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GIS TECHNOLOGY FOR HEALTHCARE SERVICE: PLANNING & EVALUATING OUTREACH

Public Health

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ABSTRACT

Geographic information systems (GIS) is an effective tool for determining the best locations for future healthcare facilities. An increasingly important form of analysis in health information systems involves the analysis of geographic distribution and trends in health service delivery. Geographic information systems software helps map the spatial distribution and coverage of health services and as a tool to identify geographic areas to target for health service development activities. The objectives of this study are to analyze the geographic distribution of the public health facilities in the Dahod District of Gujarat. The listed healthcare facilities of Dahod district were covered for data collection. The data includes detailed survey and collected GIS coordinates Using Global Positioning System (GPS) technology.

The collected Latitude and Longitude through a ground survey of every health facility were transferred into GIS software for mapping health facilities of Dahod in the state of Gujarat, India for the year 2020. The Dahod district is divided into 7 sub-districts/blocks. In the district total of 21 Community Health Centers (CHC's), 97 Public health Centers (PHC's) and, 637 Sub Centers (SC's) are operating. The GIS-based methods used in this study show how this methodology can be utilized for planning the location of new health facilities across a range of geographical terrains and regions, including hilly, tribal, and remote areas. Analysis reveals that some talukas have a clustering of health facilities while the other talukas have evenly distributed health centers.

KEYWORDS

Healthcare System, Healthcare Service, Healthcare Facility Planning, Accessibility, Public Health, Demography, Tribal, GIS, Mapping, GPS

INTRODUCTION:

The World Health Organization defines Health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (Oleribe et al., 2018). From this definition, it is clear that health care must include not only the organization and nursing services but also prevention of diseases by effectively controlling the communicable diseases, the sanitation of the environment, and educating the people about the personnel hygiene including the enhancement and meeting of the nutritional needs of the community. Health problems, issues, and concerns that transcend national boundaries, which may be influenced by circumstances or experiences in other countries, and which are best addressed by cooperative actions and solutions. At least half of the world's people still lack full coverage of essential health services. The Alma Ata Declaration in 1978 expanded the approach to "improving health for all people" from the focus on doctors, hospitals, and biomedical advances to include human rights, concern for equity, and community participation (Rifkin, 2018). As per the World Health Organization report, A health system consists of all organizations, people, and actions whose primary intent is to promote, restore or maintain health. Health systems have multiple goals. (a) Refining the health resources and carefully using the health resources so that they should be economically viable to all groups of people. (b) Some of the instant goals are: to provide quality and safe treatment, to have a very good network between beneficiaries and health facilities, and cover the whole population for better health (WHO, 2007). For Achieving universal health coverage (UHC) many countries experiences using an analytical framework that examines effective coverage in relation to the availability, accessibility, acceptability, and quality (AAAQ) of Human Resources for Health (Campbell et al., 2013).

The Sustainable Development Goals, also known as the Global Goals, were adopted by all United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. While SDG 3 is a standalone goal focusing on ensuring healthy lives and wellbeing, but there are also more than 40 SDG indicators that are directly/indirectly related to health indicators. For effective monitoring of SDG 3 and the health indicators associated with other SDGs, the current status of the 45 National Health Indicators is depicted under, Target 3.8: Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all (Government of India, 2019). In low and Middle-income countries Health care can be provided through public and private providers. Public health care is usually provided by the government through national healthcare systems. Private health care can be provided through "for profit" hospitals and self-employed practitioners, and "not for profit" non-government providers, including faith-based organizations (Basu et al., 2012). The study of the English Physician John Snow in 1854 was a milestone towards this direction. It led to the detection of the source of infection in a cholera epidemic that broke out in London. Having mapped the locations of those individuals who were affected, he concluded that contaminated water was the cause of the outbreak [Fradelos et al., 2014]. Healthcare access is crucial to improving physical and mental health, preventing disease and death, extending life, and improving quality of life. Access to healthcare is commonly defined geographically, economically, or culturally (Gulliford et al., 2002) (Health and Places Initiative, 2014). GIS technology can be used to enhance functional accessibility in developing country mountain areas (Perry & Gesler, 2000). Epidemiologists have traditionally used maps when analyzing associations between location, environment, and disease. Geographic Information System (GIS) is particularly well suited for studying these associations because of its spatial analysis and display capabilities. GIS allows the analysis of data generated by global positioning systems (GPS) (de Lima et al., 2016). The government of Orissa under NRHM has integrated GIS-based models with health care planning to locate new blood banks and blood storage facilities [Mithun Karmakar, (2010)]. using Quantum GIS analyzed the relationship between mosquito breeding places, the use of insecticide-treated nets, the use of anti-mosquito substances, the habit of going out at night, and the presence of farm animals; and malaria incidence; and examine a map of malaria distribution in Gorontalo regency. The distribution maps of malaria (Ahmad et al., 2018) effectiveness of floating catchment area (FCA) approaches, which are often used as geographical accessibility measures in Germany, to assess its need for medical services in the outpatient field (Bauer et al., 2020).

Socio-economic factors contributing to the accessibility and the availability of facilities in the urban population resulting in a reduction of health equities (Cereijo et al., 2019). The coordinates of health facilities, as well as demographic, altitude, and field data, were used to model HC availability using GIS. Two possibilities for population travel time to HC were considered: (1) Driving and (2) Walking are two of the most common modes of transportation. When measured through walking and driving transit time distance (Dos Anjos Luis & Cabral, 2016). GIS tools while planning the distribution of health care facilities focuses on increasing access (mean travel time or distance to health facilities) or increasing coverage (the proportion of the population within a distance/travel time threshold to a facility) of healthcare (Gambhir, 2013). In determining the poor accessibility regions, the planned SE2SFCA pattern is considered to be useful. It explores the extrapolation difficulties in the aftermath of giving rising healthcare availability to areas with high healthcare and dense population (Kim et al., 2018). GIS was being used to interpret spatially and attribute data in public health facilities to provide a precise estimate of connectivity (Mansour, 2016). GIS based advanced and integrated web-based information system that can process and move information in real-time, allowing public health authorities to monitor events at hundreds or thousands of public health facilities at once. It incorporates state-of-the-art technologies such as Geographic Information Systems (GIS), web-based databases, GPS, and Smart Card Technology and supports a variety of health-related web applications including early warning and response of epidemics, remote management of medical records, seamless healthcare coverage, comprehensive statistical analysis of data, decision-making procedures, inter-communication between international scientific fora and other (Ptochos et al., 2004). Global challenges in the health and social sciences, such as epidemic transmission and displacements leading to humanitarian emergencies, requires a thorough understanding of human mobility. Google Location History (GLH) data as a creative information source that could connect fine-scale mobility with unusual, long-distance, and international trips because it spans broad temporal scales with high spatial granularity (Ruktanonchai et al., 2018). Many countries for Improved geographical accessibility to basic services for rural populations uses GIS based optimal locations (location-allocation models) for decision making (Rushton, 1984). GIS and GPS enhance the quality of spatial and non-spatial data for analysis and decision making by providing an integrated approach to disease control and surveillance at the local, regional, and/or national levels (Sarkar et al., 2020). GIS technology for planning service centers to optimize access to vital lifesaving procedures such as C-sections (Vora et al., 2015). The use of GIS in public health to improve planning, implementation, and monitoring of programs and to inform policymaking processes for universal access to healthcare is grossly underutilized (Yasobant et al., 2015).

The distribution of population geographically underlines the dynamic nature of population changes and emphasizes the need for proper planning for the location of health facilities. This equitable access to healthcare, which is a primary determinant of the utilization of health services, will help reduce disparities in coverage. It is in this light; this research paper has been written to ascertain the distribution of healthcare facilities and its utilization.

MATERIALAND METHODOLOGY:

The primary and secondary data related to health facilities locations and village-level databases were collected from the National Health Mission, CDHO Dahod, Family and Health Welfare Department of Gujarat, and Census of India, Primary data is collected. Study area maps with Administrative boundaries like the village, taluka/block, District boundary were collected and used to create health facilities information for multi-purpose geospatial database for the Dahod district, Gujarat state.

The methodology adopted for this paper is to maintain a digital database using spatial and non-spatial data. Spatial data includes all the topographic and thematic maps, viz., base map, Administrative boundary, Types of Roads, railways, Major River and Village settlements, etc. The attribute data comprises general population details, socio-economic and public health facilities information from different government organizations, etc.

GIS-based methodology, Software ArcGIS 10 is used for mapping current locations of health facilities. Existing public health facilities includes CHCs, PHCs, Sub-centers data has been obtained from the district health office and CDHO, Dahod and online available date 15-08-2018 published in the website of District & Taluka wise list of new and upgraded PHC to CHC and list of PHC's & CHC's cum PHC as on Government of India, M. &. (2018). Zone-wise Health Centers Summary (India, Ministry of Health & Family Welfare, Directorate General of Health Service): Ministry of Health & family welfare. The road network was also obtained from the Survey of India topo sheet (1975) and open series maps from Survey of India (2011) were georeferenced the road network information. Google Earth imageries (2018) were used and updated the road network by digitizing some road segments from Google Earth after connecting all facilities with roads for network analysis. After correcting the topological road network problems, this dataset was overlaid with the health facilities. During this process, we verified that some health facilities are far from the road network, and classified into three categories: National Highway, State Highway, major road, and village road. Other amenities facilities include banks, post offices, police station, railway station, school, and telephone office; roads; village boundary; taluka boundary; water body and village population. The data utilized for GIS-based mapping and analysis included basic analog maps of Gujarat villages, subdivisions (talukas), and districts; GPS measure of latitudes, longitudes, and elevation of health facilities; updated list of all existing health facilities and other facilities (banks, schools, railway stations, etc.); and topographic maps containing boundaries of 7 subdivisions (taluka), elevation and other relevant information. All data were uploaded in ArcGIS to generate taluka-level maps for the Dahod district of the state.

Study Area

Dahod district is situated between 22°.30' and 23°.30' North Latitude and 73°.15' and 74°.30' East Longitude. Dahod district has come into existence with the division of Panchmahal district of Gujarat on 2-10-1997. On the north side of the state of Gujarat, Dahod is located and its area is around 3712 sq. km. The district is surrounded by the Sabarkantha district of Gujarat and Vansvada district of Rajasthan in the North, the Godhara district in the West, the Zabua District of Madhya Pradesh in the South. Dahod district is reconstructed by segregating tribal areas from Panchmahals. There are 7 talukas in the district are Fatepur, Zalod, Limkheda, Devgadh Bariya, Garbada, Dahod, and Dhanpur. For a long time, Dahod is serving as the Head Quarter of the district. There are 3 towns and 696 inhabited villages.

According to the 2011 Census, Dahod had a total population of 2,126,558 out of which the male population was 1,070,843 and female population was 1,055,715 respectively of these, 1580850 persons belong to Scheduled Tribes (STs) constituting 74.32% of the total population of the District and 17.73% of the tribal population of the state. Dahod District has the highest share of scheduled tribes to the total population of scheduled tribes of the state. The District has registered a 33.7% decadal growth of the Scheduled Tribe population from 2001 to 2011. There is very little industrialization in Dahod District as compared to other districts of Gujarat. The proportion of the urban population is only 9 % of the total population which is also the lowest amongst all the districts of Gujarat. The literacy rate is 58.82% which is also the lowest amongst all the districts of Gujarat. According to Niti Ayog assigned based on criteria in Gujarat state Dahod district is one of the Aspirational Districts. Dahod is a predominantly agricultural region and the prime share of revenue comes from agriculture-based products. Agriculture has given great impetus to home-based industries such as making jute ropes and weaving bamboo. The tribal culture and fascinating folklores of the district are a great attraction for tourists.

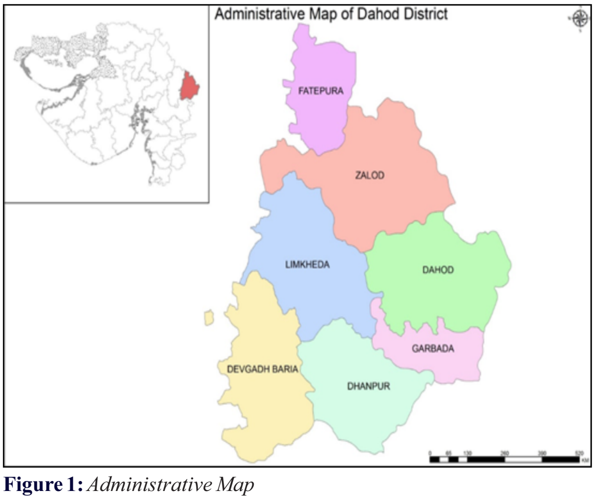

Figure 1: *Administrative Map*

HEALTH CARE SYSTEM IN INDIA

The first national population program was announced in 1951, the first National Health Policy of India (NHP) got formulated only in 1983 with its main focus on provision of primary health care to all by 2000. (Chokshi et al., 2016) As per the health care system in India, which has a population approximately of 1.3 billion out of which three-fourth of the population lives in rural areas. A huge health care facility is needed in rural areas. In India, seventy percent of the total population resides in rural or remote areas and rarely or have no access to the health center.

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The healthcare system is divided into different levels: primary, secondary, and tertiary levels. Each level has been given the population that has to be served with the given facilities, as the level increases the facility that is given also gets modified or gets better. The primary level mainly consists of sub-centers and primary health centers, the secondary level healthcare center mainly consists of the community health center and the tertiary level of health center consists of all the hospitals and medical colleges.

Sub Center:

The sub Center (SC) constitutes level 1 of the three-tier public health system in the state, with each SC serving a population of 5000 in non-tribal or plain areas and 3000 in Hilly/Tribal/Difficult Areas. The sub-Center is the most peripheral and first contact point between the primary health care system and the community. (Directorate General of Health Services Ministry of Health & Family Welfare Goverment of India, 2012) For health infrastructure and staff level, sub-center is required to be manned by at least one auxiliary nurse midwife (ANM) / female health worker and one male health worker and One lady health visitor (LHV) given the task of supervision of six SC. Sub-Centers are assigned tasks relating to interpersonal communication to bring about behavioral change and provide services about maternal and child health, family welfare, nutrition, immunization, diarrhea control and control of communicable diseases programs (*Rural Health Care System in India*, 2019).

Primary Health Center:

PHC is the first contact point between the village community and the medical officer (*Rural Health Care System in India*, 2019). Considering that the Primary Health Center (PHC) constitutes level 2 of the second-tier public health system in the state, with each PHC serving a population of 30000 in non-tribal or plain area and 20000 in Hilly/Tribal/Difficult Area. PHC is to be manned by a medical officer supported by 14 paramedical and other staff. Under NRHM, there is a provision for two additional staff nurses at PHCs on a contract basis. The PHCs were envisaged to provide an integrated curative and preventive health care to the rural population with emphasis on preventive and promotive aspects of health care. The PHCs are established and maintained by the State Governments under the Minimum Needs Programme (MNP)/ Basic Minimum Services (BMS) Programme (*Rural Health Care System in India*, 2019).

Community Health Center:

Considering that the Community Health Center (CHC) constitutes the level 3 Community Health Center first-tier public health system in the state, with each CHC serving a population of 120000 in non-tribal or plain areas and 80000 in Hilly/Tribal/Difficult Area. As per norms, CHC has 4 to 5 specialist doctors and general physicians supported by 21 paramedical and other staff. It has 30 to 50 in-door beds with instruments, and laboratory facilities. CHCs are being established and maintained by the State government under the Minimum Needs Program/Basic Minimum Services program.

FIRST REFERRAL UNIT WITH SPECIALIZED SERVICES

State Government can be declared from (District Hospital, Sub-divisional Hospital, Community Health Centre to as a fully operational First Referral Unit (FRU). It provides the three critical determinants of round-the-clock services for emergency obstetric care, newborn care and also includes access to a Blood bank at District Hospital and Blood storage facilities. In addition to all emergencies that any hospital is required to provide FRU's. If CHCs are upgrading as First Referral Units (FRU) it provides as an Emergency Obstetric care including surgical interventions such as cesarean sections; (ii) care for small and sick newborns; and (iii) blood storage facility on a 24-hour basis.

GIS is a computerized data management system used to capture, store, manage, retrieve, analyze, and display spatial information. A GIS differs from other graphics systems in several respects. First, data are geo-referenced to the coordinates of a particular projection system. This allows the precise placement of features on the earth's surface and maintains the spatial relationships between mapped features. As a result, commonly referenced data can be overlaid to determine relationships between data elements. For example; the location of the health service provider to the healthcare utilization of the population could be studied easily through GIS. Second, GIS software uses relational database management technologies to assign a series of attributes to each spatial feature. Common feature identification keys are used to link the spatial and attribute data between tables.

Recently, Geographical Information System (GIS) has emerged as an innovative and important component of research and practice in public health. GIS has proved to be useful for various research purposes including epidemiological surveys/investigation, implementation research, program/policy decision making, and dissemination of information. Since then, GIS has continued to be used in public health to address epidemiological problems by tracking the sources of diseases and the movements of contagions to target intervention and respond effectively to outbreaks. Although GIS-based methods can be efficiently used for decision-making regarding optimal locations for new health care facilities, yet only a few state governments in the country have adopted these methods Rushton, (1984). The advantage of using GIS is that maps provide an added dimension to data analysis, which helps in visualizing the complex patterns and relationships of public health issues.

Analysis

The mapping exercise was carried out for all 7 talukas across the Dahod districts in the state of Gujarat. These maps show the location of all existing health facilities in the district, along with other amenities. The maps show all features of the taluka - polygon feature (taluka and village boundary), and point features (health facilities).

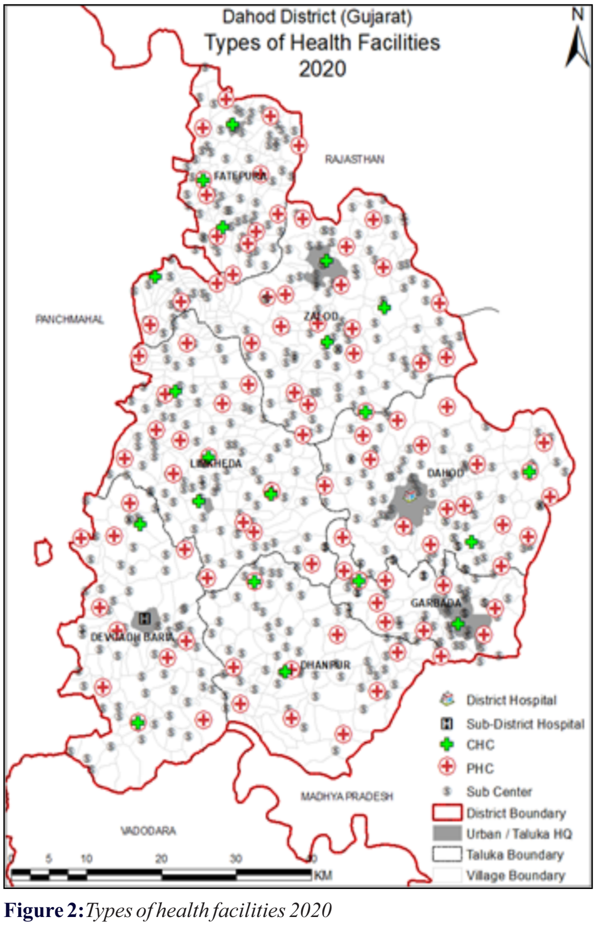

Figure 2: *Types of health facilities 2020*

No. Of Health Facilities In Dahod District Year - 2020

Table 1 No. Of Health Facilities In Dahod District In The Year 2020

Taluka/ Blocks	District Hospital	Sub-District Hospital	CHC	PHC	Sub Centers	Grand Total
Dahod	1		3	18	113	135
Devgadh baria		1	2	11	76	90
Dhanpur			2	9	60	71
Fatepura			3	12	79	94
Garbada			2	10	66	78
Limkheda			4	15	99	118
Zalod			5	22	144	171
Grand Total	1	1	21	97	637	757

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Health Facility Catchment: Average Aerial Distance Coverage
Proximity Analysis

Buffer analysis is used for identifying areas with similar attributes surrounding geographic locations for a specific distance. The process involves generating a buffer around existing geographic features and then identifying or selecting features based on whether they fall inside or outside the boundary of the buffer. Buffering can be done on all three types of vector data: point, line, area. The resulting buffer is a CHC, PHC, and SC health facilities point file. A yellow radius of 12.36, 6.09, and 2.33 km around a hospital to depict its catchment area. The user can specify the size of the buffer and then combine this information with population access to the type of health facility to determine how much population fall within the buffer Dahod district is divided into 7 sub-district/blocks and 5 Urban / Taluka Headquarters. It has a total of 757 public health facilities. Dahod had only a single District hospital and Devgadh Baria had a Sub District Hospital government facility.

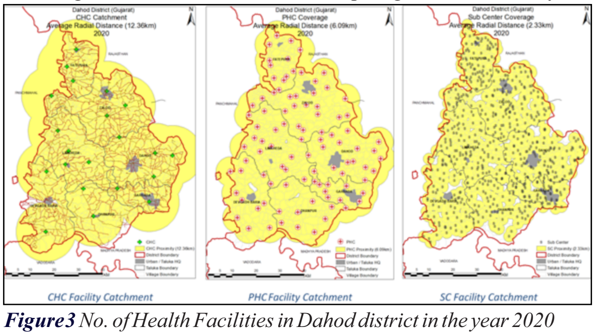

Figure3 *No. of Health Facilities in Dahod district in the year 2020*

Community Health Centers:

There are 21 community health centers in Dahod, (Figure 3 No. of Health Facilities in Dahod district in the year 2020) The number of CHC ranges from 2-5 in taluka. From the data, Zalod taluka is having the highest number of CHC public health centers and Dhanpur and Devgadhbaria are having the lowest with 2 centers each. As per the standard, each CHC average radial distance covered the area of the village of 12.36 km and is showing how much population each public health center is serving according to the area coverage of 12.36 km.

Table2: Population And No. Of Villages Served By Each CHC Catchment

TALUKA	CHC NAME	VILLAGES	POPULATION
Dahod	Katavara	86	525622
	Bordi Inami	73	426269
	Timarda	53	201742
Devgadh baria	Dabhva	63	154432
	Piplod	91	255295
Dhanpur	Agasvani	109	300610
	Dhanpur	97	224201
Fatepura	Balaiya	117	272508
	Fatepura	85	196407
	sukhsar	147	337905
Garbada	Garbada	71	337122
	Jesawada	110	517849
Limkheda	Dhadhela	127	320437
	Dudhiya	146	322333
	Limkheda	138	306807
	Singvad	152	264007
Zalod	Limdi	102	411310
	Mirakhedi	95	459827
	Pethapur	85	328845
	Sanjeli	105	207372
	Zalod	103	380522

Public Health Centers:

There are 91 public health centers are in Dahod. (Figure 3 No. of Health Facilities in Dahod district in the year 2020) The number of PHC range from 10-20 in each taluka from the evidence that the Zalod taluka is having the highest number of public health centers and Dhanpur and Garbada are having the lowest i.e, 10 public health centers, and each sub-center, on average covers a radial distance of 6.09 km of the village.

Table 3 Population and no. of villages Served by each PHC Catchment shows the Population that each PHC is serving and a number of villages.

Table 3 Population And No. Of Villages Served By Each PHC Catchment

PHC NAME	NO. VILLAGES	POPULATION
Aafva	36	91674
Abhold	18	109024
Agasvani	25	66438
Agavada	17	78200
Antela	17	68328
Balaiya	34	73353
Bandibar moti	34	76280
Bavka	16	78130
Bhathivada	18	74356
Bhathvada	9	29501
Bhuval	23	70241
Bilvani	18	66403
Bordi	23	65021
Borvani	17	62710
Chaidiya	26	66733
Chakaliya	10	27483
Chhaparvad	36	62763
Chhayan	13	37523
Chilakota	21	69818
Chitrodiya	24	113187
Chosala	15	63752
Dabhava	20	31935
Dasa	36	65297
Degavada	23	83968
Dhadela	29	58740
Dhavdiya	22	98259
Dudhiya	61	112882
Dungar	19	58250
Dungri	21	99868
Gamdi	19	63094
Gangardi	20	89146
Garadu	19	55467
Ghughas	17	39164
Gultora	18	52458
Guna	16	59859
Hadmat	34	99325
Handi	43	71620
Jagola	25	61778
Jalat	23	209944
Jambua	13	76955
Jekot	20	37895
Jesavada	16	100117
Kadwal	18	97746
Kanjeta	19	26237
Karmba	22	70732
Kathla	20	88206
Khangela	10	51348
Kharoda	11	48484
Kuva Baina	22	74057
Li-Thakor	19	89821
Madhva	39	94429
Mahudi	20	61013
Mandli	37	64618
Mandor	21	43502
Margala	34	85847
Methan	25	49318
Minakyar	17	74906
Mirakhedi	16	57871
Motidhadhel	30	71658
Motikharaj	19	222257
Nadhelav	20	105333
Nagrala	18	221917
Navanagar	26	78032
Ni.khakhari	28	75679
Pahad	40	65595
Panam	9	17155
Panchvada	18	120010
Patangadi	18	34826
Patiya	24	106065

Rachhva	23	42454
Rai	14	56202
Ranipura (Ratadiya)	18	43173
Rebari	14	58736
Rentiya	18	57290
Rupakheda	20	87850
Sagdapada	35	75219
Salra	25	61153
Sanjeli	59	84438
Sarmariya	16	97419
Sarsawa (East)	39	81435
Sevaniya	17	35048
Sudia	26	58010
Suthar Vasa	20	52206
Tanda	12	41904
Therka	22	93365
Timarda	19	74727
Tokarva	20	33501
Uchhvaniya	11	52562
Vajelav	17	86814
Vanbhori	26	101595
Vansiya	41	84101
Varod	19	90314
Ved	27	52647
Zabu	22	53859
Zari Bujarg	10	65337

Sub Centers:

There are 637 sub-centers in Dahod and each of the taluka has a good size of the Sub Centers (Figure 3 No. of Health Facilities in Dahod district in the year 2020). From the data, it is present that Zalod taluka is having the highest number of sub-centers and Dhanpur with 60 sub-centers is at the bottom. Each sub-center covers an area of 2.59 km as per the standard.

HEALTH FACILITY CATCHMENT: ACTUAL ROAD DISTANCE COVERAGE

Network Analysis – CHC Facility Catchment Area

GIS can quickly assess the geo-demographic dynamics of an organization's existing service area, service area for optimal service provision. It can also identify catchment areas of health centers and also locate suitable sites for a new health facility. Health services delivered at home can be scheduled more efficiently by analyzing transportation factors and street patterns, and by recommending the most efficient route. GIS Provides accurate and timely information about where health services are located and instructions and maps on how to get there (Figure 5 CHC Facility Catchment area). The Actual road network distance coverage area will be based on time for any emergency service availed with the nearest CHC.

As per the analysis of Figure 4 CHC Facility Catchment area identifies the 108 villages that are unserved areas and don't have any accessibility within the stipulated distance of 10km distance from CHC, and also unserved villages have 16 PHC's. To overcome this problem all the PHC's are identified which are lying in those non-accessible areas and it is proposed that those facilities can be converted to CHC's.

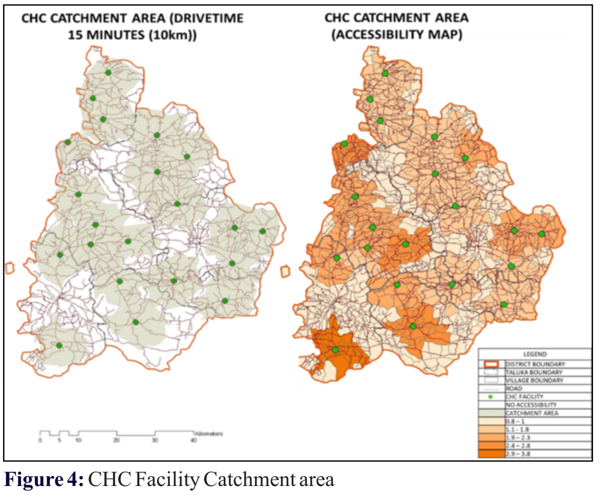

Figure 4: CHC Facility Catchment area

Table4 CHC Facility To Total Population Serving

CHC Name	No. of Villages	Total Population (in lacs)	Accessibility Range
Agasvani	23	0.63116	1.6
Balaiya	43	0.97346	3.1
Bordi Inami	24	0.65062	3.1
Dabhva	22	0.35308	2.8
Dhadhela	25	0.56331	3.6
Dhanpur	26	0.56965	1.8
Dudhiya	44	0.78079	2.6
Fatepura CHC	42	1.01501	2.0
Garbada	19	1.00356	1.0
Jesawada	22	1.26219	0.8
Katavara	28	1.32667	0.8
Limdi	30	1.32185	1.5
Limkheda	37	0.91072	3.3
Mirakhedi	24	1.0285	1.0
Pethapur	22	0.85358	2.3
Piplod	22	0.73952	2.7
Sanjeli	29	0.47973	2.1
Sigvad	41	0.66075	1.5
Sukhsar	45	1.16618	1.7
Timarda	19	0.62457	3.2
Zalod	27	1.33171	0.8

The facility catchment area of each facility is served by the facility itself. The accessibility (Map 5.6 CHC Facility Catchment area) shows the quality of access ranging from 0.8 to 3.6.

The catchment area of each of the facility sub-center, Primary Health Centre and Community Health Centre has been calculated by centroid method, in which, each village centroid and catchment area population for each facility has been calculated. Also, how much more facility needs to be installed or converted as per government rules can be assessed. Again, accessible catchment area has been calculated along the road by doing network analysis for each facility and how much population each facility is serving has been calculated. By considering patient to health facility, network analysis is carried out and average nearest and farthest point, travelled for the facility were estimated.

CONCLUSION:

Even after more than 50years of independence, health services in India is not readily available to all. Most tribal people are still not conscious about higher education, and medical facilities. Their income level is so low that they are unable to avail these facilities. It was also noticed, that tribal people of remote villages are getting basic health facilities by government schemes. Nowadays, the rapid development of technology has resulted, among other things, in the creation and deployment of new disciplines that cooperate with both the science of medicine and medical research. The Geographic Information Systems has many applications regarding medical/epidemiological research and generally in the social sciences. In a future study, we will utilize a GIS-based approach in rural areas of Dahod District, Gujarat to suggest optimal locations for CHCs by plotting and analyze the existing health facilities on GIS-enabled maps.

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