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Locating private medical practitioners using GPS and creation of geographic data base for redistribution solution in Kumbakonam

Dr. P Thirumalai

Abstract
Kumbakonam is famous for old temple culture with many number of temple tanks, now being the stagnant water areas which creates a conducive atmosphere for the growth of vectors. The town has many disease ecological problem zones with its deltaic character and the place is well-known for malaria and elephantiasis. The town does not have proper drainage system and the water is let on roads or drained in a sump. Rapid growth of population makes this temple town with many environmental impacts in the deltaic region, particularly the improper drainage system in the high density household zone, presence of number of stagnant water areas, presence of solid waste disposal sites in the centre of the town and so on. Earlier studies indicate that the rainfall is closely associated with the vector borne diseases in this town. The doctor population ratio was low during 1980's and at present the ratio is 1:875 which is higher than expected. At present there are 160 private medical practitioners are providing services to the needy people. The PMP's are clustered in two zones and the people who are in need of the PMP's have to travel widely from the peripheral wards and nearby villages.

Keywords: ALTERN algorithm, cultural heritage, elephantiasis, Japanese encephalitis

Introduction
Although the geographic approach has long been integrated into tropical diseases control programs (OMS 1965) [1], the linkage between geography and health in general has only come to the fore in recent decades (Verhasselt 1993) [2]. For tropical disease control, these links are particularly relevant as refugee movements, the continuous population flux between rural and urban areas, and environmental changes influence the distribution of vectors, reservoir animals, and the human population, and determine the transmission of diseases. Technological progress has led to the emergence of new computerized analysis tools, the simple automated mapping of epidemiological data (Pyle 1994) [3], to the sophisticated analysis of satellite images which demonstrate vector/environment relationships (Hugh-Jones 1989) [4].; Perry 1991[5]; Rogers 1991) [6]. GIS have already been widely used in other sectors such as the management of natural resources, agriculture, and rural and urban planning (Rideout 1992) [7]. Accessing data from different sources at all levels of the health care system is a general challenge. Although a large quantity of data are collected either routinely or through special surveys, the information is generally synthesized at the level where it was collected, then transmitted to the next higher level where it is aggregated and transmitted further, until it becomes difficult to isolate the basic information. Available data are often presented in the form of tables or isolated figures, the reading of which are a laborious and time-consuming task and does not permit easy decision-making (Sandiford 1992) [8].

Statement of the Problem
Kumbakonam is one of the oldest cultural heritage town which is located at the center of Tamil Nadu. The town is famous for old temple culture with many number of temple tanks, now being the stagnant water areas which creates a conducive atmosphere for the growth of vectors. Because of its cultural heritage this town draws many pilgirims from all over the country. `Mahamaham' festival which is considered to be equivalent to `Kumbamela' is held

once in twelve years is going to be held in 2004.The town has many disease ecological problem zones and its deltaic character the place is well-known for the insect diseases, particularly malaria and elephantiasis. The town does not have proper drainage system and the water is let on roads or drained in a sump. Equivalent to the several environmental problems which is the main root for the increase in the density of population and increase in land values, the town is facing severe traffic congestion problem for the past decade. There has been a rapid growth of urbanization in the past two decades in all the directions and the municipality has converted the 36 wards to 45 wards due to expansion and administrative purpose.

In 1901, the details of population of Kumbakonam are known authentically there were only 59,673 persons in 1901.It had increased gradually to more than 100,000 in sixty years. The population decreased from 64,647 in 1911 to 60,700 in 1921.This may be due to extensive famine and war conditions that prevailed. In all other decades there was an increasing trend in population growth. According to 2000 census, the total population of Kumbakonam was 141,814 of which 70,544 are females and 71,270 are males. The population distribution in ward wise is mostly even except some central parts of the town. This rapid growth of population makes this temple town with many environmental impacts in the deltaic region, particularly the improper drainage system in the high density household zone, presence of number of stagnant water areas, presence of solid waste disposal sites in the centre of the town and so on. This type of environmental conditions would bring the seasonal diseases and town is worst affected to vector borne and contagious diseases during rainy season. Earlier studies clearly indicate that the rainfall is closely associated with the vector borne diseases in this town. The common diseases that are identified in this town are Cholera, Malaria, Elephantiasis, and few brain fevers (Japanese Encephalitis).According to the disease pattern the number of private hospitals and the private doctors has also increased to cater the inflicted persons. The doctor population ratio was low during 1980's and at present the ratio is 1:875 which is higher than expected. But their place of practice is the major question; mostly they are located in a convergence zone, in other words the two important major road networks.

At present there are 160 private medical practitioners are providing services to the needy people. The private medical practitioners (PMP's) not only cater the town population but also the people from the adjoining villages also visit the town clinics and there has been an influx of patients from the nearby villages also. At present the PMP's are clustered in two zones and the people who are in need of the PMP's have to travel widely and wait for hours together to visit the PMP's. If the PMP's are evenly distributed according to the population and the road network, the PMP's also get considerable and at the same time even number of patients and on the other hand the patients can also travel small distances to acquire the medical services without traveling long distances and the waiting time could be minimized. Though the town is consisting of 160 PMP's which is well placed as far as the health is concerned and the major drawback is that it is not evenly distributed. This necessitates a systematic study of the location of each and every doctor with specialization in the form of a spatial data base that would help the users to find their appropriate doctors and the location, travel time and so on to consult without much difficulty. The location analysis of PMP's in the town necessitates a systematic planning of private health care provision and the redistribution principles would work out effectively for uniform provision of service to the patients.

Objectives

The present research is aimed to study the location and the characteristic feature of the Registered Medical Practitioners (RMP's) and transform the field location data into geographic information base to access/ provide information to the needy people in this town. Secondly, though the town is well placed as far as the private health/ health care is concerned their distribution pattern is important for a geographer and if the town has improper distribution, how to redistribute the RMP's to provide better service facilities from the spatial point of view. Based on the aim following two objectives were formulated and they are:

a. To create a Spatial Information Data Base (SIDB) about the location of each and every Registered Medical Practitioners using Global Positioning System (GPS) in the town in all categories with the service facilities they provide, and
b. To analyze the existing location of RMP's using Location-allocation model for the GPS input data and derive possible locations that could be designed in the re-distribution of private health care map which would be used for future planning purpose.

Methodology

In the present research two technologies namely, Global Positioning System (GPS) and Geographical Information System (GPS) were used to near accurate measurements and creation geographic data bases for further analysis/ research.GPS is an accurate measurement which can be used to create instant local area maps and also attach the desired data base on the point, line and area. This component has an antenna and from the antenna a cable is attached with a palm card computer that receives the satellite emitted radio signals through software called Arc PAD.

Before the measurement a data base for point, line and area has to be created using Arc View GIS mapping software. The GPS equipment particularly the palm card computer is a handheld one and the antenna can be hanged on the surveyors shoulders. This can be carried very easily to any accessible areas and instant map could be recorded in the palm carder. The finished map can then be downloaded to the mainframe computers for further analysis. The details of this technology are given in the proceeding chapters. To study the traffic congestion in Kumbakonam, at the first instant an area symbol has been created in the Arc View GIS and tracked (by walk and vehicle) all along the borders of Kumbakonam town. Then the major roads were also tracked in the Kumbakonam area map using line symbol with a global accuracy of 4 meters. Using Arc View GIS different point symbols were created to locate the different category of RMP's. All the 160 RMP's in different categories, namely MD (19), MS (23), MBBS (32), DGO (18), DCH (21), BDS (18), Ortho (10), DLO (8), Skin (6), DO and ENT (3) and Neuro (2) were located using GPS through empirical survey method. While plotting the above RMP locations a data base was attached with the point symbol which explains name of the doctor, specialization, location address, and hours of practice along with the geographical co-ordinates of lat-long positions. The Private

Hospital locations were also measured with the GPS and the attached data base to explain the nature of services they provide. The users can access these data bases and the location of their doctor of interest and visit. These data bases can be updated with the latest information about the RMP's as and when they acquire. The GPS measured location data is integrated with the Arc View GIS and it shows the individual specialization GPS maps with data bases. This map shows the spatial distribution of RMP's and their concentration in few zones. The GPS measured geographical co-ordinates are then used as input data and the individual ward wise population data for the year 2001 has been used as weight of the respective wards. Using the co-ordinates and the population data the ALTERN heuristic algorithm has been applied to derive the alternate locations for the existing distribution. After the algorithm different GIS maps were created using the above algorithm and the re-distributed co-ordinate system will give us the alternate locations so as to cover the entire population evenly without traveling and waiting time.

Profile of the Study Area

Kumbakonam is one of the special grade municipal town in TamilNadu since 1988.It is the second biggest town in Thanjavur district. Kumbakonam is one of the important pilgrim centers in India and it is also known as "TEMPLECITY". It is one of the most important cultural landscapes in South India. Maham is one of the major Hindu Festival which is being celebrated once in twelve years held in the month of 'Masi' which is equivalent to the 'Kumbamela' in the North India. Kumbakonam town has a major concentration of registered medical practitioners (RMP) in the city they play a dominant role in taking care of the patients when compared to the Government Hospitals. The field work to collect all the RMP's as per the latest count and locating them on a map indicates that the town has 148 registered medical practitioners.

Until recently, not much attention was paid to the study of private health services. Unlike Government, private health services do not have an integrated hierarchy. These can be grouped into two categories: clinics and nursing homes. The latter are primarily located in urban areas and are run by qualified doctors. The locations and functioning of nursing homes are quite independent and are determined by the service owners: a doctor or a team of doctors. Generally, private doctors prefer to locate their clinics in urban areas, while in rural areas, registered medical practitioners (RMP) are available. The majority of RMPs are not fully qualified to diagnose any major illnesses.

Distance from the town and/or city plays an important role in the location of RMPs as most of the practitioners live in urban areas and prefer to locate their clinics in areas where they can easily commute. Therefore, distance and availability of transport facilities have an impact on the locations of RMPs in rural areas. The association between availability of a clinic and distance from the nearest town and/or city is examined in the following section. There is an inverse relationship between availability of RMPs and distance from the nearest town and/or city.

It is observed that the relocation of an existing service is not only difficult but also not viable economically and politically (especially in the Indian context). But if some rationale criterion such as demand weighted distance is followed for additional locations geographical accessibility and efficiency level of health services can be improved. In this section, additional 5, 10 and 15 PHCs, and RMPs sites were identified keeping existing locations fixed.

In a study at Rokhtok shows the distribution of PHC and proposed additional sites in 1996, actual average distance for PHC was 4.4 kilometers. Keeping 1996 PHCs fixed if additional 5 PHC are located at the proposed sites average distance will decline to 4.2 kilometers. This figure will further decline to less than 4 and 3.8 kilometers with additional 10 and 15 services respectively at the proposed sites. With additional 15 proposed locations, a PHC can be made available within a distance of 10 kilometers for 99 per cent of villages and only 262 villages will remain beyond a distance of 5 kilometers against 329 villages for actual existing locations.

If 5, 10, 15 RMPs are available at the proposed site average weighted distances will be 3.5, 3.4 and 3.2 kilometers respectively. A majority of modeled locations for RMPs was suggested in Bhiwani District. With existing locations of RMPs 300 villages were beyond a distance of 5 kilometers. If additional 15 RMPs are available at the proposed sites only 212 villages will remain beyond a distance of 5 kilometers.

Locating Private Health care facilities using GPS and GIS provides more information to the users and GIS analysts. The one way of usefulness is to attach databases for the necessary parameters about the RMP or a clinic with all the facilities available and the user can select and reach them to acquire such facilities. The GPS and GIS data could be uploaded into a WEB based solutions so that this could be a model study for universal access. The specialization of doctors, the available facilities in the clinic, the infrastructure facilities available in the private hospital/ clinic, the surgical facilities can be attached with the location of a doctor/ clinic/ hospital so as to enable the user to locate their desired doctors.

Secondly a GIS analyst can analyze the existing location analysis; in other words whether the existing location of a doctor/ clinic/ private hospital service configuration and in majority of the case studies in the urban environment reveal that they are clustered in one business center. This is purely the users would always find places in the business complexes and they normally do not give due importance to the population coverage and the distances to be traveled by the patients.

There are number of techniques to analyze how effective an existing location of a clinic/ private hospital/ or a private medical practitioner. For the analysis the GPS co-ordinates are being used to find the existing location and using the population or any other relevant parameter of a spatial unit could be taken into consideration to relocate the health service center. These two methods were used and the results are given in different GIS maps in the foregoing pages.

Kumbakonam Town: Surveyed using Global Positioning System

Map 1 Shows the major road network map devised with GPS and the entire major road were measured and distance at any point can be calculated with GIS analysis. Based on the road network the entire private health care centers and private practitioners were located using GPS. This GPS measured road network within the Kumbakonam Town limit shows the names of the major roads and any length between points could be easily measured through the GIS Arc Pad software and the individual road widths are measured manually and attached with the respective databases.

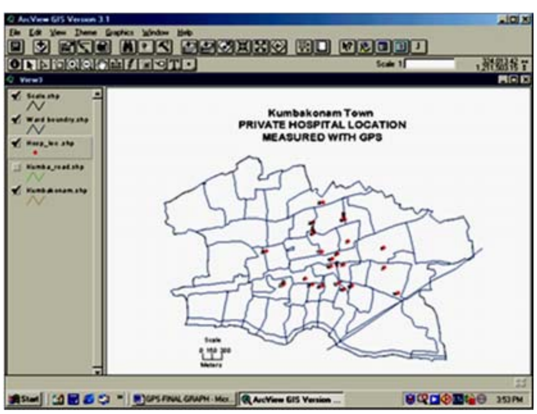
Map 1 depicts the GPS Survey methods for major road networks and location of Private Hospitals, RMP's, and Specialist Groups. According to the field survey method there are 26 Private Hospitals present in the town and all of them are located sparsely but at the same time centrally oriented to the town. These 26 private hospitals are located in Mutt Street, Ayekulam Road, K.V. North Street and Gandhiadigal salai. These areas comprising of mixed type of land use pattern and the hospitals are owned by individual to group of doctors. Among them some are providing specialized care, surgical care, gynecological and exclusively care for children.

Map 2 shows the spatial distribution pattern of Women specialists using GPS in the town. Women and Child health care are the most important health care provision for any town and there are 18 Women specialists are taking care of health problems of women. All of them are located in the centrality based location in the town. There are three major locations are identified and they are Bhakthapuri street, Mutt street and Gandhiadigal salai. The DGO's are performing service either in a private hospital attached with their residence or a clinic with few beds and it is functioning round the clock.

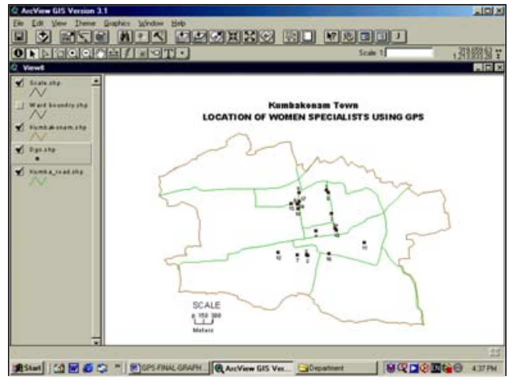
Map 3 depicts the spatial pattern of orthopedic specialists in 10 major locations which is in the centre of the town. The major concentrations are in Mutt Street, Ayekulam road and K.V.North Street. Each and every orthopedic specialist is supported by x-ray, scan and other allied services which are required for diagnosis.

Map 4 displays the spatial pattern of dental specialists and their concentration is mainly on two major roads. There are 18 dental specialists are rendering service to the users and they are concentrated in Thanjavur main road and Mutt street where the provision of bus stopping facility from the rural patients.

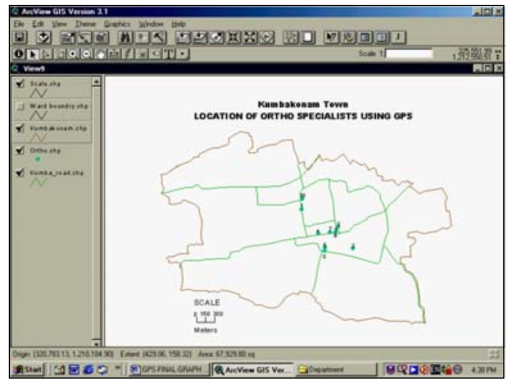
Map 5 shows the surgical specialists and they are basically located in major hospitals where such type of advanced facilities for surgery is located. The major hospitals with the surgical specialists are Raja, SNI, Vijay and ST hospitals apart from minor clinical surgery locations. The hospitals are attached with all the infrastructural facilities and functions round the clock. In Vijay and ST hospitals emergency services are being provided. There are three concentration zones of surgical specialists are noticed on the map and the areas are Mutt street, Ayekulum Road and K.V.North street where there is a large concentration of other specialist doctors.



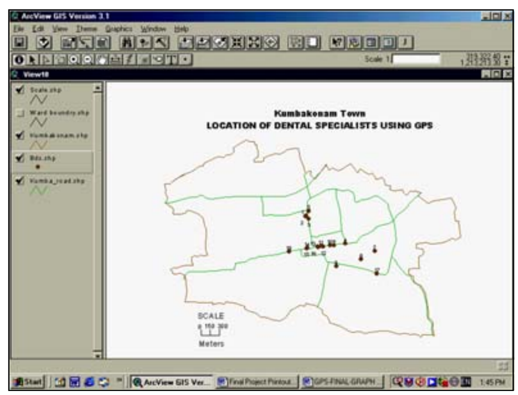
Map 1: Kumbakonam Town: Location of Private Hospital Location measured with GPS



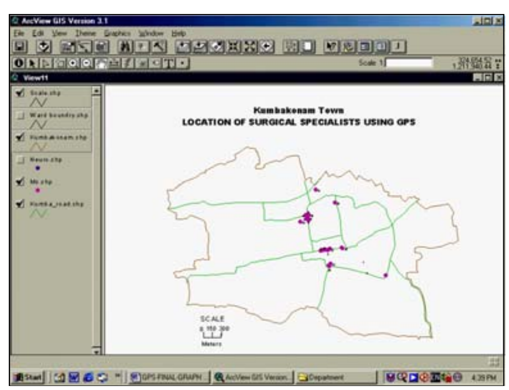
Map 2: Kumbakonam Town: Spatial Distribution of Women Specialists using GPS



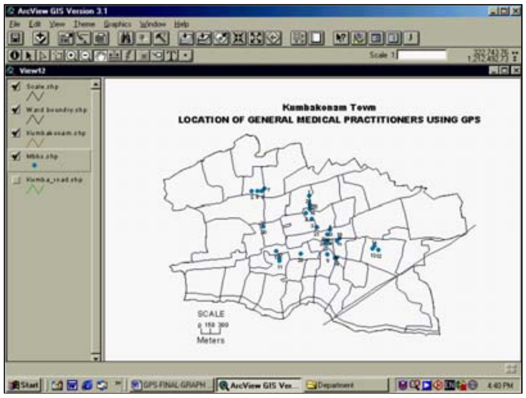
Map 3: Kumbakonam Town: Spatial Distribution of Ortho Specialists using GPS



Map 4: Kumbakonam Town: Spatial Distribution of Dental Specialists using GPS

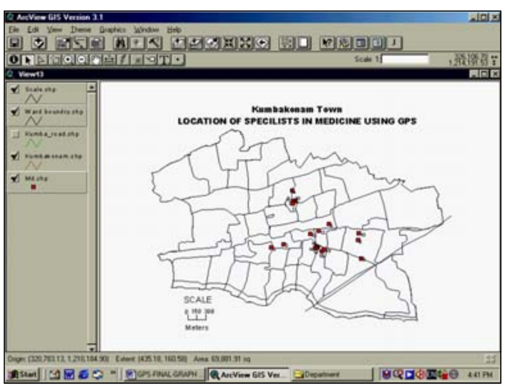


Map 5: Kumbakonam Town: Spatial Distribution of Surgical Specialists using GPS

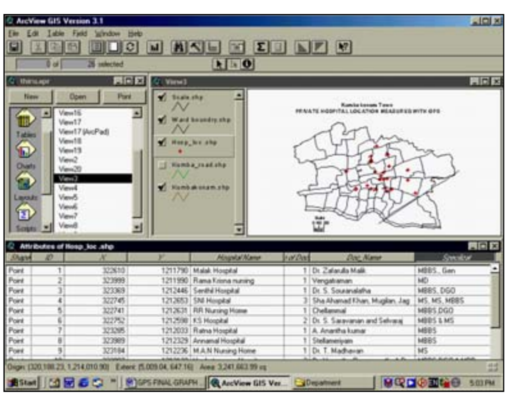


Map 6: Kumbakonam Town: Spatial Distribution of General Medical Practitioners using GPS

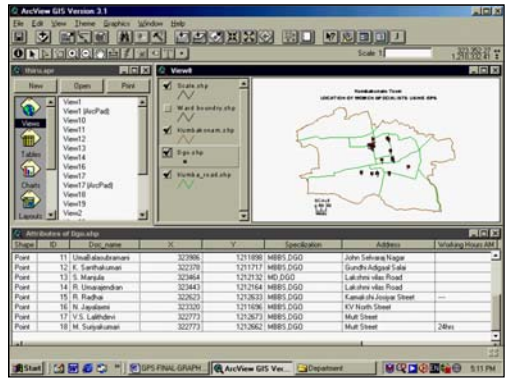
Map 6 presents the spatial distribution of General Practitioners, which is considered to be the most important health care service in general, medicine. At present there are 32 GP's are providing health services to the people of Kumbakonam town and the surrounding. The ratio indicates that 1: 4000 which is well placed as far as the general medicine is concerned. The spatial spread is concerned they are concentrated in all the directions in a circular manner from the centre of the town. The peripheral wards do not have the GP's presence and they will have to come to the central places where the GP's are located. The people who are coming from the rural areas have good access as far as the road network is concerned and some of the GP locations are near the bus stopping and new bus stand area.



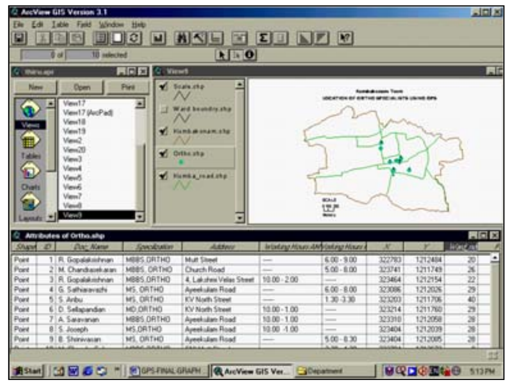
Map 7: Kumbakonam Town: Spatial Distribution of Specialists in Medicine using GPS



Map 8: Kumbakonam Town: Spatial Distribution of Private Hospitals with GIS data base

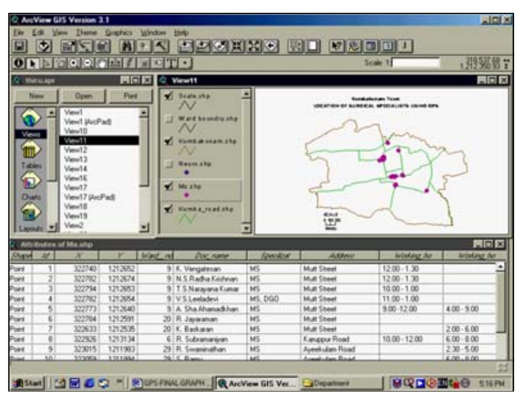


Map 9: Kumbakonam Town: Spatial Distribution of Women Specialists with GIS data base



Map 10: Kumbakonam Town: Spatial Distribution of Ortho Specialists with GIS data base

Map 11: Kumbakonam Town: Spatial Distribution of Dental Specialists with GIS data base

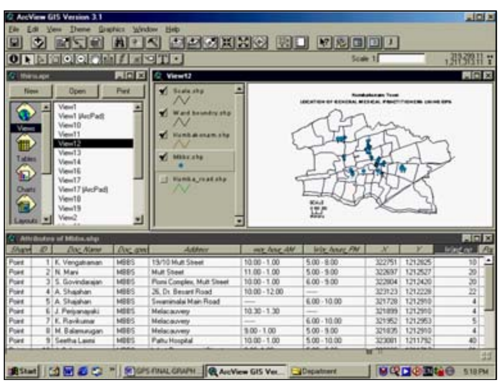


Map 12: Kumbakonam Town: Spatial Distribution of Surgical Specialists with GIS data base

Map 7 exhibits the location of Medical Specialists (MD's) and at present there are 19 MD's providing specialists services to the patients in and around Kumbakonam. There are four major concentration zones of MDs and they are Mutt street, KV North street, Ayekulum Road and John Selvaraj Nagar where there are additional facilities for x-ray, scan and medical shops are found distributed.

GPS and GIS data base for Private Health care Providers

The GPS was used to locate 160 Private Medical Practitioners with specialization and in each and every location a GIS data base was created using Arc View GIS. The data base attribute includes the individual location lat-long co-ordinate, name of the hospital, name of the doctor, specialization, the working hours and so on. The location attached a data base would indicate the desired doctors parameters and the working hours and additional parameters could be added based on further research. The GPS based GIS data base can be viewed through World Wide Web and the users can have easy access and they can select their doctor based on the additional/ desired parameters. Secondly the location analysis of the point pattern can be analyses through GIS analysis. The Maps from 3.17 to 3.27displays the location with the respective health care attribute data base about hospitals, skin specialists, child specialist, DLO, DO and ENT, Women's specialists, Ortho specialist, Dental Specialist, Surgical Specialist, General Medicine and Specialist in Medicine. Each attribute data base for the RMP's will appear in each and every move with the `view' and it is easy to access their information with locational data base.



Map 13: Kumbakonam Town: Spatial Distribution of General Practitioner with GIS data base

Map 14: Kumbakonam Town: Spatial Distribution of Specialists in Medicine with GIS data base

GPS and GIS data base for different Hospital Location Attributes with Hospital facility details

Map 8 to map 14 shows the spatial distribution of Private Hospitals with Location and individual hospital infrastructure facilities. This GIS information can be obtained in each view and this will display the Locations of all the Private Hospitals. On the Map when each location of hospital 'points' are moved with mouse pointer and click a desired point location that will indicate the details about the particular hospital. Similarly the details about DGO (Map 9), Ortho Specialist (Map 10), Dental Specialist (11), Surgical Specialist (12), General Practitioner (13), and General Medicine Specialist (14) are shown in the respective GIS maps

GPS and GIS data base for Location allocation analysis

The spatial organization of health care centers and the distribution of potential users mean that access to health facilities varies greatly between individuals. Although a degree of inequality is inevitable, because of the discrete location of facilities to serve a continuous distribution of population, spatial mal-distributions in provision exist and produce unnecessary inequalities in access opportunities on life chances and raise the question of territorial justice.

This situation is especially worrying since it is suggested that it is reinforced by the so-called inverse care law, that is, the level of provision of good medical care tends to be inversely related to the requirements of the population served.

The Location-allocation models jointly optimizing the location of facilities, employing different criteria, have been applied to examine the problem of locating health facilities (Gould and Leinbach, 1966) [9]. Different criteria are appropriate in different situations, particularly with regard to the type of hospital and the service it provides. For instance, in the provision of emergency medical service, the minimization of maximum travel distance (or time) would be a priority.

The solution depends on the distribution of the units of health facilities, both quality and effectiveness. This means that a balance be established on objective grounds between preventive and curative services and between peripheral and urban services. The solution should be a consumer-generated and not producer oriented health care service. The primary objective of such a system should also be to provide timely, easy and inexpensive care of primary and advanced levels to the rural people. Also, the organization of health care delivery must take of family welfare, nutrition, communicable diseases and other, several related problems in a continuous manner. To find the optimum locations for different health care centers like skin clinics, DLO, DO and ENT, DGO, Ortho Specialist, Dental Specialist, Surgical Specialist, General Practitioner, General Medicine Specialist, `ALTERN' a heuristic algorithm, is based on two simple principles:

a. *One is, if the allocations of demand points to a center is known, then the optimal location can be found by the algorithms such as WEBER, and that if the locations of centers are known, then the optimal allocation of demand points can be found by assigning eachdemand point to its closest source.*
b. *The algorithm alternates between locating centers and allocating demand points, beginning with either, until a condition is reached such that all demand points are*

assigned to the closest center that is at the minimum point of its set of demand points.

Classification of Location Problems

People are distributed unevenly in earth space and they must obtain many kinds of goods and services from facilities located at widely separated places. They have an obvious interest in the locations of these facilities being `most accessible' to them. For goods and services whose provision is at public expense, the people responsible for locating the facilities have an interest in providing the best service within budget restrictions. That is, other thing being the same, they too have an interest in locating the facilities to be "most accessible". Given this apparent identity of interest, we this face the challenge of specifying what conditions a location pattern must have to be "most accessible". These methods comprise sequences of computations, which it is believed will frequently lead to the desired solution. This belief is founded on the logic of the computations and is frequently supported by extensive empirical experience. Unlike the exact analytical methods, no proof exists that heuristic methods will find the best possible solution. The popularity of these methods results from their usefulness in situations where exact analytical methods for the problem studied either do not exist, or are prohibitively expensive, or when a range of possible "solutions" is desired from which policy makers may make a selection using criteria that had not been (and perhaps could not be) formalized in the algorithm used.

The location problem in most cases involves either the simultaneous or the sequential location of many facilities. In either case the best location for any one facility depends on the locations of the others in the system. For example, we have n-demand points to be supplied at minimum cost by m-centers. Where should the m-centers be located? The solution could be to minimize average unit distance from the demand points to their closest supply point. In the multi-facility case the demand the points are clustered in partitions around their respective supply centers. One important characteristic of this and all solutions to this problem is that the location of each source is optimum with respect to the points in its partition.

A mathematical formulation of the distances between two points is as follows:

$$Z=\sum_{i=1}^{n}\sum_{j=1}^{m}\sqrt{a_{ij}\, w_i(x_i-x_j)^2+(y_i-y_j)^2} \qquad 1$$

Where…

z is the aggregate distance from all demand points to their closest supply center,

w_i, y_i are the co-ordinates of the i^{th} demand point (i = 1...., n)

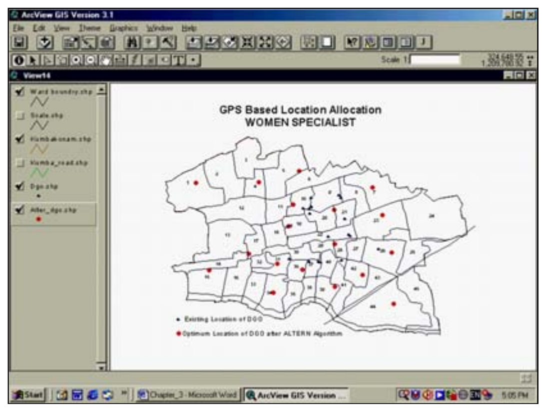
x_j, y_j are the co-ordinates of the j^{th} supply center (j=1,….m)

w^i is the weight assigned to the i^{th} demand point (population of the center, in this case)

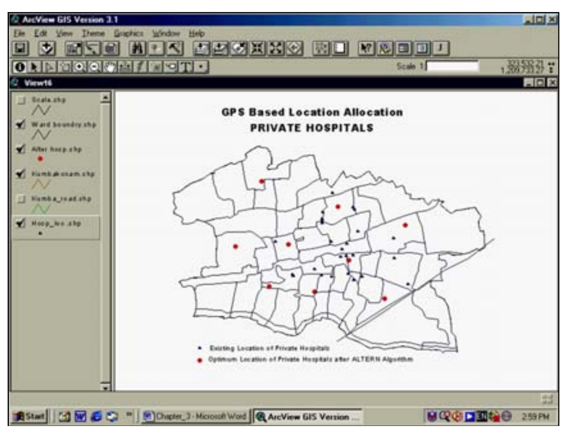
a_{ij} - 1 when demand point i is served from supply center j, otherwise a = 0

The algorithm is developed (see appendix for ALTERN Algorithm) from the above principle for a problem that the solution to the multi-facility case involves partitions (groups) of the demand points with each facility located best with respect to its group. For any group, therefore, the problem reduces to finding the solution for the single facility case. In multi-facility case the problem remaining is then, to find the partitions. The alternating algorithm starts with partitions surrounding arbitrary facility locations. After finding the optimum locations within each group, it then redefined the groups around the new locations and finds new center locations for these new groups. We will show that at every step the value of the objective function z decreases, until stability occurs. The algorithm is repeated on the same set of data starting with different center locations, the results may be better or worse than other runs of the algorithm. The number of iterations required before stability occurs is few. This has become, therefore, the most popular computerized algorithm to compute a large problem.

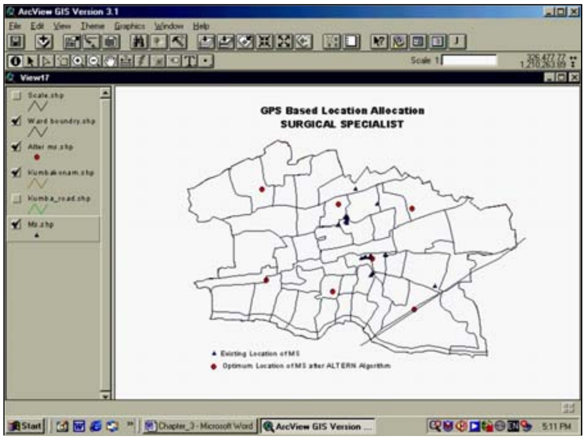
The algorithm uses the method of steepest descent in reaching a solution. The first estimate of the minimum point is the center of gravity and at each succeeding estimate a distance and direction are computed in order to locate the next estimate. The program will be terminated when the value of the location of the minimum point is within a specified tolerance, or when a specified maximum number of iterations have been performed, whichever is the first. The final result is the desired optimum point which minimizes distances. The point that derived is the optimum location for Referral hospitals, Public Health care service centers and the Health sub centers, with minimum aggregate distances from all demand points. That is, this optimum location is closest to all demand point in space.



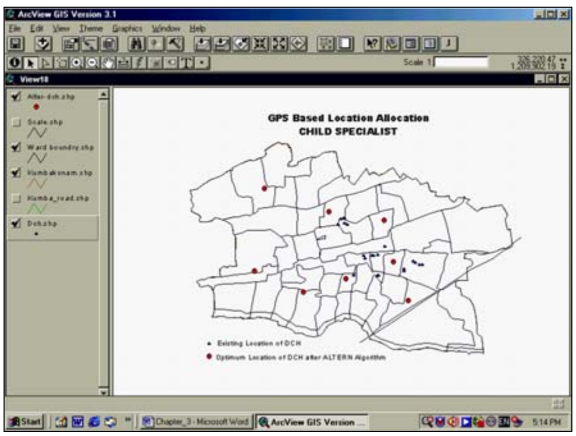
Map 15: Kumbakonam Town: GPS Based Location Allocation for all Women Specialists



Map 16: Kumbakonam Town: GPS Based Location Allocation for Private Hospitals



Map 17: Kumbakonam Town: GPS Based Location Allocation for Surgical Specialists



Map 18: Kumbakonam Town: GPS Based Location Allocation for Child Specialists

This method was applied to Kumbakonam, comprising an area of 12.38 sq. kilometer measured through GPS. The major health care services such as Private Hospitals, Women Specialist (DGO), Surgical Specialist, Child Specialist and Specialist in Medicine were selected for the location allocation analysis. To do this analysis the GPS measured locational co-ordinates for each and every centre of the ward (lat-long positions) were given as inputs (x and y co-ordinates) and the ward population as weights (z-variable).The `ALTERN' program then computes these co-ordinates and population and it allots the desired number of each and every specialization location according to the above equation 1.Accordingly for Private Hospitals (9 Health Care Centers-HCC), Women Specialist (HCC-18), Surgical Specialist (HCC-7) and Child Specialist (HCC-8) co-ordinates were given as output for the above analysis and they were plotted in the respective GPS enabled GIS Arc View maps. The maps are shown below (Map 15 to 18) confined to the redistribution map of the selected RMPs/ Hospitals. The women specialists are concerned there are at present 18 DGO's taking care from certain locations which is important on the land use point of view. Whereas the map indicates the relocated model of the distribution of DGO's in an even way with respect to the individual ward wise women population and if the model is applicable the women population have even access and also the villages of the periphery wards would also have access and they need not come and converge in one particular location of the women health care service provision. Similarly for the services of Private Hospitals, Surgical Specialists, Child Specialists, Specialists in Medicine were also computer using the GPS co-ordinates to find the optimum solution so as to have even access for the population depending on these services.

Conclusion

GPS is a near accuracy system that measures a point, line and area with an accuracy of 1 meter. It is a useful device which can be used to map any local area without depending on any inaccurate maps. The measurement system in the GPS can provide the necessary quantitative information in the instantaneous field work and the same data or any other information that is need to be attached with the data base attached with a point, line or area. This data can be retrieved in any GIS software and further GIS analysis can be performed. The similar method was used to map the Kumbakonam town limits with major roads and the selected Private Health Care service distribution. The present study has highlighted the spatial distribution of GPS and GIS based data base management system for the Private Medical Practitioners and Private Hospitals in the town and also to study their existing distribution pattern. Beyond this point the existing locations of the RMP's were also studied and using ALTERN alternate soulution method was implied on specified service categories for the redistribution solution.

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