Urban Mapping for Location of Hospitals in a Growth Center:

A Case Study of Khammam in India

Key Words: **GROWTH CENTER, CENTRAL FUNCTIONALITY INDEX, REMOTE SENSING, LOCATION-ALLOCATION, LAND USE AND LAND COVER.**

Dr.G.Padmarani, *

Dr.Satish Jayanthi, **

*Scientist ‘SE’ ISTRAC/ISRO/Department Of Space, India,

**Scientist ‘SE’ NRSA/Department Of Space, India.

ABSTRACT: Space has a profound impact on the organization of economic and social activities. Many countries irrespective of their level of development have increasingly become sensitive to a syndrome of problems crudely but succinctly expressed as a “ proplexy in the center and anemia at the edges”. On one hand, they have what seems to be excessive growth of their major city or cities with all the attendant costs of the society, on the other hand, they have regions often peripherally located, with more slower rates of growth, lower levels of employment and per capita incomes and a degree of out-migration which seems to accentuate the problems of each set region.

INTRODUCTION

The process of urbanization is eccentric of economic growth in a developing country. The converse is also true, in the sense that economic growth in any region gives rise to urbanization. With the enlargement of economic and social activities, dependance of one place on the other increases and all these places become an integral part of a system. The most important place of economics, social behavior and geographic allocation starts interacting with some places which might be still more important or central in the performance of services and functions. Even this center may fall short of expectations in respect of still higher level of services and functions so that they have to depend on the nearest city.

This would mean that within a region, not all settlements can afford to have all types of functions and services and selectively enters the process of analysis for location of different levels of functions and services at appropriate places. Satellite image that is truthful representation of earth surface and man's activity on it has become one of the essential tools to help us in planning.

Space has a profound impact on the organization of economic and social activities. Location theory developed as a discipline that addressed questions related to the spatial organization of activities. In the earlier models developed by Weber neither more complex single location problems nor the multi-faceted case could be solved. In the early 1960's several researchers working independently, formulated solutions to the general facility location problem.

CONCEPT AND THEORY OF GROWTH CENTERS

The concept of growth center evolved from an earlier approach of " Growth Poles " which were centers for economic forces but not necessarily concentrated in identifiable geographic centers. In the context of spatial development a regional growth pole has been defined as " Set of expanding industries located in an urban area and inducing further development of economic activity throughout its zone of influence". This in essence is the conceptual basis of the growth pole and growth center policy that has been adopted to develop backward regions including rural areas in a number of developing countries.

The two main reasons that have led to a rather ready acceptance of the growth center theory as a basis for policy are the problems generated by the metropolitan growth and the poor quality of life in the rural areas. The problem of over concentration of economic activities and social services in one or a few very large metropolitan centers have stimulated efforts to decentralize industries so that the economic growth would be more evenly distributed in relation to a country's population and natural locations. Some of the criteria that have been used to select industrial growth centers are the availability of untapped natural resources ion the backward regions and the existence of towns with industrial growth potential or frontier region requiring integration with national economy. The concept of growth centers does not necessarily imply the creation of whole lot of new towns in rural area, rather it implies concentrating of new investments in these existing centers that have greatest potential of developing into service centers in the near future. The nebulous of growth center theory has undoubtedly been one factor behind its widespread adoption in regional planning. The term has provided an expedient way in many cases of pro-urban policies. But, the basic implication of "steering a middle course which underlies growth - center policies, probably accounts for a large proportion of its popularity- a middle course between concentration and dispersion, efficiency and equity growth and welfare". It is clear that the ideas 'concentrated' decentralization have much more utility in our present society.

The point is that many countries irrespective of their level of development have increasingly become sensitive to a syndrome of problems crudely but succinctly expressed as a "perplexes in the center and anemia at the edges ". On one hand, they have what seems to be excessive growth of their major city or cities with all the attendant costs of the society, on the other hand they have regions often peripherally located, with more slower growth rates, lower levels of employment and per capital incomes and a degree of migration which seem to accentuate the problems of each set of regions.

The concept of development unlike that of growth relates not simply to a process of quantitative expansion but to a quantitative change. Development is an innovative process leading to the structural transformation of social systems (Priedman, 1969). The process of development can be conveniently described as the introduction and diffusion of successive waves of innovations in a functional and in geographic space (Hermenson, 1972). One of the justification for growth center policies is that innovations are necessary for development and they are normally introduced in successively low levels of urban hierarchy, but in cases of development trickling down the urban size is reaching and spreading its effect outward within the urban fields.

Study area: In Telegana region of Andhra Pradesh in India a few growthcenters of hierarchical

levels can be identified which are growing at a faster rate and rendering their services to vast hinterland with considerable functional gaps. For example, Hyderabad, Nizamabad, Karimnagar are coming up growth centers. Their hinterlands or complementary regions are vast. To avail the services and functional facilities, people from complementary regions are coming to these centers. Hence at the cost of the hinterlands the cities are developing adding up to the problems of urbanization. This problem can be resolved by increasing the number of growth centers by decreasing the distance between the center of services. Since the viability of functions depends upon the distribution of resources and human
behavior, the functions will also have hierarchical disparity in their distribution.

REMOTE SENSING APPLICATIONS: The primary base for the economic development of an economy lies in its natural resources. Evaluation of the resource potential of a country is therefore essential prerequisite for national development planning. Yet not enough information about the nature and quantity and location of these resources are available. Traditionally, resource and environment information has been acquired from different sources gathered by a variety of means and often maintained in separate agencies. For these and other reasons, current and accurate information is rarely incorporated in the planning process. The successful implementation of a development plan, is to a great extent dependant n the efficient management of available resources in accordance with the objectives of the plan. For a more comprehensive ways of studying a country's resource base and its environmental conditions is required for a sound planning. An answer to this, is remote sensing which is a technology providing information about the land and its natural resources. Remote sensing is a multi disciplinary technology system. It relies heavily upon physical means, mathematical analysis and geosciences rules and enables us to understand various conditions, characteristics and changes of the atmosphere, hydrosphere, biosphere and lithosphere. Based on this diverse scientific data, basic map information can be derived timely and can be continuously provided to users for various departments of planning, management and decision-making. A complete remote sensing exercise usually involves integrating imagery at several levels of resolution with other data sources such as, maps or aerial photography. Within a large region represented in a satellite image certain areas are usually selected for ground truth verification. In such an exercise using imagery has reduced the alternative cost of field check for the whole area. Remote sensing data can be applied to many sectors of planning. Land use and land cover mapping, Wasteland mapping, Agriculture production, Water resource management, Geological survey, Forest management etc. are some of the areas where remote sensing data has been successfully used.

METHODOLOGY AND DATABASE: Different types of analysis methods were used; in which the following steps were involved.

1. Location representations of functions/services data at each settlement level.
2. Land use / Land covers (LU/LC) assessment using remote sensing techniques.
3. Assessment of demand (population).
4. Assessment of functional gaps.
5. Settlement accessibility analysis.
6. Location - Allocation of services.

Location representations of functions/services data at each settlement level: The population and services information available at each settlement was procured from census of India and other district offices. A database for this was created. The data collected were on the number of hospitals, their location and the population being served. The point location of the settlement in the study area were all digitized and labeled using the Arc - Info package.

The attribute information of population and services were converted to ASCII format and imported to the ARC INFO. The imported tables were then related to the Graphic GIS coverage for further analysis.

Land use and land cover map: the satellite data of IRS 1B of 1993 covering the study area was taken up for LU/LC mapping and assessment. The digital data was geo referenced with the help of ground control points taken from the survey of India topographical maps. The area of interest was then extracted by marking and annotated. The data was then filmed and hard copies generated on 1:50,000 scale. These images along with the geocoded images of 1988 and 1989 were visually interpreted based on the image characteristics and the LU/LC details were identified and mapped.

Assessment of demand: the success and survival of any function or service depends on its clienteles or demand. Unless there is sufficient demand for a function it cannot continue for long. In the study area, the demand for service functions like hospitals, primary health centers, dispensaries are people. In the present study the population of each settlement has been taken up as the demand item for that settlement for service planning.

Assessment of functional gaps: In the absence of any straightforward standards that canbe adopted under Indian condition, the norms given by the planning commission of India has been adopted in this study. Based on these, the number of functions/services required for the study was estimated. The maximum distance (range), at which the facility should be available, was also adapted based on the planning commission norms. The functional gaps were then estimated based on the shortfall between existing facilities and what should be provided based on the standards. In many cases the number of function is primarily based on distance and in such cases the number of functions are decided based on the demand allocated to the center.

Settlement accessibility analysis The transportation links were extracted from SOI topographic sheets and digitized. The type of roads and new roads were updated by means of ground truth and satellite imagery. Attribute information based on the type of road Vis; metalled, unmetalled, and cart tracks were added to the database. Impedance values were then calculated based on these attributes. Since the travel time on each of these roads differ for the same length, the impedance was calculated at 1x road length for metalled road. 1.25x road length of unmetalled road and 1.5x road length for cart tracks.

Location: The network model of the Arc Info has been utilized for location- allocation of service. Based on the concept that the people utilize the service at the nearest location, the model works with the aim of optimizing the travel distance and in turn the weighted distances (sum of demand x distance) for each center, keeping in view the maximum distance criteria given. The center is decided based on repeated iterations until the weighted distance is minimum. The location of hospitals was established using this model. The total distance served at each center and the total weighted distance has been estimated.

Database: Based on the assessment of the plan framework and sectoral information needs, it was evident that the following two components are essential parts of this database.

Spatial data - consisting of maps from remotely sensed as well as conventional source.

Non-spatial data consisting of numeric attributes in respect of socio –economic characteristics from diverse sources and questionnaire. Further all spatial data will be on standard references and all non-spatial data will be on administrative hierarchy of village/ mandal / district.

Transportation network and connectivity: The creation of an infrastructure like transportation system is an essential prerequisite for the socio-economic development of an area. Although it is clear that mere provision of transportation facilities does not by itself Initiate development, inadequate transport may to limit or restrict growth/development. Generally transportation system has to serve two purposes. Vis., Accessibility and mobility. In an ideal situation the marketing, storage and processing as well as educational and medical facilities should be easily accessible to all the villages in the study area. Similarly, the transportation system should provide free and uninterrupted movement of people and goods. Thus, networking and connectivity from the vital link for the development of any area.

Transportation links in the study area: The transportation network can be spatially mapped from the various sources with the Survey of India topographic maps providing an ideal database. Thus the railway lines and various types of roads could be extracted and mapped. It is observed that in the study area, the total length of the metalled road is 598.93Kms; unmetalled roads are 890.45Kms; and cart tracks is 4003.08Kms. All the villages in the study area are connected by atleast a cart track. There are total of 14 railway stations in the study area and the railway lines pass for a distance of 167Kms.

Accessibility analysis: During the course of the analysis, the weighted distances are to be calculated for optimizing the location of a function. In the present study, the weighted distances were calculated based on the type of road as mentioned earlier.

Assessment of functionality index: For the identification of the growth center, the computation of functionality index of each settlement in the study area is essential. Functionality index basically speaks

about the centrality of that settlement vis-à-vis the other settlements in the area. Functionality index also gives an insight into the magnitude or size of the settlement. It is defined as the weightage of a given function in the study area multiplied by its frequency of occurrence in a given settlement. This can described mathematically as:

F1= (TS/FS) * N; where

F1= Functionality Index of "A" function in "X" settlement.

Ts = Total number of settlements in the study area.

FS = No. Of settlements possessing "A" function in the study area.

N = Frequency of "A" in "X".

The cumulating of all the functionality indices for a given settlement will give the Composite Functionality Index (CFI).

The computation of CFI values for all the settlements and the subsequent essaying in the descending order will give the functional hierarchy or the "Functional Dominant " and the "Functional Dependant " settlements within the study area. In other words, settlements with high CFI scores exert influence on the neighboring settlements and act as nodes for centripetal forces for smaller settlements to converge on it for their functional needs .

The settlements hierarchy that is derived simultaneously confirmed the position of Khammam settlement to be the functionally most important settlement in the study area and still caters for the needs of the rural populace in terms of their administrative, health, educational and industrial requirements.

There are however a large number of settlements without many functions and hence, they are very low in their functional hierarchy. Hence, it is very essential that these settlements with large functional gap should be provided with functions to improve its level in the hierarchy.

Assessment of demand for services: Distribution of optimal levels of services and facilities in relation to a settlement population size is a requisite in a balanced regional development. Thus, an important objective of spatial planning is to identify and correct imbalances in the availability of infrastructure services/facilities in the study area. An analysis of CFI values of the 371 villages varies from 14 to >700 CFI is considered to be central input which can address issues like; assessment of functionality centrality and their distribution within the study area; sector wise assessment of services and facilities and norms analysis; evolution of a hierarchy of settlements system.While the average CFI for the whole area works out to 28, it varies between the mandals that indicate the disparities in the levels of services. A few assumptions are that it is people in the study area avail the facilities from within the study area, secondly that people avail the services of the nearest location and quality of service is not considered.

Location and allocation of hospital: Provision of adequate medical facilities within the easy reach both in terms of cost and distance forms the primary objective of this plan. There are five hospitals serving a total population of 11.87 lakhs people. Apart from the existing five hospitals two more were required to be located. The objective weighted distance, which was 21318850 people-Kms. Earlier has been reduced to 14396120 people-Kms. Due to the location of these two hospitals. The average distance traveled has also reduced from 18.19 to 12.29 Kms (Fig1).

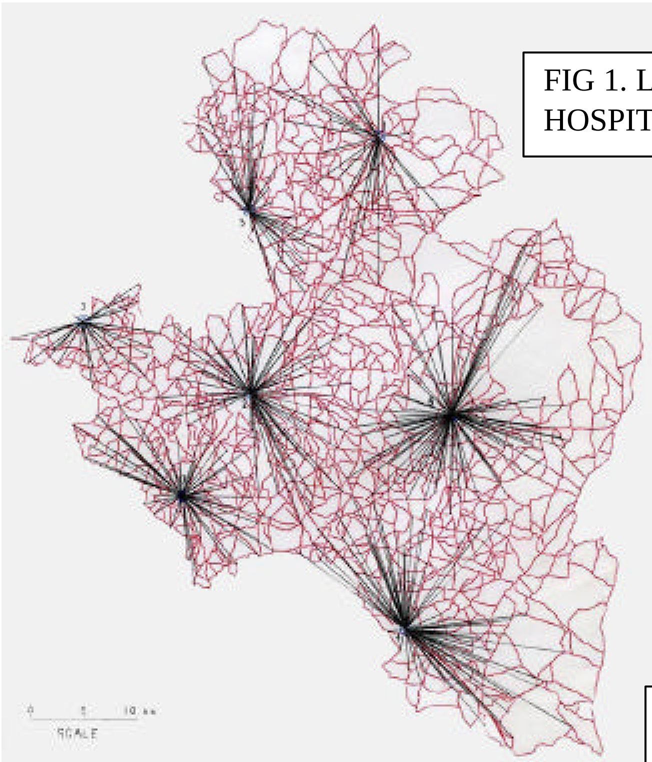

FIG 1. LOCATION/ALLOCATION OF HOSPITALS KHAMMAM REGION.

EXISTING HOSPITALS.

1. YELLANDU
2. KHAMMAM
3. SUBLAID
4. MADHIRA
5. GARLA

PROPOSED HOSPITAL:
6.TALLADA
7.SINGAREDYPALEM.

SOURCE: SOI TOPOSHEET NOS:560 65C &65D
DISTRICT CENSUS HANDBOOK,
KHAMMAM,CENSUS OF INDIA 1991.

Conclusions: In order to promote industrialization of backward areas in an effective manner, the focus is now on the development of growth centers that will act as a magnet for attracting industries to the backward areas. Location - allocation models have many applications: locating retail stores to maximize patronage, locating manufacturing outlets to minimize shipping costs and locating public services to maximize the quality of service to maximize the quality of service to the surrounding population.
These are just a few examples of applying location-allocation models for facility siting. There are many diverse applications for location-allocation in variety of disciplines. To use these models the input data of the resources is required. The remotely sensed data is a reliable source of information; hence, the location analysis using satellite data has proved very appropriate in the present study.

References:

1. Holmes, J., Williams F.B.& Brown
2. L.A 1972. Facility locationunder maximum travel restriction: an example using daycare facilities Geographical analysis, Vol4 pp 41-46
3. Jenson, J.R. 1986. Introductry Image Processing A Remote Sensing Prospective.

4. Lillesand, T.M & Keefer, R.W 1979.Remote sensing and Image Interpretation.
5. Berry, J.L 1967. Geography of market centers and retail distribution.
6. Ramani, K. 1990. Expert system for land use land cover categories from Satellite Data.
7. Re Velle, C. 1977 Facility Location A Review of Context -Free and EMS Models: Health Services Rearch Summer pp 129-145.
8. Schowengerdt, R.A. 1983 Techniques for Image Processing and Classificataion in Remote Sensing.
9. Teitz, M. 1968 Heuristic Method for Estimated Generalised Vertex Median of a Weighted Graph, Operations Research, Vol.13 pp 462-475.
10. High school location Decision Making in Rural India and Location Allocation Models, Spatial Analysis and Location Allocation Models, pp 137-162.
11. Regional Planning for Social Facilities. An Examination of Central Place Concepts And Their Applications.