Geo Spatial Distribution and Medical Information System for Central Government Health Scheme, Bangalore

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Abstract — *Central Government Health Scheme (CGHS) is providing comprehensive medical care to the Central Government employees and pensioners enrolled under the scheme. The rapid development of GIS in various fields has not left the Medical field too. The objective of the study is to incorporate the spatial distribution and accessibility of CGHS and Medical Information System in Bangalore, India with a view of Geographic Information System (GIS) technique. Every beneficiary needs the location of CGHS and the information about necessary treatment in a health centre based on specialist services provided. The necessary data about the health care centres in the study area were collected from the CGHS and administrative map from Survey of India. The coordinates of the health care centres were obtained in the field using Global Positioning System (GPS). These data were integrated into GIS environment and analysed using ArcGIS 9.3 software.*

The study reveals that despite being laboratory facilities existing in 5 out of 10 CGHS wellness centers, there are only 2 lab technicians available for entire Bangalore. Homeopathy treatment is available only in CGHS wellness center (WC) - 01 (Shivaji nagar). WC-01 contains all kinds of treatments such as Allopathy, Unani and Homeopathy. All the specialized services (Dental, Gynecologist, Pediatrician, ENT, Eye specialist, Dermatologist, Medical specialist) are available in the CGHS Polyclinic, Shivaji Nagar.

The study also infers that there are 1,12,248 beneficiaries got treatment from various wellness centres by 35 nos. of doctors in the month of July 2017. So each doctor is giving treatment to almost 3200 beneficiaries each month. As per Medical Council of India (MCI - 2011), the doctor patient Ratio must be 1:2000, whereas the ratio is much less in all the wellness centre of Bangalore and average Doctor patient ratio is only 1:3207. It clearly indicates that the number of doctors is to be increased to 1.5 times to cater the beneficiaries of the city efficiently.

The visual map and attribute database produced in this paper would undoubtedly assist in management, planning and fostering new directions to health administration. The visual map produced depicting locations of health facilities, road linkages and capacity of each wellness centre is also an important source of information on health matters. The visual map will be useful to the public which can reduce the risk of taking patients to wrong hospitals due to not having prior knowledge of their capacities or opening hours.

Keywords — *CGHS, GPS, GIS, Geospatial mapping, doctor-patient ratio.*

I. INTRODUCTION

For the last six decades Central Government Health Scheme is the model health care facility provider who is providing comprehensive medical care to the central government employees and pensioners enrolled under the scheme. In fact CGHS caters to the healthcare needs of eligible beneficiaries covering all four pillars of democratic set up in India namely legislature, judiciary, executive and press. It is generally known that the general public does not know the location of hospitals, facilities and the kinds of specialists available in them. Such problems can be addressed effectively by mapping and creating relevant databases using a GIS. The development of GIS over time is proportional to the wide general development of the computer science.

A geographic information system (GIS) is a system designed to capture, store, manipulate, analyse, manage and present spatial or geographic data. GIS applications are tools that allow users to create interactive queries, analyse spatial information. GIS makes it possible to integrate different kinds of geographic information, such as digital maps, aerial photographs, satellite images and global positioning system data (GPS) along with associated tabular database information. GIS is one of the advanced geospatial method used in health care problems. It is used to develop and store geographic and attribute data. GIS based maps and visualizations greatly assist in understanding situations.

Through the geo-coding process with the help of GPS, a GIS allows personal health data to be examined spatially so that patterns can be discerned. Furthermore, geo-referencing of personal health data can greatly enhance decisions made by public health officials. The tremendous potential of a GIS to benefit the health care industry is just now beginning to be realized. Both public and private sectors (including public health department, public health policy and research organizations, hospitals, medical centers and health insurance organizations) are beginning to harness the data integration and spatial visualization power of a GIS [1].

GIS applications in public health include tracking of child immunizations, conducting health policy research, and establishing health service areas and districts. A GIS not only provides a way to move data from the project level to become a ubiquitous resource for an entire organization but also renders the visualization of clinical and administrative data as a spatial decision support tool.

II. LITERATURE REVIEW

The work has been carried out with implementation of GPS and GIS to locate hospital and health care centres in Aurangabad city and to provide detailed information of facilities and services [2]. The main objective of this study was to integrate information on the actual position of health centers in Aurangabad city with the services and facilities provided. In addition, this study demonstrated the function of the shortest path in network analysis for finding the nearest health care facilities from patient's location. Dijkstra's algorithm was the solution to find out the shortest route to the nearby health centres.

The geo tagging was proposed in health industry for optimum route planning of emergency vehicle and ambulance service [3]. It provided a tactical decision on which patients can board to the nearest health care centre. The spatial data (coordinates) and non coordinate data like street name, pin code were also collected to get better outcome of work. They also proposed to monitor the drugs inventory level in hospitals. A geotagged hospital information was used to share the shortfall on drug inventories between hospitals, to have better a good response of resource pooling and risk sharing. Along with other information real time stock status and closeness proximity are needed to resolve this issue.

An attempt had made to demonstrate an easy way of handling time and space in same time [4]. It detected the problems faced in the health clinic. Admission related data in hospitals were tabulated and given input to the GIS environment was an attribute database. Spatial index included postcode with attribute data and it was linked to spatial location for coverage in database. Variations in time dimension for spatial location were recorded. Integrating this database with time dimension, time-space data could be visualized and analysed. Even though it had been a hypothetical study, further new ideas can be suggested for excellence.

The spatial distribution of health facilities and their attribute information by creating a database and producing a visual map of these facilities was investigated in Yola town [5]. Twelve facilities were mapped consisting of hospitals, clinics, maternities and dispensaries using handheld Global Positioning Systems (GPS) and satellite imageries provided by Google Maps [6]. Additional information comes from questionnaires issued to the facility management and that serves as attribute data for both the database and visual map. Both attribute and spatial data are linked in AutoCad and ArcGIS environments to allow querying of information. The satellite and information technology therefore can provide ease in management of health facilities and planning for future.

III. STUDY AREA

Bangalore city officially known as Bengaluru is the capital of Indian state of Karnataka as shown in fig 1. It lies on the latitude 12° 58' 17.7564''N and longitude 77° 35' 40.42'' E. The coverage area is about 796sq.km. It is elevated over 900metres from mean sea level, the highest of India's major cities. It is enclosed by Kolar district in Northwest, Charamarajanagar district in the south and neighbouring states of Tamil Nadu. Bangalore city is referred to as the "Silicon valley of India" because of its role as the nation's leading Information Technology exporter. A demographically diverse city, Bangalore is the second fastest growing major metropolis in India. It is home to many educational and research institutions in India such as Indian Institute of Science (IISc), Indian Institute of Management Bangalore (IIMB), National Institute of Mental Health and Neurosciences (NIMHANS) etc., It has a population of about 8.52 million making it the third most populous city in India.
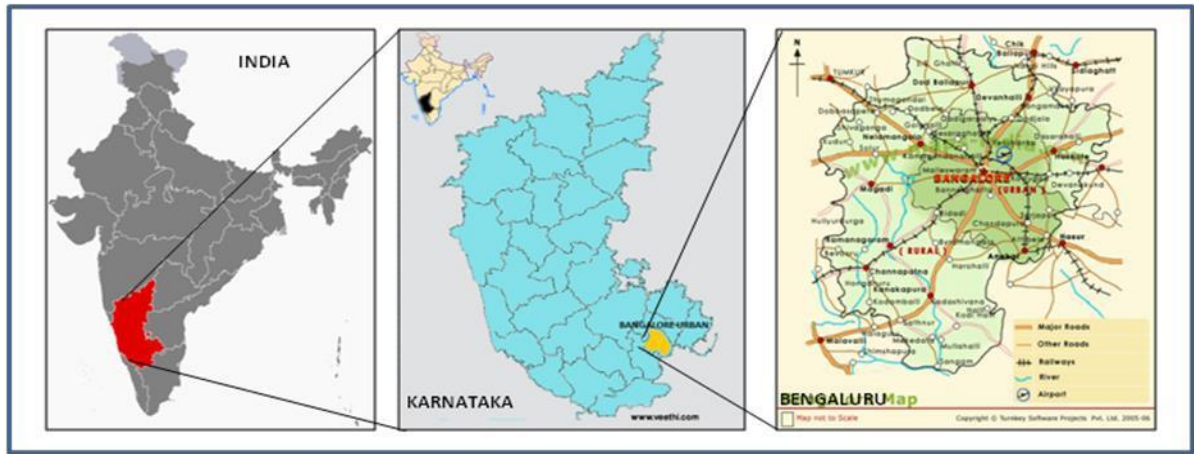
Fig 1: Location of Bangalore City

IV. METHODOLOGY

The flow chart of detailed methodology of this study is shown in fig 2. Spatial and attribute data have been collected to achieve graphical and textual output. For creation of map, spatial data is obtained by digitizing the base map of Bangalore city.
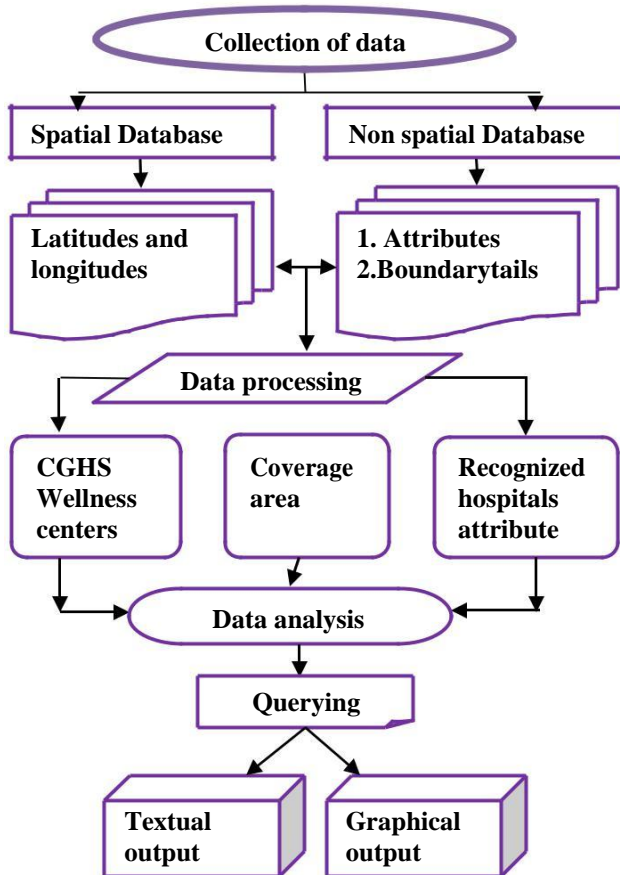

Fig 2: Flow chart of Methodology

The attribute data such as hospitals information are obtained by visiting the desired hospital and collecting the important information about the facilities provided and the specialty of hospitals etc. The attribute data like name of hospital, contact number specialty, site address etc., are needed to be stored in the separate database.

A. Collection of Data:

Topomap of Bangalore city is obtained from the Karnataka GDC, Survey of India, Bangalore, having Scale 1:50000 map scanned, which is considered as the base map for further work. The coordinates of each wellness centers and recognized hospitals are determined using the handheld GPS. To know the necessary information and details about each wellness centers and CGHS recognized hospitals, questionnaires are prepared and data collected through them. Total number of Card holders in various wellness centres of Bangalore is shown in Table 1. The questionnaires contain information such as the health centre name, website address, contact number, locality, type of dispensary (Allopathy, Ayurvedic, Unani, Homeopathy), specialized services available, laboratory facilities, availability of equipment, working hours, number of doctors, number of supportive staffs and bus routes etc.

Table 1: Number of CGHS Card Holders in Bangalore

Sl. No.	Place of Wellness Centre	Nameof WC	Serving	Pensioners	Freedom Fighters	MPs	Ex.MPs	Others	Total
1	Shivaji Nagar	(WC -1)	1559	1680	6		11		3256
2	Malleswaram	(WC -2)	1723	2054	50		11		3843
3	Banashankari	(WC -3)	1291	1825	8		3	5	3130
4	Ulsoor	(WC -4)	1788	926			1	3	2717
5	Vijaya Nagar	(WC -5)	2321	2490			4	2	4905
6	Jaya Nagar	(WC -6)	1015	2131	6		5		3168
7	Koramangala	(WC -7)	2636	1860	11		2	11	4510
8	Domlur	(WC -8)	1678	1275					2962
9	Gangenahalli	(WC -9)	2947	2818	1	1	10	12	5789
10	D.R.D.O.	(WC -10)	4233	1593	1			1	5828
Grand Total			21191	18652					40108

B. Data Processing:

Topo map of Bangalore city has been scanned and on screen digitization done using ArcGIS 9.3. The spatial features such as roads digitized as lines and Health Facilities as points. The spatial data are organized in layers, and the ability to query has made possible using the query builder in ArcGIS. Attribute data that need to be stored in the database are name and length of roads and name of hospital and their facilities. Geo-database has been created by integrating actual positions of health care centers (i.e. longitude and latitude observed by GPS) with the health care data collected as shows in Fig 3. During the data processing stage, the spatial data and the associated attributes are combined together into a single system using GIS. Based upon the coordinates the actual position of the health centers are mapped using GIS Software ArcInfo.

C. Data Analysis:

SQL Queries are generated after the attributes were added to the map. Some of the queries that were made: 1) How many CGHS recognized hospitals are there near koramangala within a range of 1km? 2) What are the eye specialized CGHS recognized hospitals available in Bangalore? 3) In which CGHS well center is Homeopathy available? 4) What are the localities uncovered by the CGHS wellness centers in Bangalore? 5) What are all the localities covered by the CGHS wellness centers and recognized hospitals?

V. RESULTS AND DISCUSSIONS

A visual map containing information about CGHS health centers and CGHS referral hospitals that a beneficiary requires is produced using the coordinates and the attributes collected from the health centers and the information retrieved from the queries. The coordinates of the health centers are taken using handheld GPS and mapped. The attributes are collected from the questionnaires prepared and given to the health centers. These attributes are fed in ArcGIS and the querying of the data was made. Boundary detailing (coverage area) of the wellness centers data are collected and mapped for wellness center-7 (Koramangala).
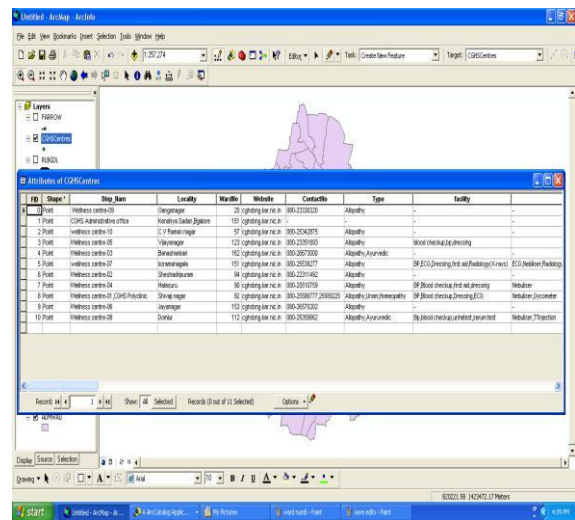

Fig 3: Spatial and Attribute data of CGHS Health Centre

Table 2: Attribute Data of Various Wellness centre

Sl. No.	Particulars	WC-1	WC-2	WC-3	WC-4	WC-5	WC-6	WC-7	WC-8	WC-9	WC-10
1	Type of dispensary	Allo pathy, Unani, Homeo pathy	Allo path y	Allo pathy, Ayur vedic	Allo pathy	Allo Pathy	Allopat hy	Allopathy	Allo pathy, Ayur vedic	Allo pathy	Allo pathy
2	Specialized services	Dental Nodal Gyno	-	Derma tology	ENT spl	Dermato logy Medical specialist	Medical spl	Eye spl Psychiatrist Child Spl Physician	Pediatri cian	Pediat rician	Nodal medical spl ENT
3	Laboratory facilities	BP, blood checkup, dressing	-	-	BP, blood checkup, dressing	BP, blood checkup, dressing	-	BP, blood checkup, dressing, Radiology	BP, blood check up, dressing	-	-
4	Equipment available	ECG	-	-	Nebu lizer	-	-	ECG, Nebulizer	Nebulize r	-	-
5	Number of doctors	3	3	3	4	4	3	4	3	4	4
6	Number of Pharamacist	3	3	3	3	3	3	4	3	4	4
7	Number of Nurse	1	1	1	1	1	1	1	1	1	1
8	Lab Tech	-	-	-	-	1	-	-	1	-	-
9	Radiographer	-	-	-	-	-	-	1	-	-	-

Table 3: Total Numbers of Beneficiaries in the month of July 2017

Sl. No.	Name of Wellness Centre	Total No. of Doctors	Total No. of Card Holders	Serving	Pensioners	Freedom Fighters	MPs	Ex. MPs	Others	Total No. of Beneficiaries treated	Doctor Patient Ratio
1	Shivaji Nagar	3	3256	4592	2629	7		19		7247	1:2416
2	Malleswaram	3	3843	6420	4185	86		24	16	10731	1:3577
3	Banashankari	3	3130	4834	3612	9		5	6	8466	1:2826
4	Ulsoor	4	2717	6473	1785			2	2	8262	1:2066
5	Vijaya Nagar	4	4905	8580	5204				14	13798	1:3450
6	Jaya Nagar	3	3168	3522	4082	8		13	24	7649	1:2550
7	Koramangala	4	4510	9023	3717	16		3	1	12760	1:3190
8	Domlur	3	2962	5854	2537					8391	1:2797
9	Gangenahalli	4	5789	6396	10675	2	2	23	26	17124	1:4281
10	D.R.D.O.	4	5828	14338	3480	1			1	17820	1:4455
	Grand Total	35	40108	40108	41906	129	2	89	90	112248	1:3207

Table 2 shows that there are totally 35 Doctors, 33 Pharmacist, 10 Nursing Staff, 2 Lab technicians, 1 Radiographer in the wellness centers. Though 5 numbers of laboratory facilities out of 10 CGHS wellness centers, there are only 2 lab technicians available for whole Bangalore. Homeopathy is available only in CGHS wellness center-1. All the specialized services (Dental, Gynecologist, Pediatrician, ENT, Eye specialist, Dermatologist, Medical specialist) are available in the CGHS Polyclinic. From the queries developed after feeding the data in the software, which gives the suggestion to have CGHS wellness center in the uncovered areas of the Bangalore city from which the beneficiaries would be benefited. These facilities must reach all the beneficiaries of Bangalore City.

Table 3 shows that there are 1, 12, 248 beneficiaries got treatment from various wellness centres by 35 doctors. So each doctor is giving treatment to almost 3200 beneficiaries each month.

As per Medical Council of India (MCI - 2011), the doctor patient Ratio must be 1:2000, whereas the ratio is much less in all the wellness centre of Bangalore and average Doctor patient ratio is only 1:3207. It clearly indicates that the number of doctors is to be increased to 1.5 times to cater for the beneficiaries efficiently.
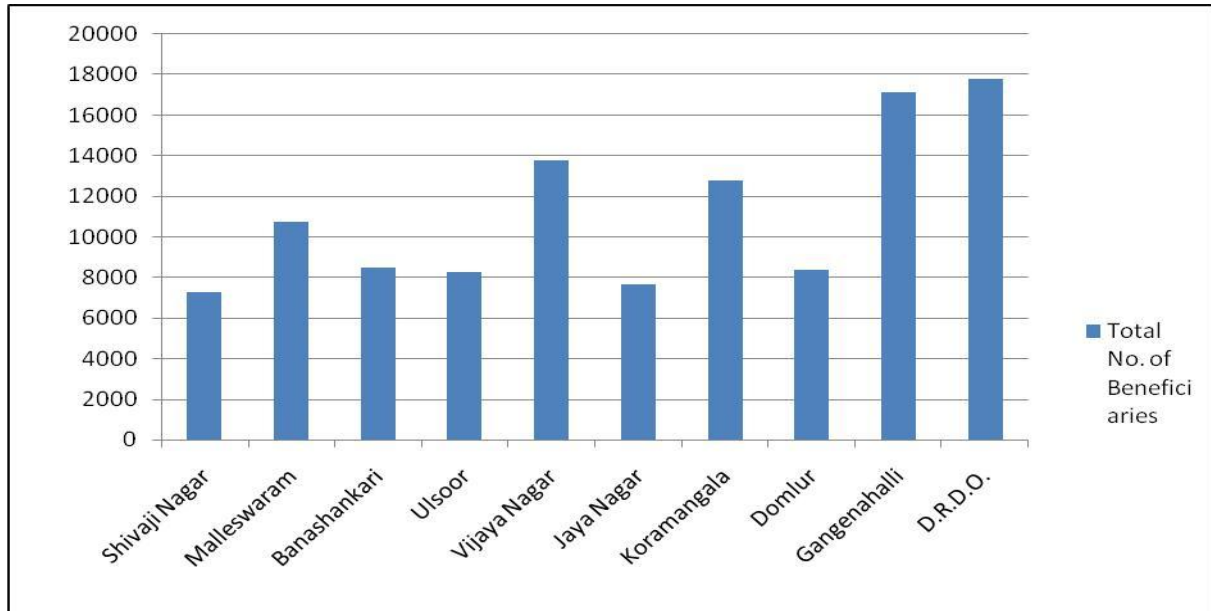

Fig 4: Total Number of Beneficiaries treated in July 2017

It is seen from Fig 4 that over 10,000 beneficiaries each visited Malleswaram, Vijaya Nagar, Koramanagala, Gangenhalli and DRDO Wellness centres for treatment in the month of July 2017. The total number of card holders are more for these wellness centres in Bangalore. But the doctor patient ratio is about 1:4000 which is much less than 1:2000 as prescribed by MCI in Gangenhalli and DRDO wellness centres. It gives an indication to the CGHS administration to improve the above ratio especially in these wellness centres.

Query 1: How many CGHS recognized hospitals are there near koramangala within a range of 1km?

The coverage area of CGHS recognized hospitals within the range of 1km as shown in fig 5 for Koramangala ward. There are seven recognized hospitals (indicated in blue dots) around the koramangala coverage area. Beneficiaries residing in koramangala can make usage of these recognized hospitals. Beneficiaries from CGHS Wellness center-7 (Koramangala) can avail the facilities in recognized hospitals which are not available in wellness center.
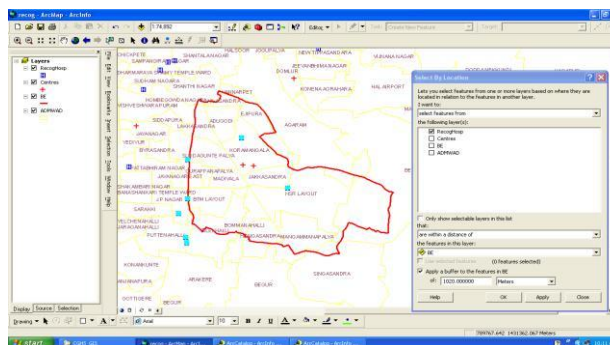

Fig 5: CGHS recognized hospital in Koramangala

Query 2: What are the eye specialized CGHS recognized hospitals available in Bangalore?

Specialized treatments like Cataract or Glaucoma, Retinal & Vitreo-Retinal surgery except corneal transplant surgery, Strabismus, Occuloplasty, Adnexa can be done in these four CGHS recognized eye care

hospitals indicated in pink dots as shown in fig 6, for more advanced treatments referred by the CGHS wellness centres.
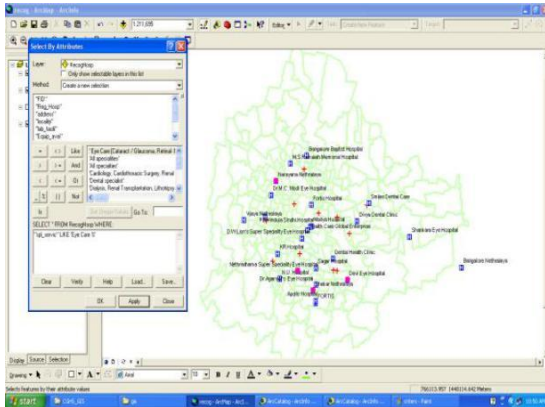

Fig :8 CGHS Wellness center with Homeopathy

Fig 6: Eye care hospitals referred to CGHS system Wellness center.
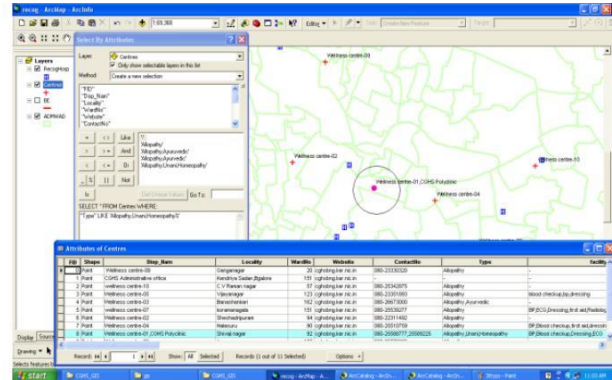
Query 3: What are the localities uncovered by the CGHS wellness centers in Bangalore?

There are about ten CGHS wellness centers and one polyclinic in Bangalore city, each of the wellness centers covers an area of about 3km radius around them, for the beneficiaries to make use of the near by wellness center in their locality. While doing query about the coverage area of the wellness centers there are certain areas which does not come under the coverage area indicated in orange colour as shown in fig 7. The beneficiaries in these uncovered areas finds it difficult to travel a long distance to come to the near by wellness centers. This can be avoided by having a new wellness center in any of these uncovered areas for the betterment of the beneficiaries.
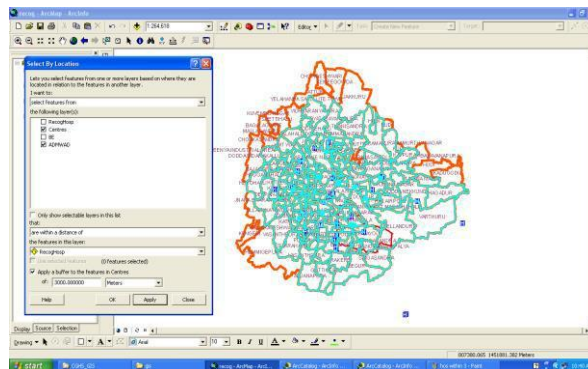

Fig :7 Uncovered areas of CGHS Wellness centers

Query 4: In which CGHS well center is Homeopathy available?

The only CGHS Wellness center that has homeopathy system of treatment is wellness center (WC) -01 (Shivaji nagar). WC-01 contains all kinds of treatments such as Allopathy, Unani and Homeopathy. The people interested in taking Homeopathy treatment and medicine can approach this centre. This center is highlighted by encircling it as shown in fig 8.

Query 5: What are all the localities covered by the CGHS wellness centers and recognized hospitals?

Red and blue plus sign represent CGHS wellness centres and recognized hospitals respectively. Minor and access road networks in the city links these health facility centres as shown in fig

9. There are more CGHS recognized health facilities 16 (61.54%) than CGHS wellness centres 10 (38.46%). The CGHS recognized hospitals with all facilities are located all over the city for the beneficiaries. The database query using attribute data shows in fig 8 the names of the CGHS wellness centre and recognized hospitals facilities. It is also possible to query the database spatially. In this case, the spatial map is generated showing locations of facilities and highlighting what is queried.
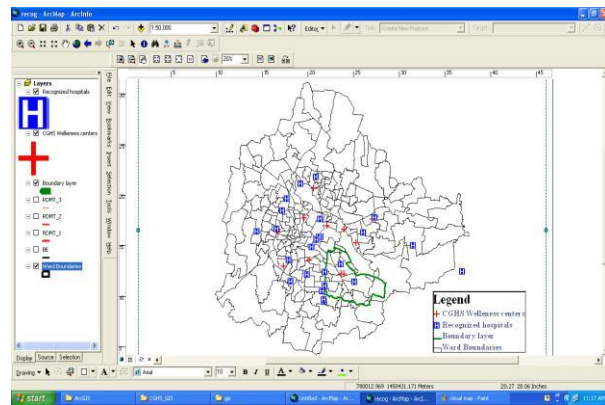
Fig 9: CGHS Wellness centers and the CGHS recognized hospitals

CASE STUDY

Let us consider the case of a CGHS beneficiary who is residing in Shivaji Nagar or near to it, experiences symptoms such as chest pain, shortness of breath indicating Cardiac problem for the first time. Since he is not a diagnosed Cardiac patient, uncertainty of his state he wants to find out if he needs to see a

Cardiologist or not, he can search the Medical GIS as shown in fig 10 for a CGHS center with ECG facility which is also close to a recognized hospital in the event of his need emergency hospitilazation.
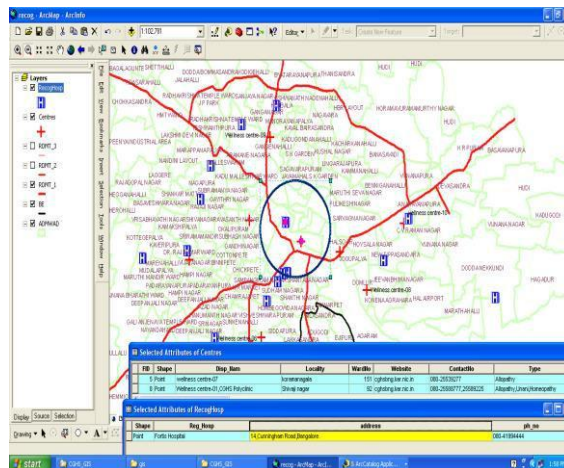

Fig : 10 CGHS wellness center with ECG facility.

VI. CONCLUSION

Facilities available at CGHS centres vary from centre to centre, and also the kind of treatment. Beneficiaries can use the results of Medical GIS to locate the centre with the most suitable / necessary kind of treatment on an event by event basis. Since the GIS also gives information about the specialists available at different centres and the timings, beneficiaries can make informed and planned visits to the centres. Since CGHS recognizes only specific hospitals for specific purposes, beneficiaries are often not confident of which recognized hospital to go for the treatment they need. Medical GIS of CGHS will enable them to make confident and quick decisions as it provides not only details of recognized hospitals and procedures but will also

spatially enable them to choose based on proximity and approachability of the hospital.

Most importantly as highlighted by the case study, in an emergency, medical GIS will prove to be life saving since it helps the patient and the caregiver to take vital decisions regarding reaching the right centre and recognized hospital in the shortest possible time. Patient details specifying age, ailment, medication, mortality, when input into a medical GIS will aid the administration to analyse the spectrum of beneficiaries availing different facilities treatment / medication or undergoing specific procedures with respect to different parameters such as age group, geographic location, gender etc. Such analysis will enable the administration to effectively distribute centres, facilities. It will also help

administration in selection of hospitals for recognition. Further analysis on patient healthcare will help improve awareness programs as well as take preventive steps so that the general health of beneficiaries will improve, which is the aim of the CGHS.

This is a sample medical GIS project done for the Central Government Health Scheme. If the full-fledged GIS is created, it will be useful for the beneficiaries, management, and the Government. It helps the government to improve the health care facilities for government employees.

ACKNOWLEDGMENT

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