APPLICATION OF GIS IN HEALTHCARE SECTOR IN TAMIL NADU

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ABSTRACT

The purpose of our project is to apply the tool of Geographic Information System (GIS) in study area of facilities and process planning for the betterment in the healthcare sector of Tamil Nadu. The project aims to carry out work to find the optimized suitable location for government healthcare facilities in the state by cumulating the information obtained from GIS and correlating it with the data obtained from various sectors of Tamil Nadu and then implementing statistical tools of standard deviation and variance. Hence this project will be an initial and a critical step to select an optimized and an organized location from the results obtained thereby developing the heath care sector in Tamil Nadu.

Keywords: Geographic Information System, planning, mapping, healthcare, facilities

INTRODUCTION

A geographic information system (GIS) is a system used to design, capture, manipulate, store, manage, and analyze all types of geographical data. GIS applications are tools that allow users to create queries which are interactive , help in analyzing spatial information , correlate and edit the data in form of maps and finally conclude presenting the results of all these operations[1].GIS is also referred as geographic information science (GI Science) the science underlying geographic concepts, applications, and systems[2].

This data is usually combined with tabular data which is known as attribute data .Attribute data is basically appended in Tabular format to spatial features. A typical example of this would be market. The appropriate location of the market is the spatial data. Additional data such as the market products, stock capacity would make up the attribute data [3].

It is the cumulation of these two data types that makes GIS an effective tool in the area of facilities planning through spatial analysis [4]. GIS cannot be considered just software because people and numerical methods are combined along with the software to enable spatial analysis, manage big data and display information by mapping [5].

GIS finds its importance in both problems solving as well as decision making processes, as well as for visualization of data in a spatial environment. It can be used to determine (1) features location as well as also for those linked to it, (2) where there is an actual need of location, (3) density of the given features within the given boundary, (4) detailed information about ongoing activities in the vicinity (5) detailed information about the activities in the neighbourhood, and (6) and how a specific area has improved or deteriorated over time by studying the causes for the same [6-8].

STUDY AREA

The study area is the southern state of Tamil Nadu in India. The states' coordinates are 11.1271° N, 78.6569° E. Tamil Nadu, being a coastal state is prone to various water-borne diseases like cholera, acute diarrhoeal diseases (ADD) etc. The state is having 33 districts and a population of 6.79 Crores as in 2012. The sex ratio is 996 females per 1000 males, the population density is 555 and literacy rate of the state is 80.09%.

METHODOLOGY

The objective of our paper is to determine the best location where our healthcare facility can be located using GIS. Hence we have carried out a simple statistical approach for accomplishing the same. This model follows four basic steps

Step1: The first step of our model involves gathering data from various districts of Tamil Nadu [9]. This data includes the number of cases of Actual Diarrhoea disease and cholera as well as the number of deaths caused by the same. Given below is the data list.

Sn No	Districts	2006		2007		2008		2009		2010		2011		2012		2013	
		Cs	Ds	Cs	Ds	Cs	Ds	Cs	Ds	Cs	Ds	Cs	Ds	Cs	Ds	Cs	Ds
1	Kancheepuram	3402	0	1649	2	1576	1	1855	3	545	3	8639	1	2436	1	4725	2
2	Tiruvellur	6606	0	6420	0	6655	4	4823	0	8583	0	5764	2	4740	0	4726	5
3	Cuddalore	7217	2	8758	2	8522	10	7459	2	6124	1	16440	4	20875	0	31026	1
4	Vilipuram	1850	2	955	2	787	7	12219	2	655	5	4890	5	11549	0	10759	2
5	Vellore	3400	0	3805	4	3871	5	2700	0	3355	1	10840	0	11241	0	9644	3
6	T.V.Malai	6499	1	6425	2	7311	0	7371	1	9423	0	10963	1	12497	0	12754	1
7	Dharmapuri	7	0	1	0	57	3	124	0	106	3	3471	0	209	2	179	0
8	Krishnagiri	251	3	160	1	115	1	62	1	260	8	3171	0	5248	2	4120	4
9	Salem	27	0	11	0	4	3	7021	2	268	0	9524	0	10185	0	2792	2
10	Namakkal	497	1	501	3	287	0	245	1	12	0	92	1	166	0	102	0
11	Erode	1509	2	495	0	1622	0	1461	0	814	0	6284	0	5171	0	4040	0
12	Coimbatore	1846	1	1374	0	1447	0	835	0	538	0	2897	0	2243	0	1645	0
13	Tiruppur			0	0	0	0			539	0	301	0	61	0	609	0
14	The Nilgiris	0	0	0	0	34	0	97	0	0	0	3713	0	6698	0	4246	0
15	Tiruchi	1368	1	2482	2	5324	0	4648	0	5218	3	18151	0	15459	1	14097	0
16	Karur	522	1	0	0	0	0	656	1	34	0	1954	0	1713	0	1581	0
17	Perambalur	596	0	156	1	199	4	169	3	230	0	15386	0	12439	0	13002	1
18	Pudukotai	319	3	601	2	418	0	335	1	32	0	12216	1	7157	0	5214	0
19	Thanjavur	199	1	175	0	625	0	1760	0	715	1	1070	3	1113	2	1481	2
20	Tiruvarur	273	0	15	0	61	1	6852	0	419	1	10856	0	9597	0	11435	0
21	Nagapattinam	500	0	21	0	1611	3	3	0	0	0	844	0	451	0	1185	0
22	Madurai	6424	1	7247	2	7416	7	7528	0	7433	2	6084	1	7166	2	4524	0
23	Theni	366	0	22	0	159	1	3062	0	6540	5	5333	0	5079	0	4252	0
24	Dindugal	2804	0	3211	2	4351	3	4467	1	5363	5	5931	3	5334	3	4551	0
25	Virudunagar	1015	0	347	0	561	2	1212	0	2009	1	2417	0	2640	3	2236	1
26	Ramanathapuram	608	0	113	0	286	2	750	1	82	2	1196	0	3251	0	3229	0
27	Sivaganga	739	0	1294	1	1316	2	1356	0	1424	1	1440	0	1184	0	1427	0
28	Tirunelveli	878	1	0	0	172	1	37	0	251	1	4187	2	4951	1	5833	0
29	Tuticorin	1085	2	1178	0	1797	2	1361	2	656	2	1330	0	1529	0	1916	0
30	Kanyakumari	11	0	5	0	1500	1	5608	0	0	0	2887	0	1427	0	1172	0
31	Chennai	1683	0	2499	0	2211	2	2670	0	1150	0	31803	0	26121	0	20786	0
	Total	52555	22	49920	26	60325	63	88746	21	62778	45	210074	24	199930	17	189288	24

Source: Department of Public Health and Preventive Medicine, Govt of Tamil Nadu

Fig. 1: Cases of cases and deaths in Tamil Nadu due to Acute Diarrhoeal Diseases (ADD)

STEP2: The second step is the selection process. Now in order to get the best results we need to locate the facilities in an area which is more prone to cases and deaths. Hence we selected three regions with the maximum cases namely Cuddalore, Vellore and Tiruchi districts. Out of these three we need to find the best district where our facility can be located [10].

STEP3: After collecting the data we have focused these three areas. We have followed a simple statistical approach . The statistical tools used in our paper are Mean, Standard deviation and Variance. The purpose of using these tools is to calculate which area out of the three is more prone to such cases in the given period of years and also to measure how much deviation is there from the mean . The image below represents the calculations carried out .

S NO		YEAR	CASES	DEATHS	DEVIATION ABOUT THE MEAN	F^2(CASES)	DEVIATION ABOUT THE MEAN ([	H^2 (DEATHS)
1	CUDDALORE DISTRICT							
		2006	7217	2	-6085.625	37034831.64	-0.75	0.5625
		2007	8758	2	-4544.625	20653616.39	-0.75	0.5625
		2008	8522	10	-4780.625	22854375.39	7.25	52.5625
		2009	7459	2	-5843.625	34147953.14	-0.75	0.5625
		2010	6124	1	-7178.625	51532656.89	-1.75	3.0625
		2011	16440	4	3137.375	9843121.891	1.25	1.5625
		2012	20875	0	7572.375	57340863.14	-2.75	7.5625
		2013	31026	1	17723.375	314118021.4	-1.75	3.0625
		AVG	13302.625	2.75				
		VARIAN(	68440680	8.6875				
		SD	8272.8882	2.94746				
2	VELLORE DISTRICT							
		YEAR	CASES	DEATHS	DEVIATION ABOUT THE MEAN	F^2	DEVIATION ABOUT THE MEAN ([	H^2 (DEATHS)
		2006	3400	0	-2707	7327849	-1.625	2.640625
		2007	3805	4	-2302	5299204	2.375	5.640625
		2008	3871	5	-2236	4999696	3.375	11.390625
		2009	2700	0	-3407	11607649	-1.625	2.640625
		2010	3355	1	-2752	7573504	-0.625	0.390625
		2011	10840	0	4733	22401289	-1.625	2.640625
		2012	11241	0	5134	26357956	-1.625	2.640625
		2013	9644	3	3537	12510369	1.375	1.890625
		AVG	6107	1.625				
		VARIAN(	12259690	3.73438				
		SD	3501.3839	1.93245				
3	TIRUCHI DISTRICT							
		YEAR	CASES	DEATHS	DEVIATION ABOUT THE MEAN	F^2	DEVIATION ABOUT THE MEAN ([	H^2 (DEATHS)
		2006	1368	1	-6975.375	48655856.39	0.125	0.015625
		2007	2482	2	-5861.375	34355716.89	1.125	1.265625
		2008	5324	0	-3019.375	9116625.391	-0.875	0.765625
		2009	4648	0	-3695.375	13655796.39	-0.875	0.765625
		2010	5218	3	-3125.375	9767968.891	2.125	4.515625
		2011	18151	0	9807.625	96189508.14	-0.875	0.765625
		2012	15459	1	7115.625	50632119.14	0.125	0.015625
		2013	14097	0	5753.625	33104200.64	-0.875	0.765625
		AVG	8343.375	0.875				
		VARIAN(	36934724	1.10938				
		SD	6077.3945	1.05327				

Fig. 2: Manual Numerical Calculations for finding the most suitable location for health care facility for Acute Diarrhoeal Diseases (ADD).

Step 4: This is the final step which is the conclusion drawn from the above results .The following numerical results was obtained for the Cuddalore District:

Mean (for cases):13302.625 and Mean (for deaths):2.75

**Variance (for cases):68440680 and variance (for deaths):8.6875**

Standard Deviation (for cases):8272.8882 and Standard Deviation(for deaths):2.94746

From the above results we interpret and conclude that Cuddalore district is facing the most difficulties and is most prone disease area. Hence we need to locate our district in this district out of the other districts in Tamil Nadu to get the best outcome.

EXPERIMENTAL WORK

After getting the numerical data for all the districts, the geographic information was mapped by using ArcGIS Software. Different GIS layers were used in the study including the population density and the existing healthcare facilities in the region [11]. The study showed that the ADD and Cholera are more common in female worker population in Tamil Nadu. Therefore GIS map for female workers density were drawn using different layers. (Fig.3)
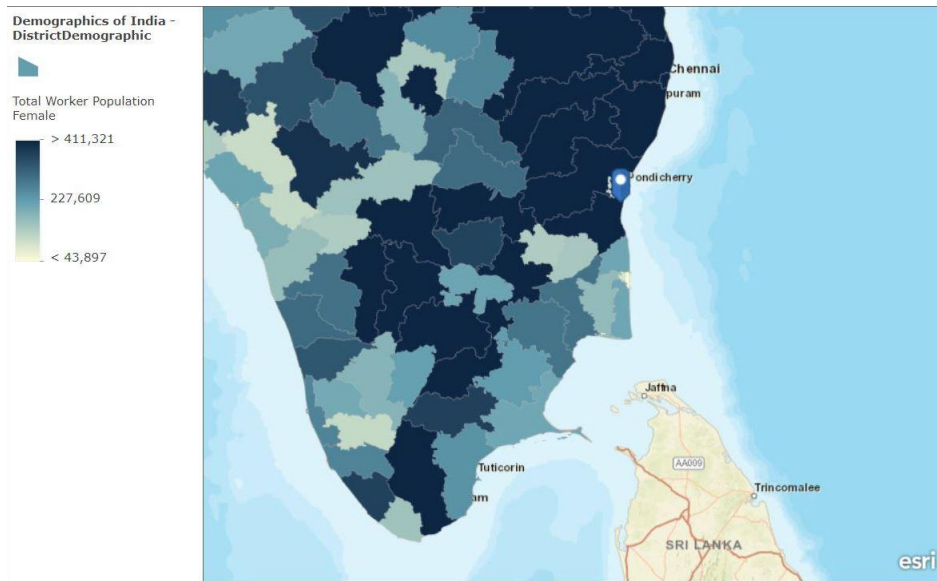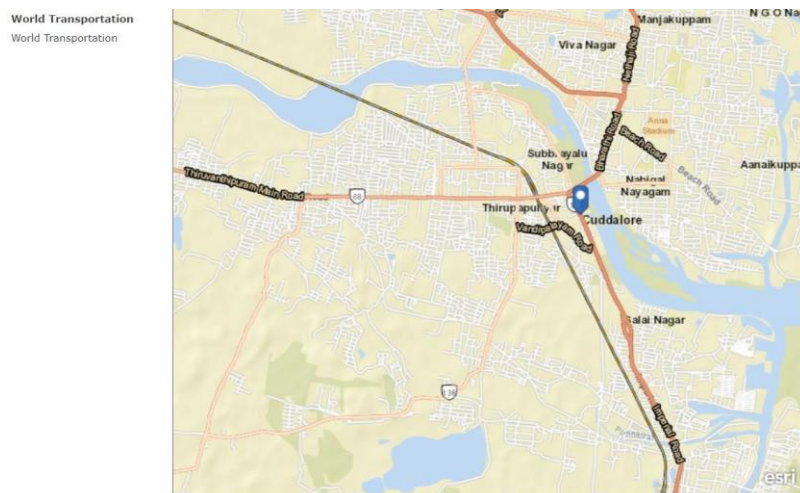
Fig.3: GIS map showing the population density of female workers in and around Cuddalore, Tamil Nadu.

The healthcare facility location should be well connected to highways and railway. Therefore using transportation layers in GIS tool the transportation maps in and around Cuddalore were drawn. (Fig.4)
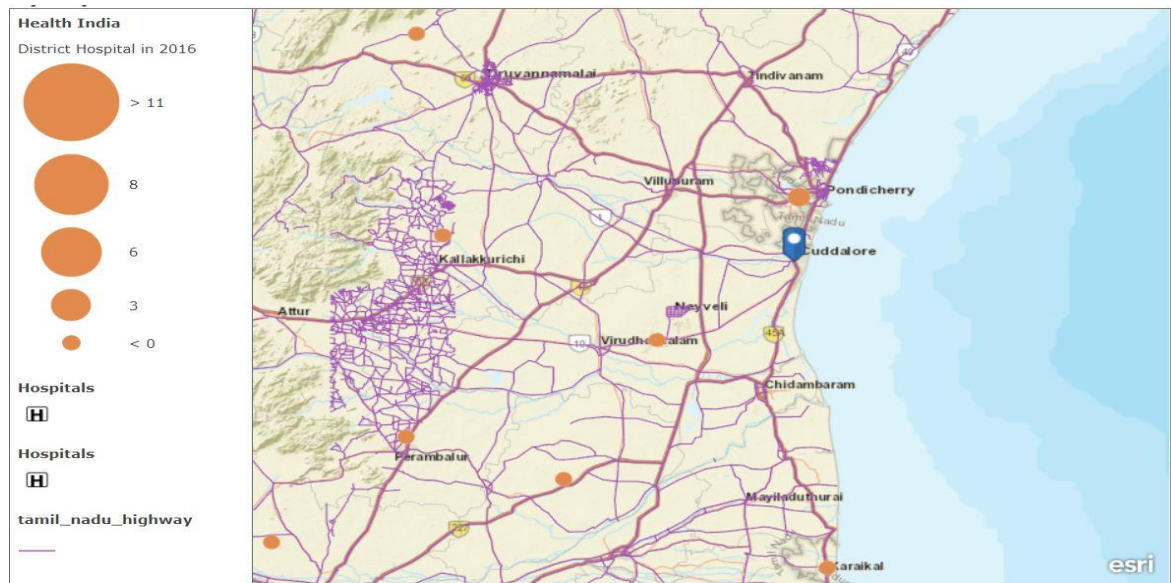

Fig. 4: GIS map showing the presence of highways and railway in Cuddalore, Tamil Nadu.

The next step is to determine the location of existing healthcare facilities around Cuddalore. For this we used the layer Health India to draw the map along with Tamil Nadu Highway layer and then superimposed the maps [12-13]. (Fig.5)

Fig. 5: GIS map showing the highways and existing health care facilities in and around Cuddalore, Tamil Nadu.

RESULTS AND DISCUSSIONS

The most suitable location for the establishment of healthcare facility for acute diarrhoeal diseases was found to be the Cuddalore District in Tamil Nadu. Several layers were added on ArcGIS and the maps were overlapped [14-15]. It is well connected to roadways and railways with frequent occurrence rates of transport. The establishment of healthcare facility will impact most number of patients and will prove to be beneficial and efficient use of public money.

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