Accessibility Analysis of Primary Healthcare Services in Mysore District Using Geospatial Techniques

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ABSTRACT

The accessibility of healthcare centers is one of the most important indicators for measuring the efficiency of a healthcare system. Accessibility is a complex indicator that reflects the number of health care institutions, their geographical distribution and the impact of different types of barriers social, Economic and culture (1). Primary health centre which acts as the first level of contact between the population and health centers. It acts has a cornerstone of rural health services. Primary healthcare is affordable, accessible and appropriate care for the particular needs of a given population especially in rural areas. The main objectives of the study are to study the spatial distribution pattern and delineation of service area of primary health centers; to identify the gap between the availability and accessibility of health services. The base map of study area has been geo-referenced and digitized using ARC GIS software. The Global positioning system (GPS) was adopted to take the coordinate of all the existing primary health centers in the study area. Simple Euclidean buffers are mapped and analyzed to define the service area, Thiessen polygon and Nearest Neighbour Technique was used here to identify the availability of health services in Mysore district. The results reveal that, the spatial variation in the distribution of PHC's, which were not evenly distributed across the study area and there is scarcity in the availability of workforce among the study area.

Keywords : Affordable, Accessibility, Delineation, Euclidean Buffers, Thiessen Polygon

I. INTRODUCTION

Health is an invaluable gift of nature. It is one of the basic needs of all the human beings Health and Healthcare are become very important concept now a days. Health care is an essential sector to develop for better standard of living, it refers to the treatment and management of illness, and the preservation of health through services offered by the medical, dental, pharmaceutical, clinical laboratory sciences (i.e. Diagnostics), in using and allied health professions. Health care embraces all the goods and services designed to promote health, including, "Preventing,

curative and palliative interventions whether directed to individuals or to populations" (2)

The Millennium Development Goals of WHO for healthcare is to reduce the inequalities in the distribution of health resources are services of all countries (3). Primary Healthcare Centre is the cornerstone of rural health services; they are established to provide availability, accessibility, affordability to the common people mainly focus on the rural areas and vulnerable sections. Health care resources differs from region to region depending on several factors like geographical and socio-economic etc., with this background in this paper an attempt has been made to study the spatial distribution pattern and delineation of Service area of primary healthcare centers in Mysore District using GIS techniques.

II. BACKGROUND OF STUDY AREA

Mysore District is an Administrative District lies in the Southern part of Karnataka state, India. Mysore district is located between latitude 11°45' to 12°40' N and longitude 75°57' to 77°15' E. The District spreads across an area of 6854 sq.km constituting 3.5% of the state's total geographical area and is situated in Southern Karnataka. It holds the 6th place in the state in terms of the area with Population of Mysore District density was at 385 peoples per sq.kms. It's bordered by Hassan District to the North, Kerala state to the South, Kodagu District to the West; Chamarajanagar District surrounds south east and Mandya district to the northeast. Totally, Mysore district is having 7 taluks namely, Mysore, Tirumakudal_Narsipur, Nanjangud, Heggadadevanakote, Hunsur, Piriyapatna, Krishnarajanagara. According the Census of 2011 Mysore District had a population about 30, 01,127 lakhs of which male were 1,511,600 and 1,489,527 respectively making it third largest district in Karnataka. Map no.1 shows the location of the Mysore district in the country and state.
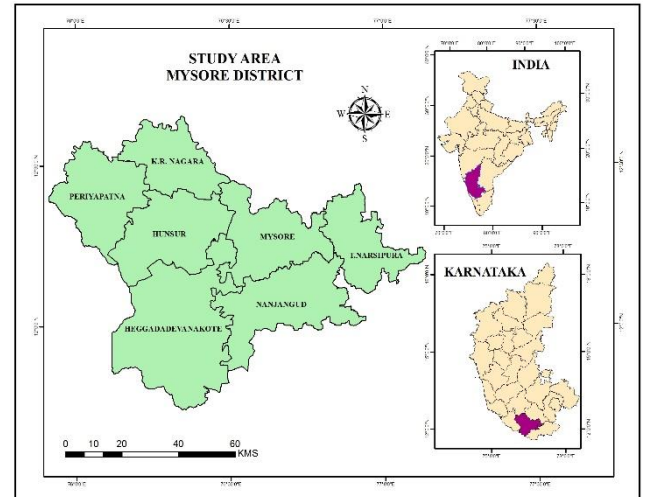

Map 1

III. METHODOLOGY

The present study used both Primary and Secondary source data. The study was conducted in 7 taluks of Mysore district. The Secondary data related to healthcare centres are collected from various offices like District Health Office and Taluk Health Office, Municipal Corporations. Population Data are collected from Census Office Bangalore for the Year 2011. The Spatial Data Such as, Toposheets of the study area at a scale of 1:50,000 are collect from Survey of India and to generate the spatial village maps involves the extraction of district and taluk boundaries from topographical map. The base map of the study areas has been geo-referenced and digitized using ARCGIS software, to show the spatial distribution and accessibility of healthcare centres. The primary source of data has been collected by questionnaire through the field survey; it contains the information related to health workforce facilities. The collected information has been compiled and put in the form of maps and tables for further analysis. The Global positioning system (GPS) was adopted to take the coordinate of all primary health centres in the study area. Simple Euclidean buffers are mapped and analysed to define the service area and Thiessen polygon and Nearest Neighbour Technique was used

here to identify the availability of health services in Mysore District.

IV. RESULTS AND DISCUSSION

A. Spatial Distribution of Primary Healthcare Centres in Mysore District

The location of healthcare centres depends on the basis of economic feasibility and requirement of people. The spatial distribution of healthcare centres is uneven as the human population on the earth's surface and the factors for such uneven distribution is almost similar. The uneven distribution of health centres are observed even at micro level not only between the regions but within the region also depending up on the demand for the health care institution and the supply of the patients. So far as the Primary health institutions of the Mysore district is comprises of 143 Primary Health Centres, has been shown in the following Map no.2 and Table no 1.
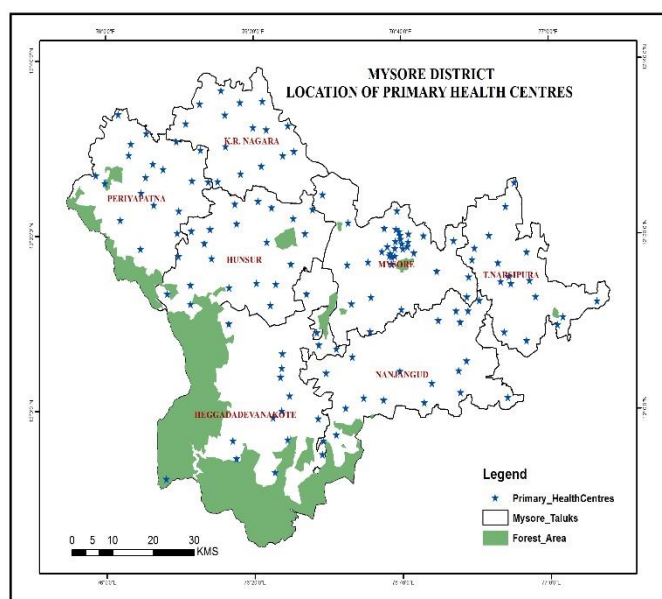
Map 2

i) Population and Health Services

As per Government of India, National Rural Health Mission (NRHM) policy the population norms for the provision of Primary Healthcare Centres in plain areas are suggested 30,000 people where as in the Hilly/Tribal regions it is 20,000 respectively. According to 2011 census the total population of district was 3001127. As per NRHM norms in Mysore district reveals that, the existing number of health institutions each PHC is serving to a population of 22231 persons in the district. The (table 1) reveals that in spite of more number of PHC is available in Mysore taluk, the ratio of population and health service is also observed high in the taluks. In case of PHC the population and health service ratio of all taluks of the Mysore district does not exceed the norms of NRHM except Mysore Taluk where the ratio is 1:38841.

TABLE 1: Taluk Wise Distribution of PHC'S and Ratios to the Population

Sl No	Taluks	Population	PHC	PHC/ Population Ratio (1:30,000)
1	K.R.Nagar	2,52,657	15	1:18047
2	P.Patna	2,43,076	19	1:12793
3	Hunsur	2,82,963	21	1:13474
4	Mysore	12,81,768	35	1:38841
5	H.D.Kote	2,63,706	17	1:16482
6	Nanjangud	3,84,922	19	1:21385
7	T.Narsipura	2,92,035	17	1:20860
	Total	30,01,127	143	1:22231

**Source:** Field Survey and Compiled by Author

ii) Population and Health Workforce

The population and health workforce availability in the hospitals is one of the important aspects from

management and planning point of view; which helps to access the availability of health workforce in the particular area. The total population of the district is 3001127 and the district have 224 doctors of them 100 doctors are serving in the rural areas and 124 doctors are serving in urban city of Mysore. The existing ratio of doctors in the district is 1:13398. It shows that, the existing number of doctors in the district is inadequate. Totally 435 nurses are working in the primary health centres of the Mysore district including urban area of Mysore. The existing ratio of Nurse in the district is 1:6899. Whereas, 257 Health assistant are working in the primary health centres of the Mysore district including urban area of Mysore. The existing ratio of health assistant in the district is 1:11678. In most of the taluks vacancies of doctors are below the average, doctors and other health workforce are reluctant to work in study area. The high vacancies not filled so this leads the scenario more institutions functions at below and capacity levels and are unable to fulfil local needs. The health workforce of different categories available in Primary health centres of Mysore district is shown in Map no. 3, it depicts that, the low availability of health workforce are noticed in the hospitals of H.D.Kote, Periyapatna and T.Narsipura taluks.

Map 3

B. Delineation of Service Area

The services area in the field of Medical Geography is called regionalization of health care. The regionalization of healthcare explains some sort of allocation of service delivery of utilization. Healthcare regionalization states that health facilities should be responsible for geographically defined populations and there should be systematic relationships and referred patterns between different facilities (4). In this study it is important to select suitable methods to demarcate the importance of delineate of healthcare services. So, in the present study the role of geospatial technique are important. The service area of each PHC has been delineated by using different GIS tools. The actual service area has been demarked to show the population of each PHC. The buffer analysis has been applied to show the served and unserved area. Thiessen polygons have been used to demarcate the service area; it creates a polygon within a polygon. It helps to understand number of villages and population within specific range from the health centre in the study area. Nearest Neighbour Analysis has been used to study how these health centres are distributed in the district.
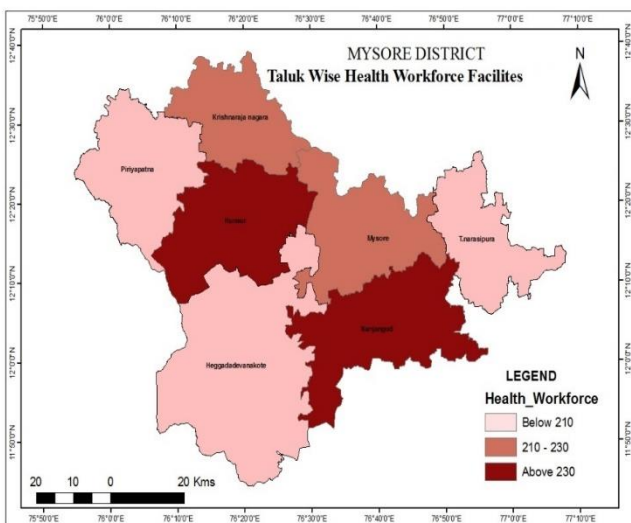
i) Actual Service Area of PHC's

Healthcare accessibility has many components. Geographical accessibility has been defined as the extent to which the population finds the distance, travel time and means of transport to healthcare services acceptable (5). Actual Service Area is a limit or border of a geographic area under the jurisdiction of Primary Health Centre. The area of each health centre has been delineated to provide the better service to the people and also to utilize the health services in an efficient way. To delineate the health service areas of PHCs, following methods are applied in GIS. Based on population the PHC actual service area has been categorized into three categories

namely Low, Medium and High population served health centres. The Map No.4 and Table No.2 provide the actual service area analysis of the health service centre in the district.
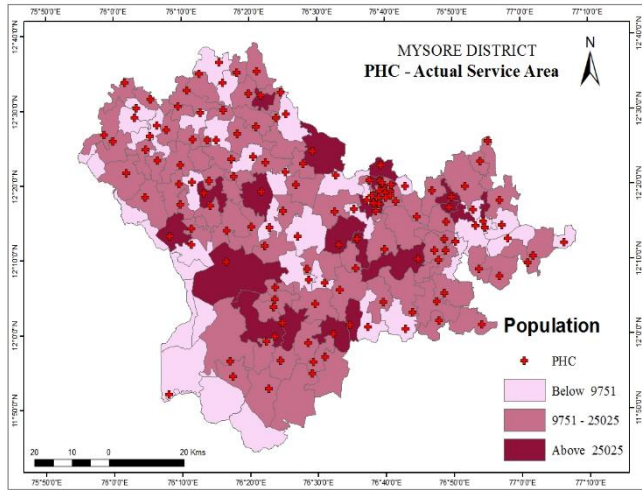
Map 4

The table 2 depicts the analysis of population of different PHC's of Mysore district. The data reveals that, out of the 143 PHC's 33 are serving below 9751 population each and it serves (8.30%) of population while as in the medium category (9751 - 25025) 77 PHC's are serving the population of 1185668 which accounts (39.62 %) population of the study area. The highest percentage of population (52.09 %) i.e. in high category is served by 33 Primary Health Centres.

TABLE 2: Population and Actual Service Area

Population Range	No of Health centres	Population	Percentage
Below 9751	33	248261	8.30
9751 - 25025	77	1185668	39.62
Above 25025	33	1558803	52.09
Total	143	2992732	100

Source: Field Survey and Compiled by Author

ii) Buffer Analysis

Buffer analysis has been used to show the served and un-served area for PHC's in the study area. It has been used to identify the villages within a given buffer limit of facility. Euclidean buffer is drawn around each PHC. The villages of an area can be easily determined whether they are served or un-served. A village within the buffer was considered to have access to a facility, while those outside the buffer were assumed not to have access. In the present study the buffers are drawn from each PHC at a distance of 5 and 7 Kilometers to define different service areas. The Map No.5 and Table No.3 shows the buffer Zone of the PHC's in the study area.
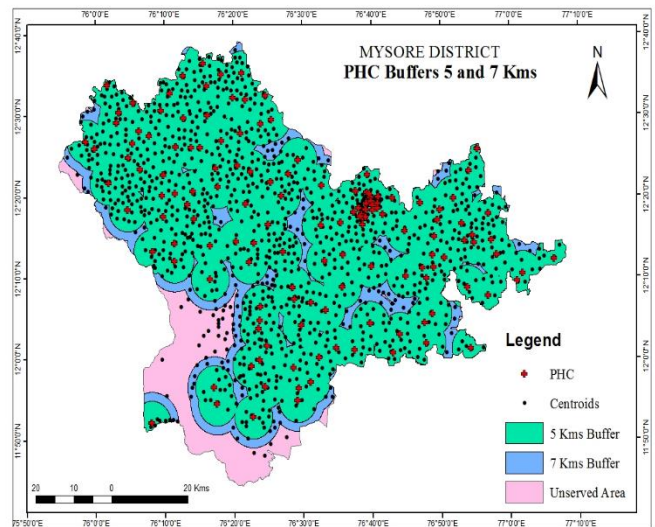
Map 5

The results of served and unserved areas for PHC's, is shown in the below table.no.3 in the study area. The 91.06 percent of the population is being served within the buffer of 5 kilometres and 7.08 percent of population is being served by PHC's. Beyond the buffer of 5 kilometres up to 7 Kilometres i.e. (within 2 Km) 7.08 population is being served by PHC's of the study area. The unserved area accounts the population of 1.85 percent of the total population of the study area.

TABLE 3: Buffer Analysis for Primary Health Centres

Buffer	Population	Percentage of Population	Percentage of Settlements
Less than 5 KMS	2759097	91.06	86.64
5-7 KMS	214514	7.08	8.93
More than7 KMS (Unserved)	56200	1.85	2.43
Total	3029811	100	100

**Source:** Field Survey and Personal Computation

iii) Thiessen Polygon

Thiessen polygons are named for the American meteorologist Alfred H. Thiessen in 1911. Thiessen polygons (otherwise known as Voronoi polygons or Voronoi diagrams), are an essential method for the analysis of proximity and neighbourhood. Thiessen polygons are polygons whose boundaries define the area that is closest to each point relative to all other points. They are mathematically defined by the perpendicular bisectors of the lines between all points. These are used to allocate space to the nearest point feature. They define individual areas of influence around each of a set of points. This method has been applied to show the serving population and area of PHC's as associated centres of Mysore district. In the study area Thiessen polygons were generated and the population and area of villages within the catchment area of each. Thiessen polygons were calculated based on population the Thiessen polygons have been categorized into three categories (Low, Medium and High). The Table no.4 and Map no.6 provide the Thiessen polygon analysis of the study area.

TABLE 4: Proximity Analysis of Health Centre Using Thiessen Polygons

Population Range	No. of PHC's	Population (%)	Settlements (%)
Below 10564	45	11.84	20
10564 – 31811	77	43.87	65
Above 31811	21	44.29	14
Total	143	100	100

Source: Personal Computation
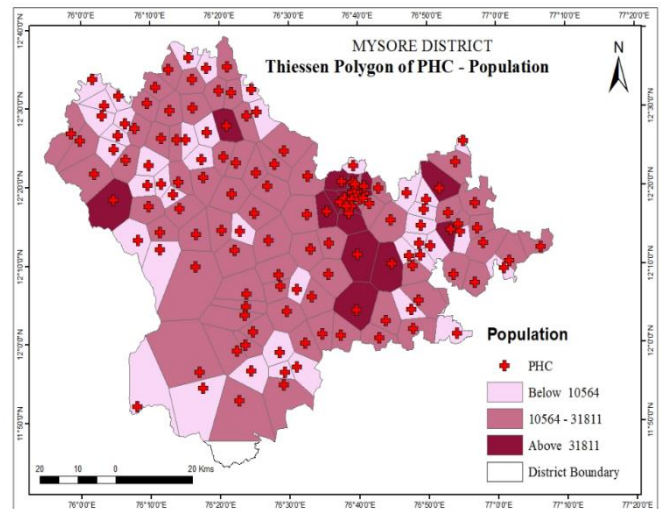
Map 6

Thiessen polygon techniques help in calculating the area of polygon and population covered by it. Table No. 4 provides the analysis serving of population of Thiessen polygons of different PHC's of Mysore district. Out of the 143 PHC's 45 in low category (Below 10564) are serving only 11.84 percent of population of 20 percent of settlements while as in the medium category (10564 - 31811) 77 PHC's are serving the population of 43.87 percent of the serving population of 65 percent of the settlements of the study area. The highest percentage of population of 44.29 percent of 14 percent of settlements i.e. in high category is served by only 21 Primary Health Centres.

iv) Nearest Neighbour Analysis

The spatial distribution of health centres unevenly distributed in the study area. The study of the spatial distributional pattern of health centres is an important aspect in Medical/health care geography. In the present study Nearest Neighbour Technique has been used to observe how these health centres are distributed in the district. The 'Nearest Neighbour method, was firstly developed by two botanists (6), they have used this techniques to measures the pattern of incidence of different species of plants in a region. Later on, geographers have widely used this technique in order to study the distributional pattern of the places and other phenomena in different geographical regions of the world. As a result, the researcher has using this technique to study the spatial distribution pattern of health centres in the study area. The following formula is as

$$Rn = 2\bar{d}\sqrt{\frac{n}{A}}$$

Where: Rn = The description of the distribution
$2\bar{d}$ = The mean distance between the nearest neighbours (KMS)
n = The number of points (Health Centres) in the study area
A = The area

By using this formula, Rn values for seven taluks of the district have been calculated.

The Nearest Neighbour analysis statistics for all seven taluks of Mysore district were derived from the distance between nearest health centres. The Rn value of the district is 1.3941, it shows that these health centres are randomly distributed, these can be observed in the Map no: 7 and Table 5 reveals the fact that, all most all the taluks are having a tendency of approaching towards random pattern of distribution of health centres with the Rn values of 1.39.
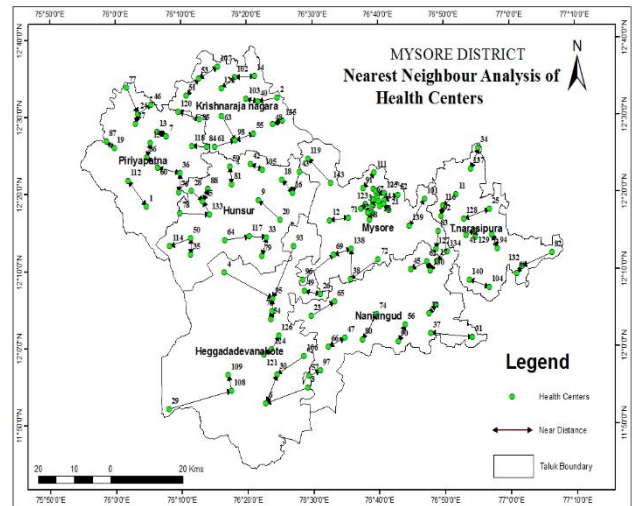
Map 7

TABLE 5: Talukwise Rn Values of Health Centres in Mysore District.

Sl. No	Taluk	Rn Value	Pattern
1	K.R.Nagar	1.6366	Randomly Distributed
2	P.Patna	1.4536	
3	Hunsur	1.3941	
4	T.Narsipura	1.4328	
5	Nanjangud	1.365	
6	H.D.Kote	1.2990	
7	Mysore	1.3776	
	Total	1.3941	

Source: Personal Computation

V. CONCLUSION

From the above analysis it can be concluded that, healthcare centres are not equally distributed among different taluks of the study area. In addition to this there is scarcity in the availability of workforce among the taluks of the study area. Though, in general the ratio of healthcare centres and health workforce fit according to NRHM norms, but the ratio of health care centres and workforce differ from taluk to taluk. In this study, actual service area, buffer analysis, Thiessen polygon and nearest neighbour techniques shows the distribution of

health services area of Primary Health Centres in Mysore District. Euclidean buffer analysis shows the identification of served and unserved areas of health care centres. Whereas, in Thiessen polygon techniques used to delineate of healthcare services area of PHCs, it helps in calculating the population covered by PHC. The healthcare centres of Mysore taluk serving more population while Periyapatna and H.D.Kote and Hunsur serving less population. Even though, number of health centres exists, but there are some spatial gaps and functional deficit in the health centres and accessibility in the study area, showing that the existing health centres are unable to serve the area and population properly. The results of the average nearest neighbour analysis revealed that, the distribution of primary health centres are randomly distributed. The Rn value of the health centres in the district is 1.3941. There is a significant difference in the spatial pattern of distribution of primary health centre in Mysore district. To reduce the imbalance in the distribution of primary healthcare centres, the study gives an idea for planning of new health care centres should be based on structured criteria, good number of staffs and geographical aspects and also transportation is responsible for emergence of new health centres in future for better services.

VI. ACKNOWLEDGEMENT

VII. REFERENCES

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