central Pharmacy	Pharmacy	Pharmacy		1146.341192	470465.994701	999821.461639
13	Point ZM	Gulele	10/11/12	9	Yeroam Pharmacy	Pharmacy	Pharmacy		196.257338	470126.922876	999958.441308
14	Point ZM	Gulele	13/14	10	Koseb Pharmacy	Pharmacy	Pharmacy		260.65332	469055.156894	1001463.59168
15	Point ZM	Gulele	13/14	10	berco Pharmatical p.l.c	Pharmacy	Pharmacy		930.977219	468990.242347	1000707.80673

Record: 1 Show: All Selected Records (0 out of 16 Selected) Options

Figure 14:

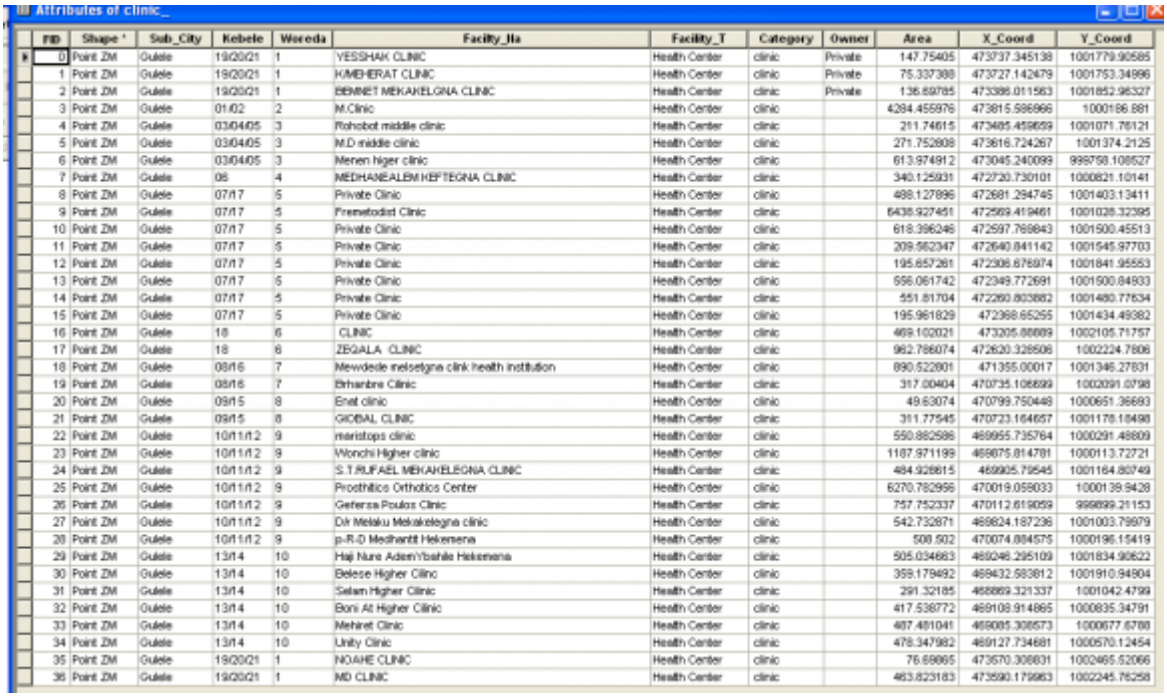


Attributes of hospital_

FID	Shape *	Sub_City	Kebele	Woreda	Facilty_Ha	Facility_T	Category	Owner	Area	X_Coord	Y_Coord
0	Point ZM	Gulele	01/02	2	Cure Hospital	Health Center	Hosepital		6768.863318	474229.402526	1001057.1312
1	Point ZM	Gulele	10/11/12	9	poulos Hospital	Health Center	Hosepital		18264.000592	470036.305996	999951.689764
2	Point ZM	Gulele	19/20/21	1	KIDUS PETROS TV CENTER	Health Center	Hosepital		48315.913317	473281.63192	1002897.25723

Record: 1 Show: All Selected Records (0 out of 3 Selected) Options

Figure 15:



Attributes of clinic_

FID	Shape *	Sub_City	Kebele	Woreda	Facilty_Ha	Facility_T	Category	Owner	Area	X_Coord	Y_Coord
0	Point ZM	Gulele	19/20/21	1	YESSHAK CLINIC	Health Center	clinic	Private	147.75405	473737.345138	1001779.90585
1	Point ZM	Gulele	19/20/21	1	KIMEHERAT CLINIC	Health Center	clinic	Private	75.337388	473727.142479	1001763.34996
2	Point ZM	Gulele	19/20/21	1	BENINET MEKAKELGNA CLINIC	Health Center	clinic	Private	136.69785	473386.011563	1001852.96327
3	Point ZM	Gulele	01/02	2	M.Clinic	Health Center	clinic		4284.455976	473815.586966	1000186.881
4	Point ZM	Gulele	03/04/05	3	Rohobot middle clinic	Health Center	clinic		211.74615	473485.459659	1001071.76121
5	Point ZM	Gulele	03/04/05	3	M.D middle clinic	Health Center	clinic		271.752808	473616.724267	1001374.2125
6	Point ZM	Gulele	03/04/05	3	Menen higer clinic	Health Center	clinic		613.974912	473045.240099	999758.108527
7	Point ZM	Gulele	06	4	MEDHANEALEM KEFTEGNA CLINIC	Health Center	clinic		340.125931	472720.730101	1000821.10141
8	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		488.127896	472681.294745	1001403.13411
9	Point ZM	Gulele	07/17	5	Premetodist Clinic	Health Center	clinic		5438.927451	472589.419461	1001028.32395
10	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		618.396248	472597.769843	1001500.45513
11	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		209.562347	472640.841142	1001545.97703
12	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		195.657261	472306.876974	1001841.95553
13	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		556.061742	472349.772691	1001500.84933
14	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		551.81704	472260.803882	1001480.77634
15	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		195.961829	472368.65255	1001434.49382
16	Point ZM	Gulele	18	6	CLINIC	Health Center	clinic		469.102021	473205.88889	1002105.71757
17	Point ZM	Gulele	18	6	ZEQALA CLINIC	Health Center	clinic		982.786074	472620.328506	1002224.7808
18	Point ZM	Gulele	08/16	7	Mewdesle melsetgna clink health institution	Health Center	clinic		890.522801	471355.00017	1001346.27831
19	Point ZM	Gulele	08/16	7	Birhanbre Clinic	Health Center	clinic		317.00404	470735.106899	1002091.0798
20	Point ZM	Gulele	09/15	8	Enat clinic	Health Center	clinic		49.63074	470799.750448	1000651.36693
21	Point ZM	Gulele	09/15	8	GIOBAL CLINIC	Health Center	clinic		311.77545	470723.164657	1001178.18498
22	Point ZM	Gulele	10/11/12	9	maristops clinic	Health Center	clinic		550.882586	469955.735764	1000291.48809
23	Point ZM	Gulele	10/11/12	9	Wonchi Higher clinic	Health Center	clinic		1187.971199	469875.814781	1000113.72721
24	Point ZM	Gulele	10/11/12	9	S.T.RUFAEL MEKAKELEGNA CLINIC	Health Center	clinic		484.928615	469905.79545	1001164.80749
25	Point ZM	Gulele	10/11/12	9	Prosthitics Orthotics Center	Health Center	clinic		6270.782996	470019.058033	1000139.9428
26	Point ZM	Gulele	10/11/12	9	Gefersa Poulos Clinic	Health Center	clinic		757.752337	470112.619059	999899.21153
27	Point ZM	Gulele	10/11/12	9	Dr Melaku Mekakelegna clinic	Health Center	clinic		542.732871	469824.187236	1001003.79979
28	Point ZM	Gulele	10/11/12	9	p-R-D Medhentit Hekensena	Health Center	clinic		508.502	470074.884575	1000196.15419
29	Point ZM	Gulele	13/14	10	Haji Nure AdemYoahle Hekensena	Health Center	clinic		505.034883	469246.295109	1001834.90622
30	Point ZM	Gulele	13/14	10	Belese Higher Clinc	Health Center	clinic		359.179492	468432.583812	1001910.94904
31	Point ZM	Gulele	13/14	10	Selam Higher Clinic	Health Center	clinic		291.32185	468889.321337	1001042.4799
32	Point ZM	Gulele	13/14	10	Boni At Higher Clinic	Health Center	clinic		417.538772	469108.914865	1000835.34791
33	Point ZM	Gulele	13/14	10	Mehret Clinic	Health Center	clinic		467.481041	469085.308573	1000677.6788
34	Point ZM	Gulele	13/14	10	Unity Clinic	Health Center	clinic		478.347982	469127.734681	1000570.12454
35	Point ZM	Gulele	19/20/21	1	NOAHE CLINIC	Health Center	clinic		76.69865	473670.306831	1002465.52066
36	Point ZM	Gulele	19/20/21	1	MD CLINIC	Health Center	clinic		463.823183	473590.179963	1002245.76258

Figure 16:

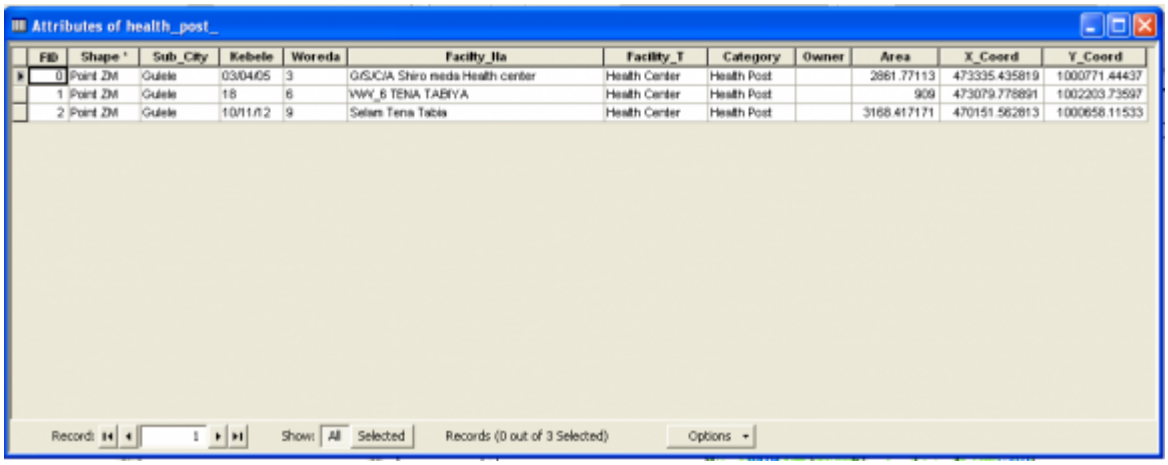


Figure 17:

1

Gulele sub-city	Population	Pharmacy	Population sharing one pharmacy
Woreda 01	29235	1	29235
Woreda 02	20932	1	20932
Woreda 03	28124	1	28124
Woreda 04	13264	-	0
Woreda 05	24495	-	0
Woreda 06	26123	-	0
Woreda 07	37066	3	12355
Woreda 08	31954	1	31954
Woreda 09	32704	7	4672
Woreda 10	23727	2	11864

Figure 18: Table 1 :

2

Gulele Subcity	Population	Clinic	Population sharing one Clinic
Woreda 01	29235	5	5847
Woreda 02	20932	1	20932
Woreda 03	28124	3	9375
Woreda 04	13264	1	13264
Woreda 05	24495	8	3062
Woreda 06	26123	2	13062
Woreda 07	37066	2	18533
Woreda 08	31954	2	15977
Woreda 09	32704	7	4672
Woreda 10	23727	6	3955

Figure 19: Table 2 :

3

Gulele Sub city	Population	Health Center	Population sharing one Health Center
Woreda 01	29235	-	0
Woreda 02	20932	-	0
Woreda 03	28124	1	28124
Woreda 04	13264	-	0
Woreda 05	24495	-	0
Woreda 06	26123	1	26123
Woreda 07	37066	-	0
Woreda 08	31954	-	0
Woreda 09	32704	1	32704
Woreda 10	23727	-	0

Figure 20: Table 3 :

.1 Acknowledgements

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