Trans. Inst. Indian Geographers
Vol. 6, No. 2, July 1984

SPATIAL PATTERN OF URBAN CENTRES AND IMBALANCES IN REGIONAL DEVELOPMENT

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ABSTRACT : The urban centres develop definite regional trends and spatial variations in the pattern of distribution. Identifying such trends and variations, as well as the local factors accounting for the existing spatial pattern serve as meaningful pointers to finding methods of removal of prevailing regional imbalances. It is therefore imperative that a study on the spatial pattern of urban centres, while identifying the salient aspects of distribution pattern should explain, as well, the components comprising the internal forces at work within a region in order to reveal the role of local factors on its development. Trend surface analysis is one such measure of identifying the spatial pattern of urban centres as well as the role of local forces at work in discerning such pattern. Linear and quadratic trend surface models are fitted to identify the pattern of distribution of urban centres in Ramanathapuram District in Tamilnadu. The result reveals the existance of a regional imbalance in the distribution. The west and southwestern parts of the district have higher concentrations of urban centres and towards east and northeast the distribution is relatively sparse. The western and southwestern parts have high positive residuals highlighting the presence of local potentials for the development of urban centres while the sparse distribution of urban centres is exemplified by the presence of negative residuals speaking for poorly endowed development potentials.

INTRODUCTION

Economic and social conditions encourage concentrations of productive and developmental activities in the urban centres while the spatial aspects influence their (urban centres) spacing and size. The complex interplay of these two major factors ultimately control their distribution over space. Possessing such economic and social potential, the urban centres through their distribution over space exert strong and discernible control on the development of the surrounding rural areas as well.

As they emerge on space, the urban centres develop definite regional trends and spatial variations in the pattern of distribution. Identifying such trends and variations, as well as the local factors accounting for the existing spatial pattern serve as meaningful pointers to finding methods of removal of prevailing regional imbalances. It is therefore imperative that a study on the spatial pattern of urban centres, while identifying the salient aspects of the distribution pattern, should explain as well, the components comprising the internal forces at work within a region in order to reveal the role of local factors on its development. The empirical analysis of the pattern based on a sound conceptual framework requires identifying the appropriate analytical tools and procedures.

TREND SURFACE ANALYSIS

Nearest neighbour analysis and simplical graph method have demonstrated their applicability in the study of distribution of urban centres. But analysis of the spatial distribution of urban centres within a directed distance context necessitated choosing an appropriate technique of analysis suited to the exploration of regional trend. Trend surface analysis being a two dimensional least squares regression technique useful in analysing spatially continuous phenomena as statistical surfaces was opted for, as an exploratery and explanatory tool. This tool (TSA), a proven measure of spatial filtering is well suited to this task. The surface obtained could be considered as response surface from which aspects of origin, dynamics or process can be inferred wherein variations in any form may be thought of as responses to corresponding areal variations in the strength and balance of the controlling factors' (Chorley and Haggett, 1965). The ability of TSA to effectively generalise spatial pattern and to bring out the local forces at work in the form of residuals warrants its utilisation in understanding the existing pattern of distribution of urban centres.

AN OVERVIEW

The trend surface analysis was being applied very widely in Geology and Geomorphology, in studying the planation surfaces. King (1969) has used TSA to study the altitudinal data in the search of planation surfaces. Chorley and Kennedy (1971) have generalised the elevation of sand ridges to a quadratic surface. Using this technique Doornkamp (1972) evaluated, measured the scale of warping, and Pawling (1973) evaluated the regional trend. Heikkinen (1975) applied linear and quadratic trend surfaces as response surfaces. Heikkinen and Kurimo (1977) employed linear, quadratic and cubic surfaces to study the raised shorelines.

Despite the tedious mathematical computations involved, the TSA has been slowly gathering momentum to find itself being widely applied in geographical studies since its introduction by Chorley and Haggett in the sixties. They stressed its potentially wider range of applicability besides its use to such conventional isarhythmic surfaces as terrain elevation or isobaric pressure. Consequently, not only Geographers, but Economists too began using Trend surface mapping in analytical contexts of varying sophistication to less conventional surfaces such as social and economic phenomena at the regional and inter and intra-urban scales. Haggett (1964) has fitted a linear trend surface to separate regional and local components in the distribution of forests. Gould (1966) has fitted trend surfaces upto third order to the development process of historical settlements. Fairbarn and Robinson (1967) have examined the location pattern of urban services among a set of towns and also have evolved a pattern of residuals from regression. Newling (1969) has used a second order polynomial to describe population densities and change within North American cities. Muller (1973) used second and sixth order polynomial trends in studying the pattern of net income per acre. Urban growth rates were studied by Robson (1973) using TSA upto sixth order. Yeates (1974) has applied non orthogonal polynomials of orders 1 to 3 to a random sample of the dates of foundings of certain settlements to develop a series of dischronic trend surface models. Wrigley (1975) has analysed the perception of noise disturbance around Manchester (Ringway) airport by obtaining the first three orders. While Cliff et al. (1975) have analysed housing densities, Schroeder and Sjoquist (1976) have applied TSA (upto sixth order) to identify population density surface. McDonald and Bowman (1979) have used TSA for an analysis of land values; Jackson (1979) for an analysis of hedonic housing prices; Hembol and Infanger (1981) for estimation of the sequential land value surfaces and Parker (1981) for analysing the residual land use intensity and household housing expenditure surfaces.

As against such wider application in Human Geography TSA has not been used in understanding the regional trend and spatial variation in the distribution of urban centres. The present study applying TSA upto the second degree identifies the regional trend, in the pattern of distribution of urban centres (measured in terms of number of service establishments) as well as the local factors contributing to the existing regional trend in Ramanathapuram District, a backward area in Tamilnadu.

TSA : THEORETICAL BACKGROUND

The urban service surface is a function f(x,y) of two variables. Each (x,y) pair denotes a location point within the geographical coordinate system of the study area. The number of service establishments measured at each of the (x,y) points, namely the urban centres constitutes the Z variable. Thus the data set consists of (x,y,z) triplets – one triplet for each urban centre.

The method adopted in TSA is least squares regression, where the (x,y) locational coordinates are treated as the independent variables and Z value is the dependent variable. Viewing the values of Z – number of establishments – as points in the actual urban service surface, TSA fits a surface to the (x,y) coordinates of the points, which minimizes the differences between the fitted and actual surfaces. TSA through a series of filtering process seperates and describes the components of variations present in the actual distribution. This is done by identifying the function Z = f(x,y) that isolates and represents the essential features of the regional variation pattern of Z and the local factors influencing the actual observation of Z.

The progressive TSA programme, expansions of polynomial functions from degrees one through six, take the general form:

$$= a + bx + cy + dx^2 + exy + by^2 + \ldots$$

The linea and quadratic surface models applied in this study take the forms:

$$z = a + bx + cy$$

and

$$z = a + bx + cy + dx^2 + exy + by^2 \ldots$$

respectiv ly, where z is the number of establishmen s at any given points. A plot of the first degree (linear) equation is that of a plane and provides an indication of the general overall trend of the variable under consideration according to its dip. The second degree (quadratic) equation plot allows the surface to have one extremum while third – and higher – degree polynomial plots represent surfaces with the maximum number of extrema possible; the number of extreme in each case being $(n-1)^2$, where n is the degree of the polynomial.

REGIONAL TREND

Linear and quadratic trend surfaces and associated residuals are defined for the distribution pattern of urban centres. The array consists of 34 points spread over the entire study area. The study possible constraint of the data set could be that the urban centres are not uniformly distributed in space (in the study area). Further, there are no more than 34 urban centres in Ramanathapuram District, all of them, therefore, have been subjected for the analysis. Hence certain deviations found to surface in the result may be considered definitely due to the above limitations.

As observed in Table 1 the linear trend surface explains 1.9% more of the variation than the quadratic surface. The non-systematic distribution of data points explains the lower values of % RSS for quadratic surface.

The explanatory power (% RSS) for linear surface is only 20.4%. The linear surface possessing much lower explanatory power is obviously due, largely, to the nonsystematic distribution of the urban centres leading to the intercorrelation between independent variables [1].

The linear trend presents a highly generalised first order surface (Fig. 1). The isopleths run from the Northwest to the Southeast, with a dip towards the Northeast. A higher proportion of urban services (more than 900 establishments) is found in the southwestern part of the study area and declines steadily towards Northeast to a minimum of less than 350 service establishments.

The explanatory power (% RSS) of quadratic surface is only 18.5%, which again could be attributed to the factors responsible for a low explanatory value of the first degree surface. The quadratic surface reveals a ridge of higher proportion of urban services (above 650 service establishments) in the central part of the study area abutting the northern banks of the river Vaigai (Fig. 2). The surface slopes down to the north and south while climbing up with a steeper gradient to the west of the ridge reaching a maximum of 1000 service establishments.

LOCAL FACTORS AS REGIONAL TREND

Figs. 3 and 4 depict the pattern of distribution of residuals from linear and quadratic trend surface models respectively. The areas of negative residuals are found in the southern part of the study area and on the northeastern part except for the zones of positive residuals around Karaikudi-Devakottai and Tiruppattur Sivaganga (Fig. 3). The central belt of positive residuals runs along the course of the Vaigai river forming a corridor. The pattern of distribution of positive and negative residuals resulting from quadratic trend surface model presents almost an identical pattern like the linear residuals except for the break in the southern belt of negative residuals (Fig. 4). The national highway from Madurai to Kanyakumari passing through Virudunagar has contributed significantly to the development of service establishments in this area. The negative residuals over northeastern part has shrunk in its extent. Around Tiruppattur – Karaikudi – Devakottai, a zone of positive residuals is found.

The trend and residual surfaces of the first degree polynomials (Figs. 1 and 3) put together explain the capability of the urban centres in extending their services to the surrounding rural areas. The declining surface towards northeast forms an area of negative residuals except for certain isolated pockets of positive residuals. Similarly,

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1. Heikkinen (1975) reasons out the higher value of % RSS as a result of absence of intercorrelation between independent variables owing to the systematic distribution of data points. Here, in the present the reverse of this statement holds good.

TABLE 1 : PER CENT RSS VALUES AND F VALUES WITH THEIR LEVELS OF SIGNIFICANCE

Trend Surface	% RSS	F Value
Linear	20.4	2.05 (.1% level)
Quadratic	18.5	2.65 (.025% level)

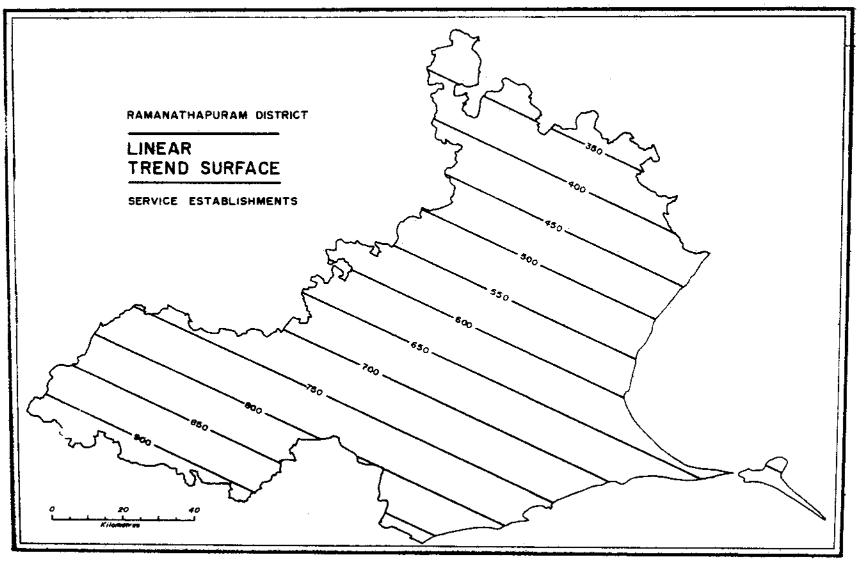

Fig 1

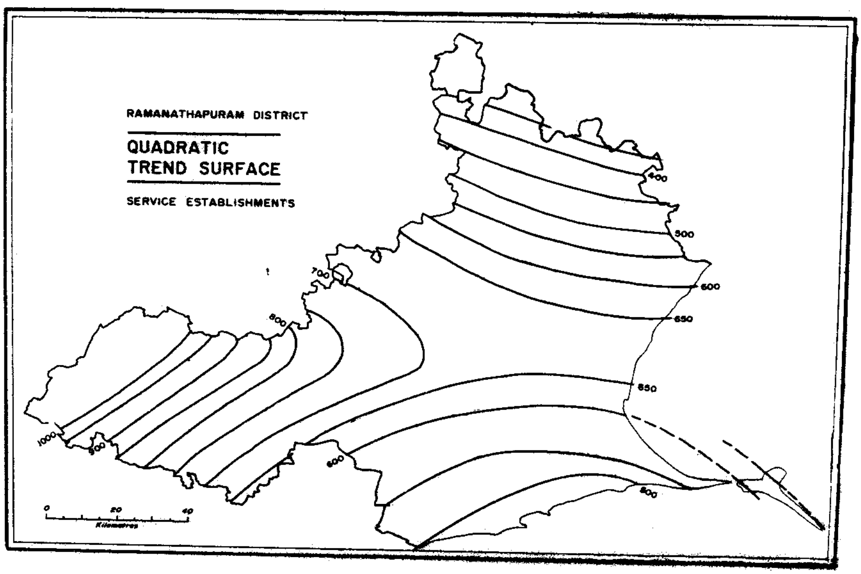

Fig 2

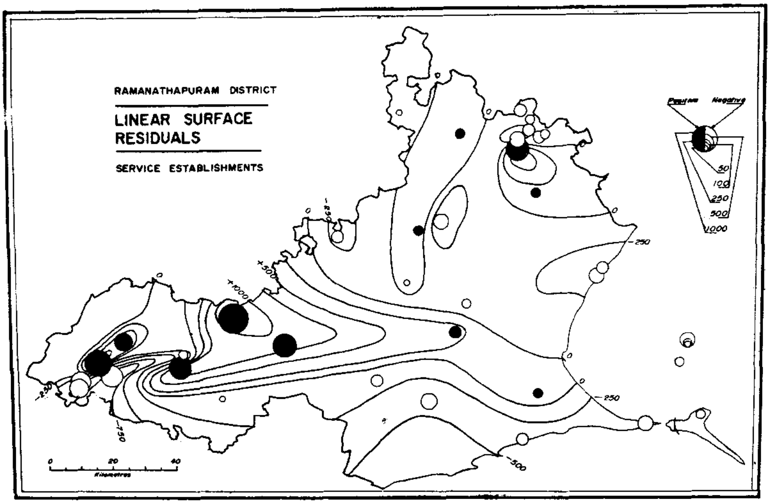

Fig 3

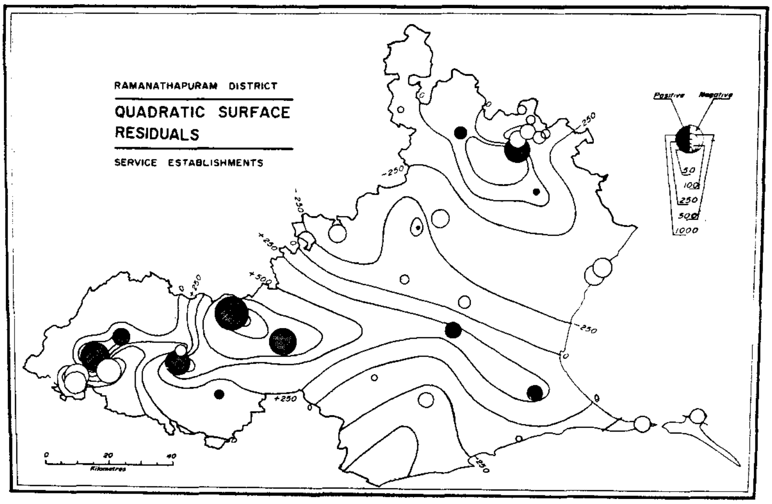

Fig 4

the southern part of the study area forms a zone of negative residuals. As the surface climbs up on the western part of the study area, a zone of high positive residuals also gain prominance. This zone further extends along the course of river Vaigai, forming a central belt, upto Ramanathapuram.

The trend and residual surfaces of the second degree polynomial (Figs. 2 and 4) emphazise the findings of the linear model except for certain deviations. The central ridge of 650 service establishments in the trend surface forms the zone of negative residuals. To the north of the ridge, along with the declining trend of the surface, a zone of negative residuals also emerge, alongside a significant smaller zone of positive residuals around Tiruppattur – Karaikudi – Devakottai. To the south of the ridge, the surface forms a narrow belt of positive residuals. As the surface further declines, the negative residuals keep increasing towards the periphery reaching a maximum of –500. On the other hand the surface increases in value towards the west, with a parallel increase in positive residuals displayed by the higher order urban centres.

The significant aspect of both the linear and quadratic residual surfaces is that the positive residuals persisting in the western part extends into its southern periphery as Sattur displays positive residual.

The prevailing positive residuals in the western part exemplify the higher level of development potentials in this area. This is largely due to the better resource endowment coupled with good transport linkage to the north and south contributing to accelerated economic development. The extension of this zone of positive residuals further east upto Ramanathapuram along the Vaigai river which is straddled by the national highway and the Madurai – Ramanathapuram rail link further underlines the role of transport network in the growth of urban service system. The positive residual over Karaikudi is accounted for by the conspicuous absence of any higher order urban centres in its vicinity as well as the lower service potentials of the smaller order urban centres.

The smaller order urban centres generally display negative residuals irrespective of their location. This is mainly due to the overshadowing effect of the higher order urban centres, which hamper the growth of smaller centres, when the later are found closer to them. Rajapalayam and Karaikudi convincingly substantiate this aspect. On the other hand the negative residuals of the smaller order centres located away from larger urban centres is solely due to poor resource endowment, both physical and fiscal, of the surrounding rural areas, curtailing the buying capacity of the population, as illustrated by the urban centres in the northern and southern parts of Ramanathapuram District.

CONCLUSION

The existing imbalance in the regional development of Ramanathapuram District is succinctly brought forth by the analysis. The western part of the district seems to possess a higher level of economic development in contrast to the northern and eastern sectors. The local factors accounting for deviations from their general regional trend are well illustrated by the analysis. The differential values of positive and negative residuals firmly emphasize the importance of such local factors as (i) the over shadowing effect of the larger order urban centres in their closer proximity, and (ii) the inadequately endowed pockets of varying proportions unable to generate sufficient system of feedback in the smaller order urban centres even when located in the typical rural areas.

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