MEASURING SPATIAL ACCESSIBILITY TO PRIMARY HEALTH CENTER IN MYSORE DISTRICT

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Abstract

Human health has been prime factor in the sustainable development of the society, irrespective of the developmental status of the society or the country. Health care system of any country or region has an important role to play for the sustainable health management. This paper demonstrates a method for estimating the geographical accessibility of Primary Health centers of Mysore District. For the network analysis the road network of the district has been converted into network dataset. Depending upon the road hierarchy and characteristic, roads were allotted an average vehicular speed. On the basis of the speed, travelling time and travelling distance, the service areas and closest facilities both in terms of distance and time were calculated. The results reveal that a large proportion of the residents have to travel a long way to access the health care facilities most importantly in South and south western parts of Heggadadevanakote and western parts of Piriyapatna.

Key Words:*Closest Facility, Service Area, Accessibility, GIS, Distance, Time*

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Introduction

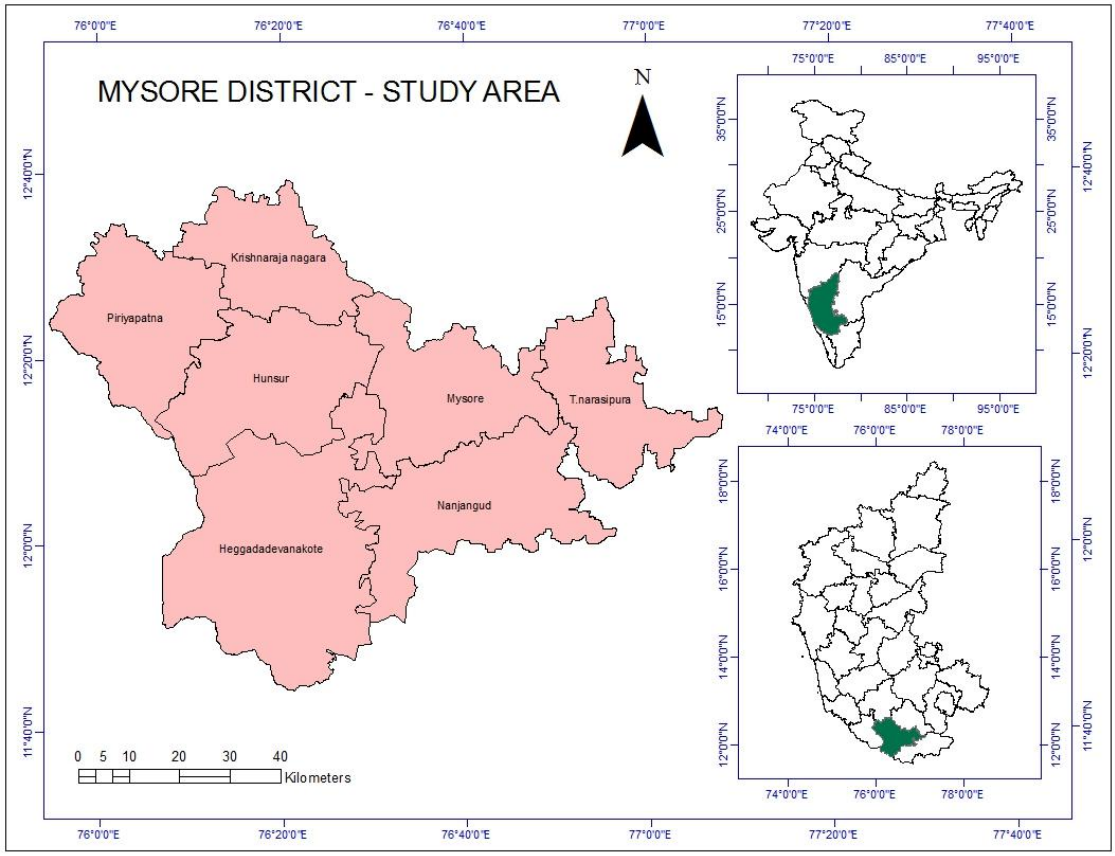
Access as defined by Andersen is the "ability to use health services when and where they are needed" (Andersen, 1995). Cromely&McLafferty further describe access as the "power to command health service resources" (2002). Access can be described as the 'degree of fit' between users and a service. The 'degree of fit' might be influenced by the availability, accessibility, accommodation, affordability and acceptability of a service (Penchansky and Thomas, 1981). According to Vic Kerman (1974), accessibility is a combination of two elements: locations on a surface relative to suitable destinations, and the characteristics of transportation networks linking points on that surface. Potential access or the population's potential for access is more simply defined as the "presence of enabling resources" (Andersen, 1995).

The lack of enabling resources can lead to decreased access to healthcare services. Barriers of access such as race, age, education, income, sex, culture, ethnicity, sexual orientation, lack of insurance, and geographical location can affect the use of healthcare services (Cromley&McLafferty, 2002). The concept of access is multidimensional. Dimensions of access include availability, accessibility, accommodation, affordability, and acceptability. Aday and Andersen (1974) further divide accessibility into socio-organizational and geographical aspects. The geographical dimension of access includes empirical measures such as distance, travel time, transportation, and the associated cost. Measures of access often focus on geographical location of service "provision" and the relationship to the population in "need". Both "time" and "space" create constraints to access (Cromley&McLafferty, 2002). Therefore, the location of healthcare services and the associated distance and travel time are important health policy issues.

Spatial accessibility refers to the relationship between the locations of the supply of and the locations of demand for specific services, taking into account existing transportation infrastructure and travel impedance. In the literature, spatial accessibility and geographical accessibility (McLafferty, 1982; Pooler, 1987; Brabyn and Skelly, 2002; Apparicio et al., 2008) are often used in an interchangeable manner, in the sense that both concepts are location-based and spatially constrained, as Khan (1992) has noted that spatial accessibility is specifically conditioned by the spatial or distance variable (as a barrier or a facilitator of access) and the pattern generated has the most direct geographic manifestation.

Study Area

Mysore District is an Administrative District located in the southern part of the state of Karnataka, India. This district has a prominent place in the history of Karnataka. Mysore district is located between latitude 11°45' to 12°40' N and longitude and 75°57' to 77°15' E latitude. The District spreads across an area of 6854 sq.km (ranked 12th in the state) constituting 4% of the state's total area. 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 over 30 lakhs making it third largest district in Karnataka.



Methodology

The present chapter deals with the physical accessibility of PHC's of the Mysore district. For the network analysis the road network of the district has been converted into network dataset. Depending upon the road hierarchy and characteristic, roads were allotted an average vehicular speed. The speed limits on different are as National Highway 50 Km/h, State Highway 40 km/h, Metaled 30 Km/h, un-metaled 20Km/h and Pedestrian as 10 Km/h. On the basis of the speed, travelling time and travelling distance, the service areas and closest facilities both in terms of distance and time were calculated. GPS has been used to locate the PHC of the study area and the population of the settlements were been collected from census. Since the population is not distributed uniformly across Settlement polygons, the settlement centroids were considered as a

demand points, and the PHC facilities were considered as destination points (supply). The population of each service area (Distance and Time), were calculated. Similarly the closest facility or shortest route has been generated both in terms of distance and time. The population of different shortest routes of PHC's has been calculated.

Analysis and Results

This paper demonstrates how Network analysis in GIS can be used to model travel distance and time to Primary Health Centers in Mysore District using 143 health centers and 1276 settlements. The centroids of each threshold were generated as demand points. The approximate travel time and distance from each centroid to the closest Primary Health Center were calculated.

Service Area

A network service area is a region that encompasses all accessible streets (that is, streets that are within specified impedance). Service areas created by Network Analyst also help evaluate accessibility. Concentric service areas show how accessibility varies with impedance. It is used to identify how many people, how much land, or quantities of anything else within the neighborhood or region. Service area on the basis of time and distance is also helpful to predict the travelling time and traveling distance from demand points to service or Health Centers. In the present study the service area has been generated by from Primary Health Centers as service Points on the basis of distance and time. The service areas on the basis of time have been generated by taking the interval of 20 minutes i.e. 20, 40 and 60 minutes. While as on the basis of distance service areas have been generated by taking the interval of 7 kilometers i.e. 7, 14 and 21Kilometers. The populations of each service area zone (Distance and Time) have been calculated.

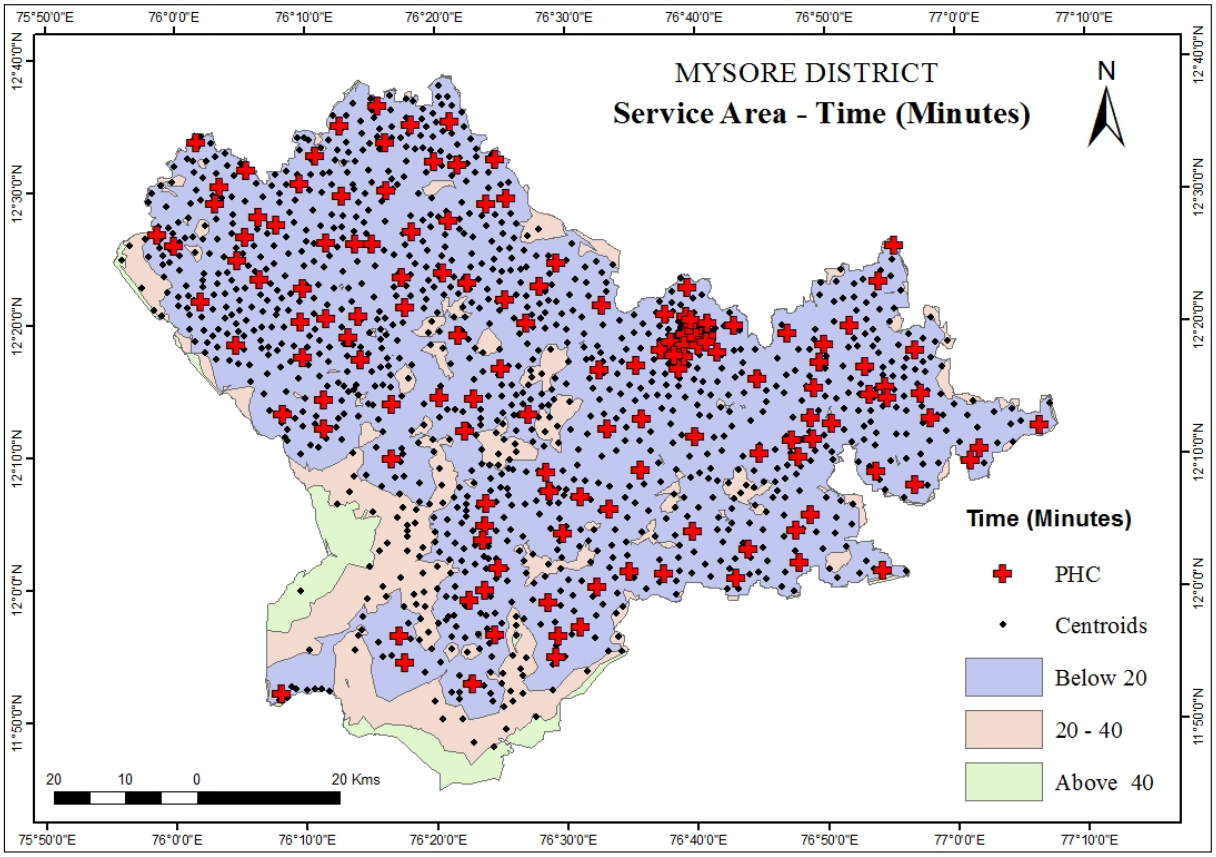


Table No 1: Service Area of PHC (Time)

Time (Minutes)	Population	Percentage of Population	Settlements	Percentage of Settlements
Below 20	2847749	93.99	1117	87.54
20 – 40	178369	5.89	152	11.91
40 - 60	3693	0.12	7	0.55
	3029811	100	1276	100

The table No.1 presents the served population in different time zones of the study area. Majority of settlements (87.54 percent) which accounts the population of 93.99 percent of the total population is being served within the 20 minutes. The PHC's of the district are serving the population of 5.89 percent within 20 to 40 minutes. The population of 0.12 percent is being served within the service time of 40 to 60 minutes.

Service Area in Distance

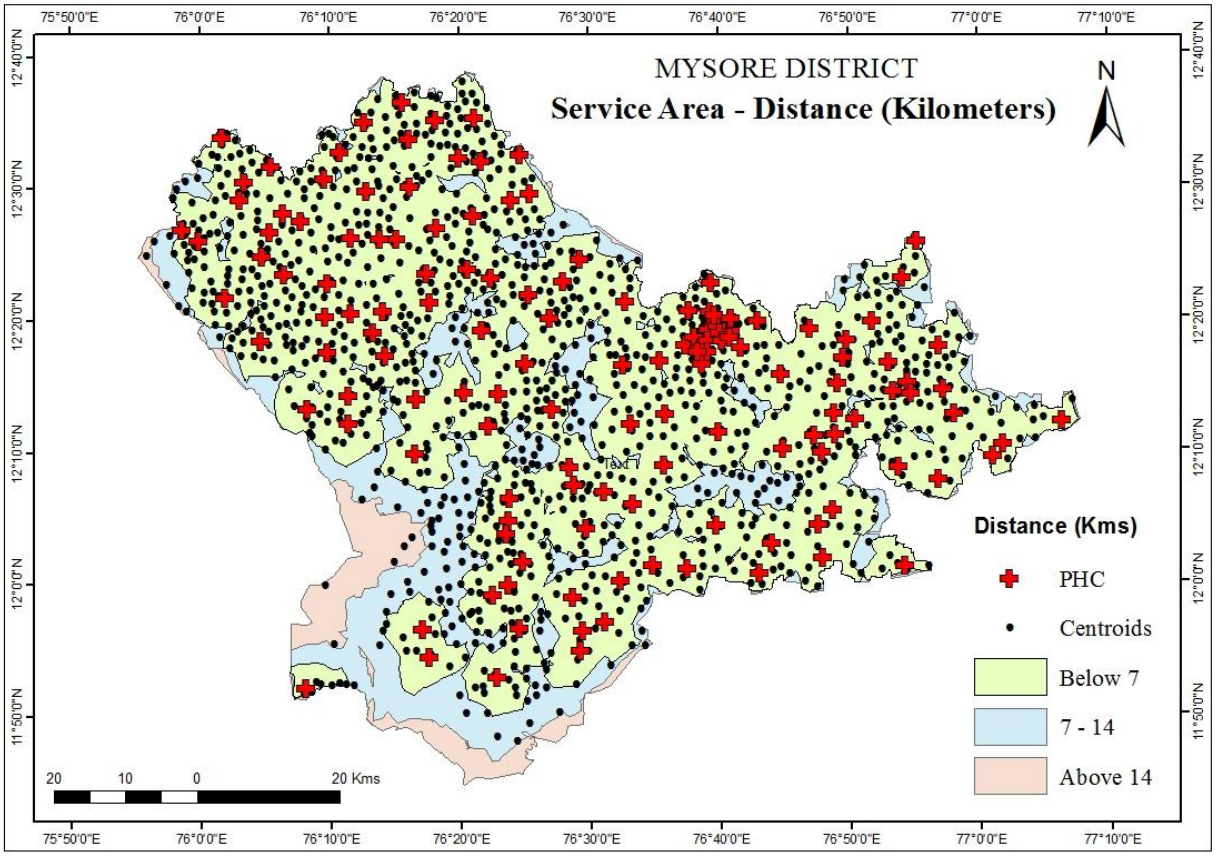


Table No. 2: Service Area of PHC (Distance)

Distance (Kilometers)	Population	Percentage of Population	Settlements	Percentage of Settlements
Below 7	2725104	89.94	1069	83.78
7 – 14	295583	9.76	200	15.67
14 - 21	9124	0.30	7	0.55
	3029811	100	1276	100

The table No.2 depicts the scenario of the served population in different distance zones of the study area. The data reveals that Majority of settlements (83.78 percent) is being served within the 7 kilometers which accounts the population of 89.94 percent of the total population of the district. 9.76 percent of the population of 15.67 percent of the settlements is being served within

the distance of 7 to 14 kilometers. Out of the total population, 0.30 percent population of 7 settlements are able to access PHC's within 14 to 21 kilometers of travelling distance.

Closest Facility

The closest facility solver measures the cost of traveling between incidents and facilities and determines which are nearest to one other. The two most common types of distance measure used for determining spatial accessibility in the literature are the Euclidean distance (more often known as straight line distance) and the Manhattan distance (distance along two sides of a right-angled triangle, the base of which is the Euclidian distance). Ingram (1971) suggests that the Manhattan network distance measure is more appropriate than Euclidean distance in measuring gridded road network in urban areas. But Apparicio et al (2008) argues that the shortest network travel time is more accurate than any other distance measures. Spatial accessibility to service facilities from population points have been determined using travel time (Burt and Dyer 1971), where travel time is often calculated using the existing road network, the distance is converted to travel time by using a suitable conversion algorithm and the travel time is also dependent on the mode of transportation used. In the study area the shortest route distance and travelling time from the PHC to settlement centroid has been calculated.

Travel Distance (Kilometers) to closest health care facilities

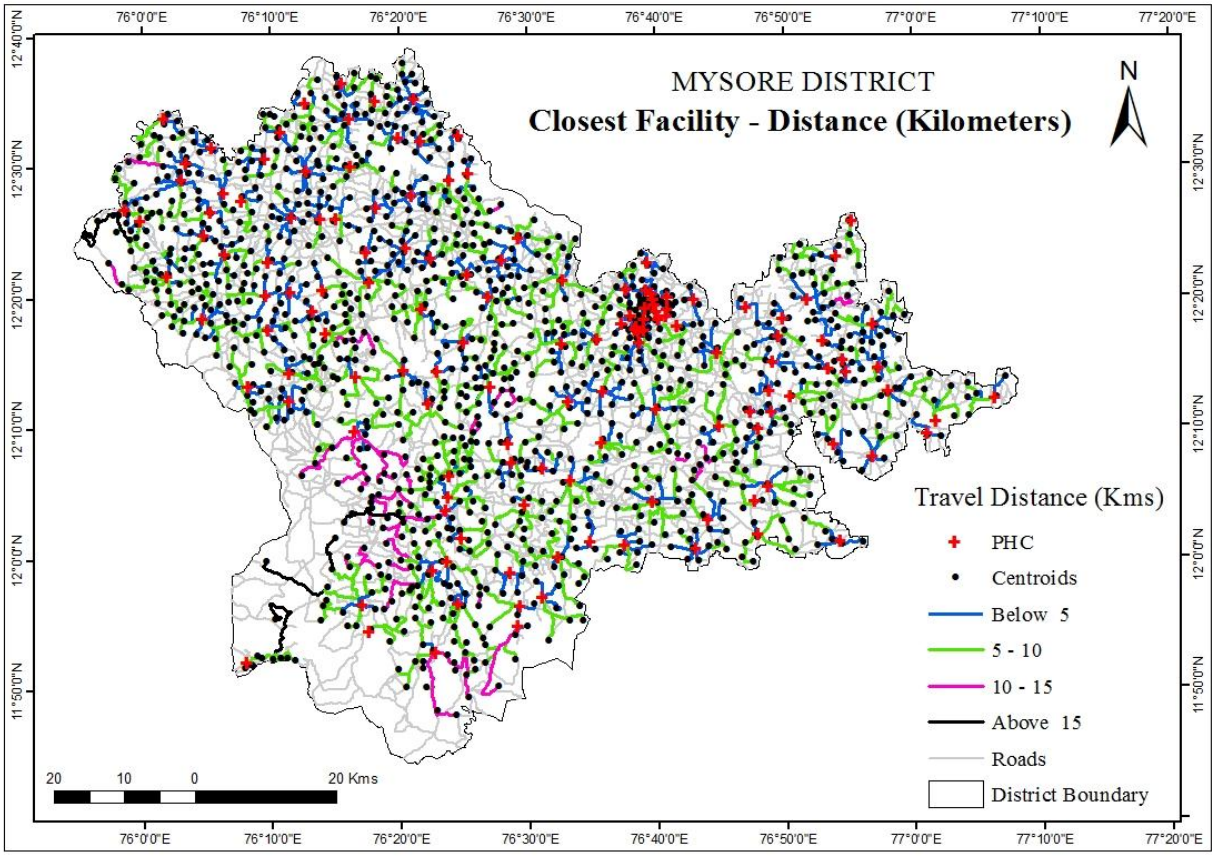


Table No. 3: Travelling Distance (Km) of Population to their closest facility

Distance (Km)	Population	Percentage of Population	Settlements	Percentage of Settlements
Below 5	2095024	69.15	766	60.03
5 to 10	873389	28.83	465	36.44
10 to 15	53561	1.77	39	3.06
Above 15	7837	0.26	6	0.47
	3029811	100	1276	100

The table No.3 provides the travelling distance of the people of the Mysore district to reach the closest PHC. The data revels that majority of population (69.15 percent) of 60.03 settlements of the district have to travel the distance of below 5 kilometers to reach the closest PHC. Similarly 28.83 percent of population has to travel the distance of 5 to 10 kilometers to access the closest PHC. Within the travelling distance of 10 to 15 kilometers 53561 persons (1.17 percent) can

reach the closest PHC. 0.26 percent of populations of 6 settlements have to travel the distance of above 15 kilometers.

Travel time (Minutes) to closest health care facilities

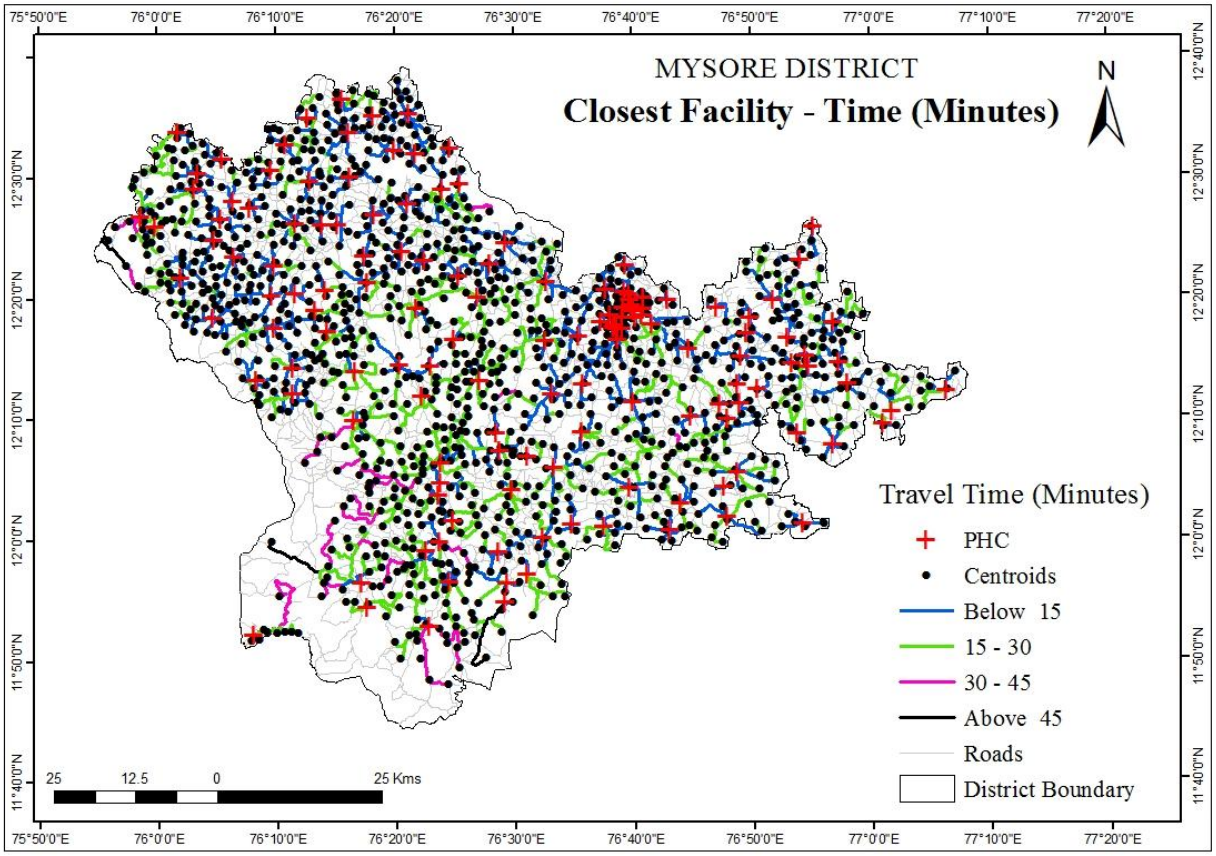


Table No. 4: Travelling Time (Minutes) of Population to their closest facility

Time (Minutes)	Population	Percentage of Population	Settlements	Percentage of Settlements
Below 15	2472576	81.61	889	69.67
15 - 30	525952	17.36	362	28.37
30 - 45	29123	0.96	21	1.65
Above 45	2160	0.07	4	0.31
	3029811	100	1276	100

Travel time (measured in minutes) to the closest health care facilities from Settlement centroids via road network is derived from the measured travel distances. Table No 4 shows that the major portion i.e. 81.61 percent of population has to travel for less than 15 minutes to reach the PHC.

Within the travelling time of 15 to 30 and 30 to 45 minutes 17.36 percent and 0.96 of population can access the closest PHC. Similarly the population of 0.07 percent of the district has less access to PHC as they have to travel for the time of above 45 minutes.

Conclusion

This study investigated spatial accessibility to health care facilities by the local communities of Mysore District. The study reveals that there exists the spatial variation in the distribution of PHC's, which were not evenly distributed across the study area. A large proportion of the residents have to travel a long way to access the health care facilities most importantly in South and south western parts of Heggadadevanakote and western parts of Piriyapatna. Geographical access models have enormous potential for informing policy development and grounding debate on how to achieve social equity of hospital access. The use of advance GIS tools has proved to be boon to the researchers and planner to visualize and conceptualize the health plans and policy also the public health administrator are at the advantage of saving time and resources by application of such tools.

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