through selective, diversified and decentralized provisions of infrastructure and overheads. These points, being closer to the people, prove to be more suitable, for injecting the elements of growth and welfare, at lowest level. Experience shows that, trickling down of benefits, from such centres to surrounding settlements, is natural process. Keeping in view, the maximum diffusion of innovations and benefits, the rationalization of spatial organisation of settlements, at this rural level becomes necessary, e.g., number, size and spacing of these centres in a region. For a well linked hierarchically arranged growth centre, i.e., optimum location, one looks towards the Central Place Theory.

The Central Place Theory

Walter Christaller (1893-1969), a German scholar, submitted his dissertation on the structure of settlements in the Southern Germany in 1932 to the University of Erlangen. He was influenced by the locational theorists like J.G. Kohl, Johann von Thunen, Alfred Weber (Christaller's former teacher) and also the settlement geographer Robert Gradmann. His works got greater recognition in the 1940s and 1950s, when scholars in the United States, realized their value.[5] The gist of Christaller's theory, stripped of details and elaborations (given in the sequel), is as follows:

(1) A central place is located at the centre of the minimum aggregate travel distance, provides functions and services to its complementary zone, as well as minimum cost, to the customers, and the maximum profit to the sellers.

(2) Hierarchy of central places exists, where higher order places provide functions, which the lower order places do not have. But, the reverse may not be true. The higher order places provide functions, in addition to, what the lower order places have.

(3) Unique functions to the higher order places have wider area of influence, than those which are common.

(4) Higher order places command a larger area than the lower order places, i.e., former have higher degree of centrality.

(5) The higher order places are widely spaced and fewer in number.

(6) The higher order centres, not only possess, unique function but also, a larger number of establishments, providing lower order ubiquitous functions than the lower order places. This is, because the customers minimise the travel distance cost by shopping, both, higher order and lower order goods in the same place.

(7) Hierarchy of central places develop with each order of centre nesting the lower order centre. The nesting of lower order centres, within a hexagonal complementary zone, is determined by three principles: (i) marketing, (ii) traffic, and (iii) administrative.

The basic concepts of the theory, can be best explained, through the study of movements, networks, nodes, hierarchy and surfaces (zones of influence) as successive stages. The core of the Central Place Theory is, thus, formed by six basic concepts[6] as enumerated and explained below.

(1) *Centralization as an ordering Principle*: Christaller propounded, that services tend to concentrate around certain points, which are more important, rather than around, other points.

(2) *The Central Place*: It is the most important aspect of the theory. It provides goods and services to an area larger than itself. The Central Place is determined by its centrality in the region. There are area bound and point bound places or settlements around it. The number of central functions performed, the size of the population served by these centres, determine the rank, of course, according to a notional scale of ordering, hence, higher and lower order

places.

(3) *The Importance and Centrality*: The importance of a settlement, is not the sum total of its inhabitants, but rather of their combined economic efforts. It may be that correlations exist between size of population and degree of centrality.

(4) *The Central Functions*: These functions are those, which by their nature are available in a few places but are availed of by a number of places. Thus, central functions are non-ubiquitous. The degree of a function is supposed to vary, inversely, with the frequency of its occurrence. The higher order central functions, belong to higher order Central Place, and the lower order functions, belong to a lower order central place or an auxiliary central place. These functions are trade, banking, administration, education, commerce and transportation.

(5) *Complementary region*: While a central place is one, where an importance-surplus exists, a complementary region is one, where an importance-deficit exists. The former balances the latter through functions and services.

(6) *Economic Distance and the Range of A Good*: The spatial supply of, and demand for, goods and services are determined by factors like freight, storage cost, loss of weight and the time; in the case of passenger movement, by travel cost, travel time and discomfort perceived by the consumer. Proceeding further from the Central Place, the cost of travelling to the central place, besides the cost of goods and services on arrival, is so great that consumer demand is reduced to zero. This *distance* is called the range of a good or upper limit. Likewise, any good or service, has a threshold of demand or size of market area, which is the minimum number of consumers required to support a business (Fig. 9.1). A primary school or a local grocery has a low threshold, whereas a Higher Secondary School or a departmental store has a high threshold or lower limit. It shows, that each good or function, has its own characteristic range, which may vary from one central place to another. The upper limit is a *spatial index*, determined by the farthest distance from the central place; the lower limit is a *quantity index*, determined by the minimum number of people required to support that function in the central place.

Christaller's Centrality of an urban centre, however, was defined as *the ratio* between all the services provided there, (for both, its own residents and for visitors from its complementary region) and the services needed just for its own residents. Centres with high centrality supply many services per resident, and those, with low centrality, few services per resident. Christaller

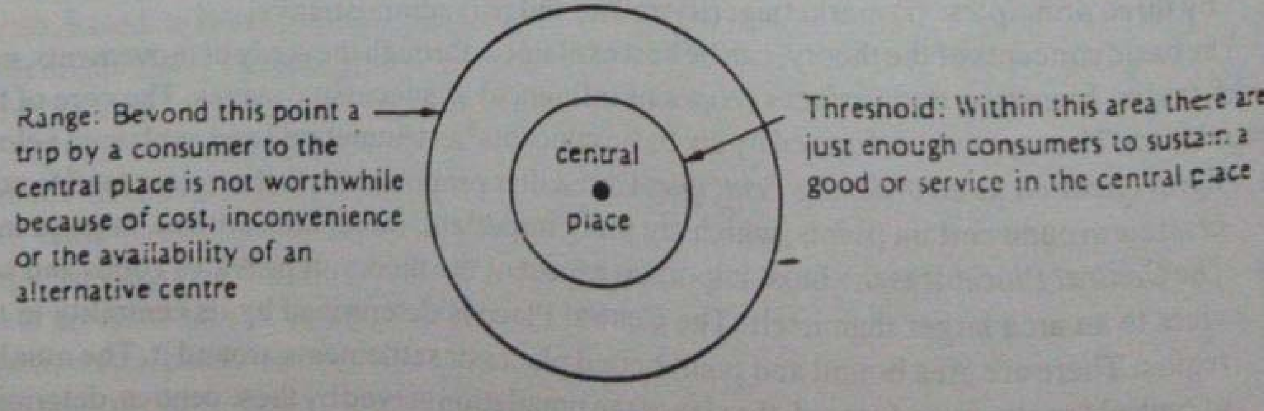
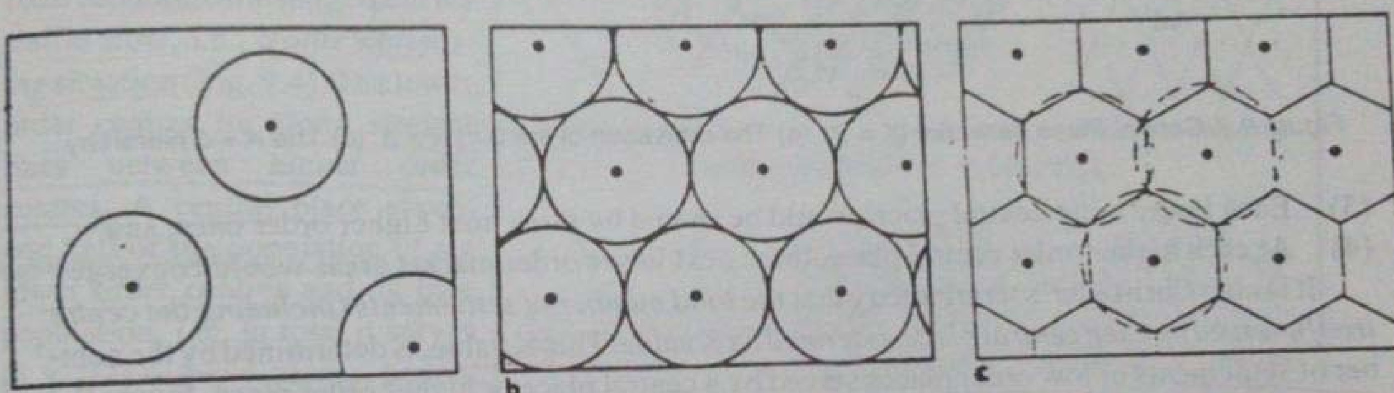


Figure 9.1: The threshold and range of a good or service

discovered in his study that the number of telephones provided a useful indicator for the range of central goods available in a town. With the telephone data he defined the centrality of a town, as equal to the number of telephones in the town, minus the town's population multiplied by the average number of telephones per population in the towns' complementary region, e.g., a town of 25,000 with 5000 telephones in a region with 1 telephone for every 50 people would have an index of 5000- 25000 (1/50) or 4500. This index, basically, measures the difference between the expected level of services (required in a town to serve its residents) and the level of services actually measured within the centre. But, later on, the two concepts of *range of a central good* and *market size threshold*, discussed earlier, proved to be the basis of his theory.

Complementary Regions and Hierarchy

On the basis of two concepts of range and threshold, it is now possible to see, how an hierarchy of central places, supplying goods of different orders, develops (Fig. 9.2). In the stages of colonization of the area, the arrangement of central places follows, the best suited geometrical form, triangular lattices tessellation, thus, giving final hexagonal pattern. Five assumptions precede such a pattern:



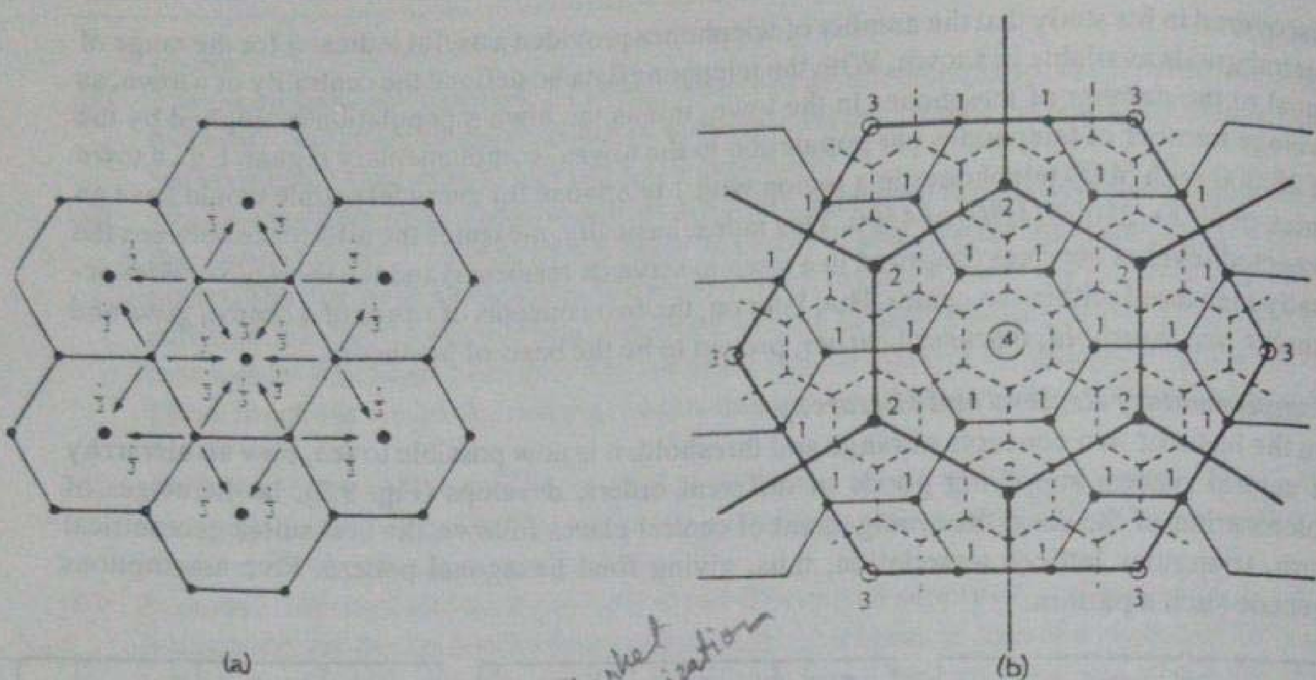
a b c

Figure 9.2: Stages in the development of hexagonal market areas (a) Isolated central places in an area of low population density (b) Population growth leads to increase in number of central places—market areas touch (c) Further population growth means that, to pack central places even more densely, market areas have to overlap and hesagons are produced.

(1) The region should form an isotropic plain with a homogeneous distribution of purchasing power,
(2) Central goods must be purchased from the nearest central place,
(3) The Central place's complementary zone must coincide the plain boundary,
(4) Consumer movement must be minimized,
(5) No excess profits may be earned by any central place.

If this pattern is observed at lower level, for successively lower order goods and central places, down to the lowest order ones, one gets a complete hierarchy of centres and market areas. The main features of such an hierarchy, obviously, emerge as follows:

(1) Each lower order central place, would be located, midway between three higher order central places,
(2) Each higher order central place would have, six next lower order ones around it-one on each of the six points of its hexagonal market area,

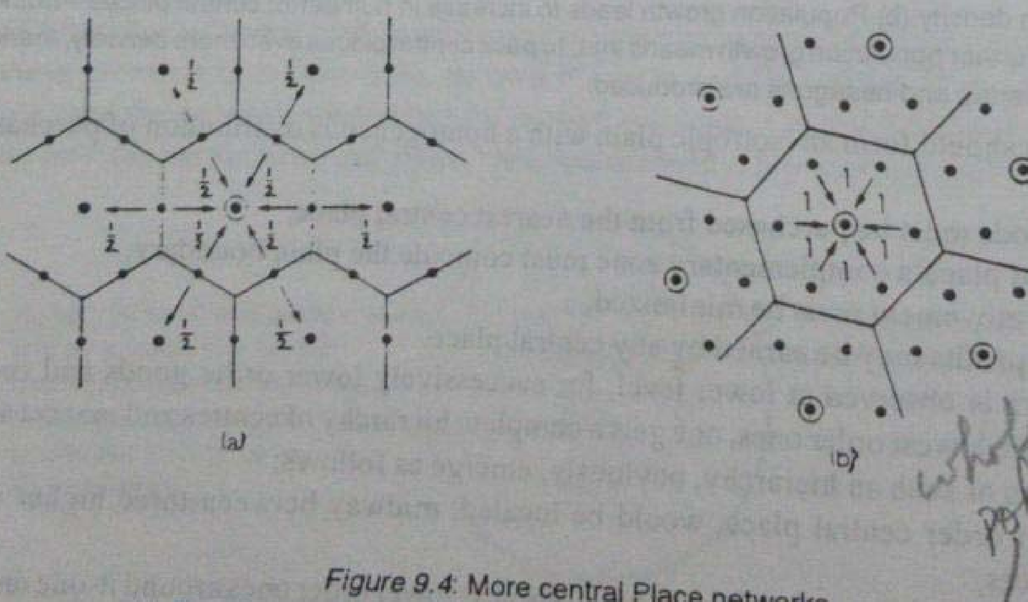


Market optimization

Figure 9.3: Central Place networks (K = 3) (a) The derivation of the 3 in K = 3 (b) The K = 3 hierarchy

(3) Each lower order central place, would be shared by three next higher order ones, and
(4) At each higher order central place, three next lower order market areas would converge.

It is also Christaller's terminology that *the total number of settlements (including the centre itself), served by each central place, is termed its K value*. This K value, is determined by the number of settlements of low order places served by a central place or higher order place. Figure 9.3



whole pop

Figure 9.4: More central Place networks
(a) The derivation of the 4 in K = 4 (b) The derivation of the 7 in K = 7

Traffic optimization

shows that a first order centre provides goods and services for one third of the population of six settlements as well as its own population, it, thus, serves the population equivalent of three settlements, i.e., K=3. This, provides efficient marketing, and in its most simple form, allows consumers in the lower order centres, to choose between three competing central places, hence, *market optimizing case* or *marketing principle* of Christaller. The K=4 network is the most economical arrangement for traffic flow, i.e., *traffic optimizing* situation (Fig. 9.4). The lower order centres lie along straight lines between higher order centres. A central place serves one half of the population of six lower order centres and its own population, i.e., in total it serves (6 × 1/2) + 1 = 4 places, hence, K=4 hierarchy. In an administration-optimizing situation, there is clear-cut separation of the higher order centre and its neighbouring lower order centres. The central place serves, the entire population of six lower order places, plus its own population, hence, K = 7 hierarchy[6a] Fig. 9.5. These were called by Christaller as fixed-K hierarchies, because, the same fixed relationships hold at all levels of the settlement hierarchy (Fig. 9.6).

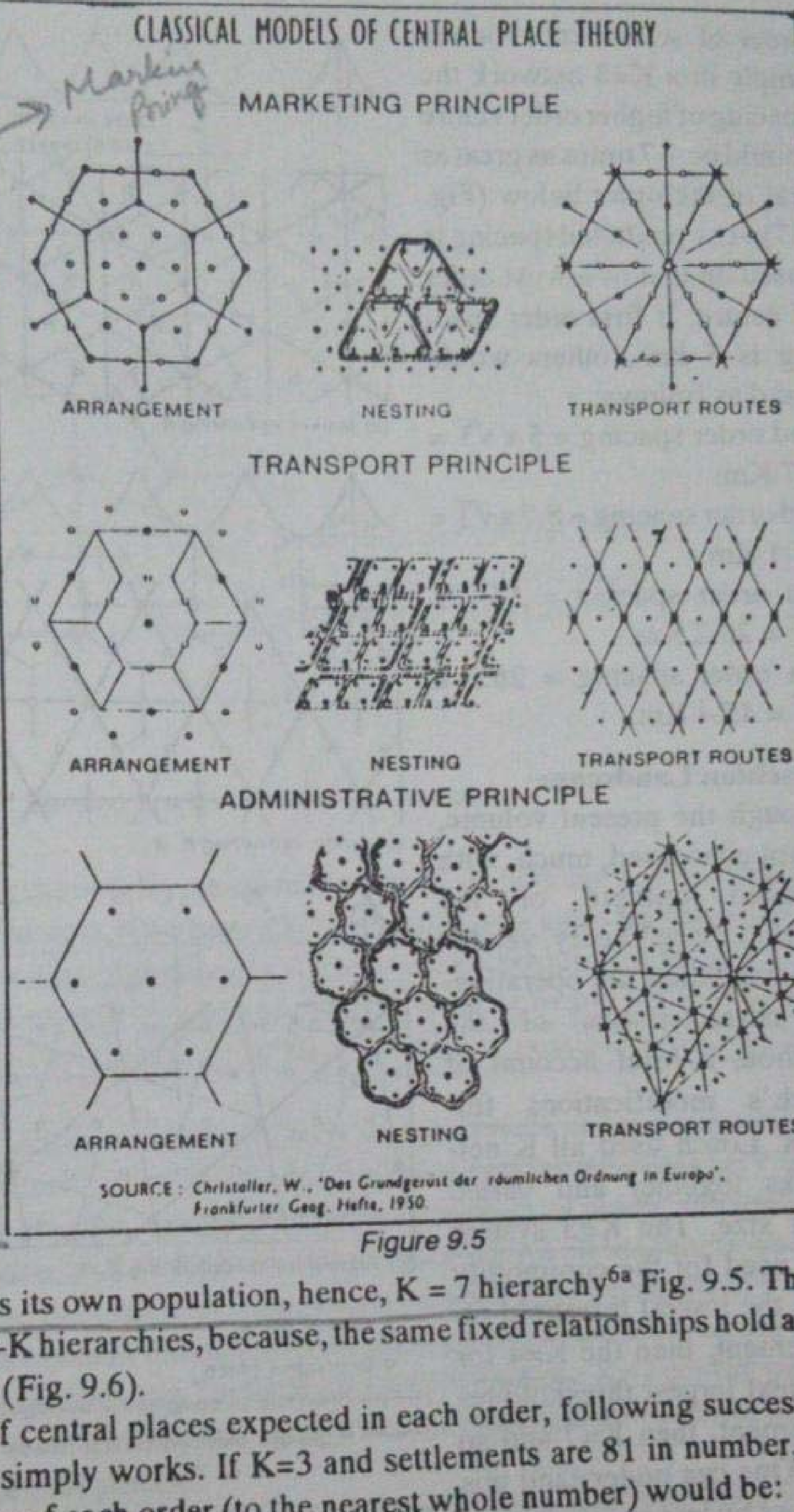


Figure 9.5

For calculating the number of central places expected in each order, following successive subtraction and division method simply works. If K=3 and settlements are 81 in number, the predicted number of central places of each order (to the nearest whole number) would be:

1st order = 81-81/3 = 54
2nd order = 81/3-81/9 = 18
3rd order = 81/9-81/27 = 6
4th order = 81/27-81/81 = 2
5th order = 81/81-81/243 = 1

The average spacing, between centres of each order, will become greater with increasing order of settlement. For example in a K=3 network the spacing of higher order centre should be 1.7 times as great as that of the order below (Fig. 9.7). Any predicted spacing is based on that of lowest order of centre. If first order spacing is 5 km., others would stand as follows:

2nd order spacing = 5 x $\sqrt{3}$ = 8.7 Km.

3rd order spacing = 8.7 x $\sqrt{3}$ = 15.1 Km.

4th order spacing = 15.1 x $\sqrt{3}$ = 26.2 Km.

5th order spacing = 26.2 x $\sqrt{3}$ = 45.4 Km.

Löschian Landscape

Though the present volume, is not concerned, much, with detailed critique of the Central Place Theory, yet, for understanding the operational characteristics of the method, a brief account of losch's modifications follows. Lösch used all K networks together and varied their size. The K=3 system was used for the commodity with the lowest threshold requirement, then the K=4 for the next largest threshold requirement, then K=7 and so son. One can understand this process by imagining that the fixed K=3 network is drawn on a map. The K=4 network is now drawn on an overlay of transparent tracing paper and pinned to the K=3 map by a single thumb tack through the

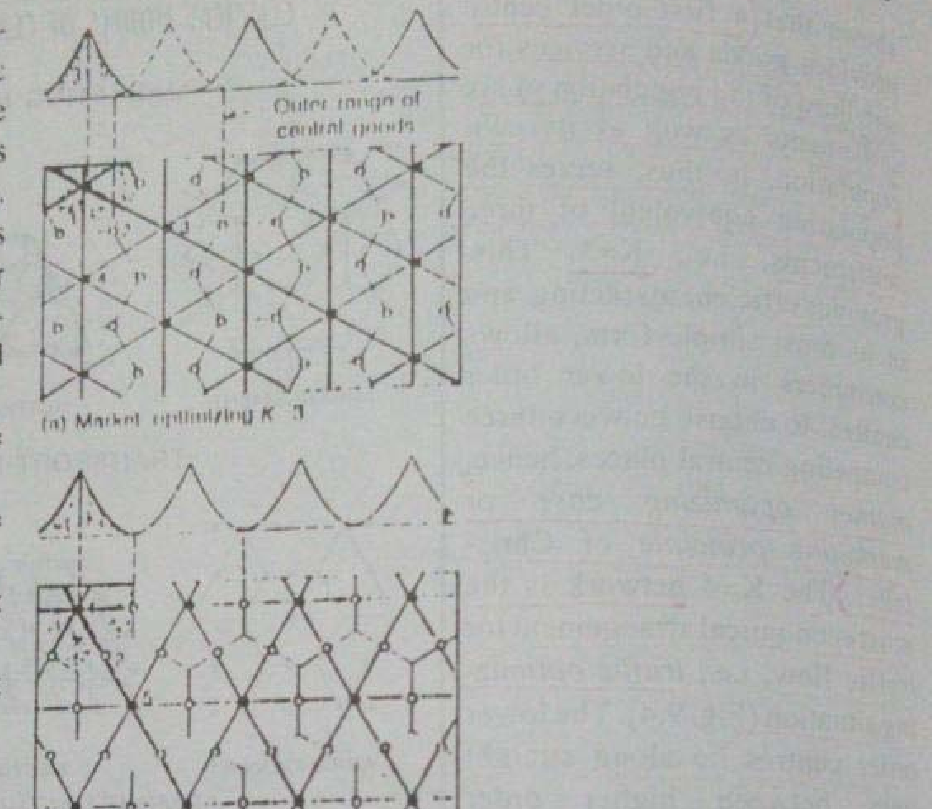


Figure 9.6. Alternative principles of organization in the Christaller model. Settlements can be partiltioned in one of three basis ways, (a), (b), or (c), by enlargning and rotating the hexagonal cells. The cells can then be grouped hierarchically to give tiers of higher-order centres; for example, (d) shows higher-order centers in a traffic-optimizing (K = 4) hierarchy. Note the way in which lower-order centers "nest" whthin the market areas of higher-order centers in a manner reminiscent of sets of Russian dolls.

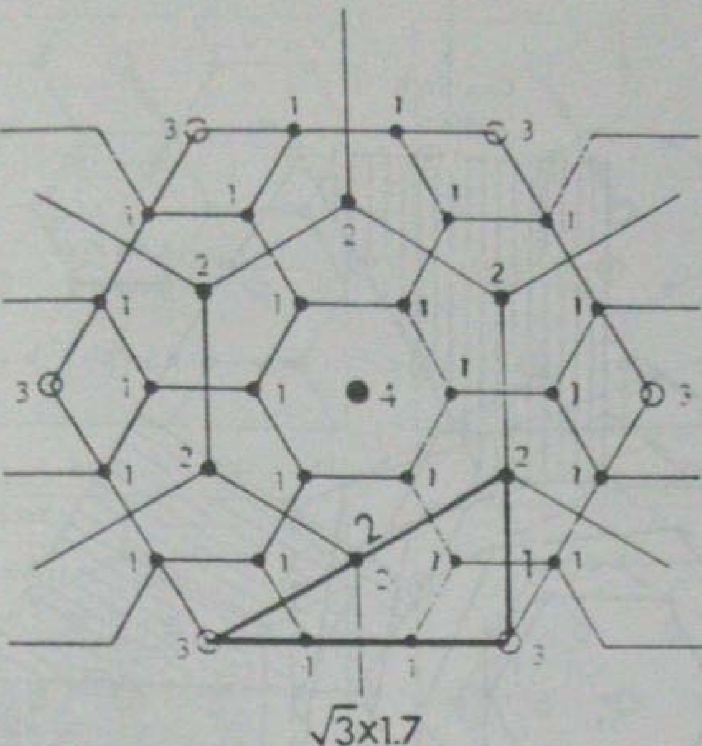


Figure 9.7: Spacing in a K = 3 settlement hierarchy

common central place. By rotating the overlay, many major places, on both the K=3 and the K=4 paper, are made to coincide. For example, if we have a K=3 school system and a K=4 hospital system, we try to rotate the overlay so that high school and the Doctor's hospital, both, coincide in the same locations, rather than being split between two. Lösch went on to add the K=7 and still higher K network to the map, always trying to get as many services as possible to overlap in the same locations.

Rotation, thus, produces 12 sectors of which six offer many services and the remaining six offer few services. Lösch called these *city rich* and *city poor* sectors respectively (Fig. 9.8).

Thus, Christaller's hierarchy, consists of several fixed tiers, in which all places, in a particular tier, have the same size and function, and all higher order places perform all the functions of the smaller central places. *In Contrast*, the Löschian hierarchy is far less rigid. It consists of a nearly continuous sequence of centres rather than distinct tiers. So, settlements of the same size need not have the same function (e.g., a centre serving 7 settlements may be either a K=7 central place or a centre where, both, a K=3 and K=4 central place coincide) and larger places need not perform all the functions of the smaller central places.[8]

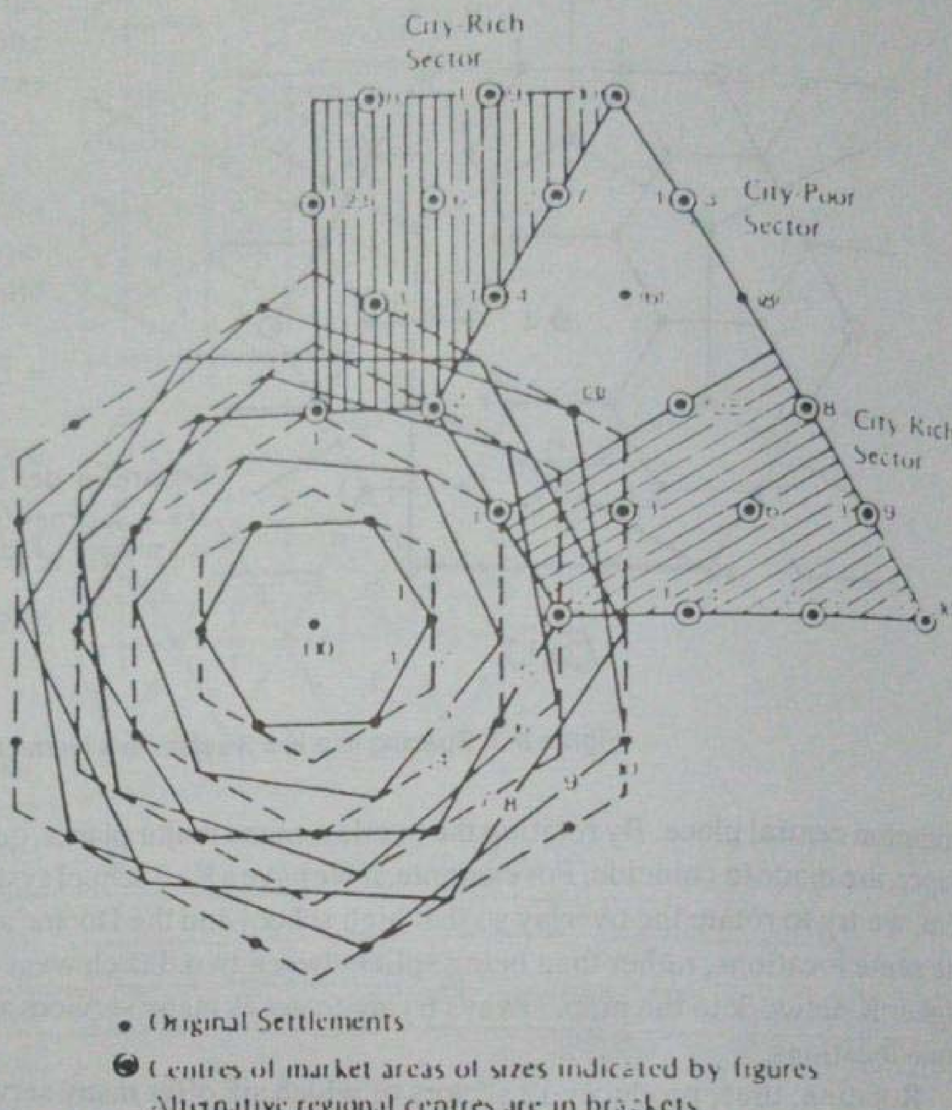
The hexagonal territories in a Löschian landscape is clear from the map (Fig. 9.9a, 9.9b).

Lösch's landscape was criticized by Walter Isard for failing to take account of variations in population density. The economic landscape produced, when variations in population density are considered, is clear from map (Fig. 9.10); there is a set of irregular sized polygons, each containing the same number of people, smaller ones being found nearer city centres.[9]

Lösch also marks an attempt to introduce economic equilibrium conditions, but Beckmann finds these inadequate.[10]

Identification of Hierarchy

The foregoing discussion, on the nature and concept of growth centres and Central Place Theory, provides sufficient understanding for proceeding towards measuring the centrality and hierarchy of settlements. As referred to earlier, the centrality of a place is equal to its surplus of importance, i.e., equal to the relative importance of this place in regard to region belonging to it. It is the outcome of the quality and quantity of functions performed by a settlement. These central functions, are available in a few settlements, but, are availed of by a number of settlements. Obviously, the degree of importance of a function, is supposed to vary inversely, with the frequency of its occurrence. The level and types of functions, both, affect the quality of a central function.



Figue 9.8: The ten smallest possible market areas

Thus, the hierarchy of settlements, is closely associated with the hierarchy of central functions. This functional hierarchy is decisive in measuring centrality, which needs measurement of the level and number of functions available in a centre. Let us discuss its various aspects.

(a) *Methods*: Various *methods* are used to measure the centrality of functions and settlements and their hierarchy. These are: (i) Scalogram analysis, (ii) Population threshold and ranking of central places and functions, and (iii) Ranking of settlements on the basis of hierarchy of function.[11] We may digress a little, to consider other aspects of hierarchy, before coming again to a tested method to be adopted for study.

(i) Rank Size Rule

Functional hierarchy and rank size rule are also closely related to the spatial distributional pattern of settlements in rural landscape. Relation between the rank of a settlement and its size, and

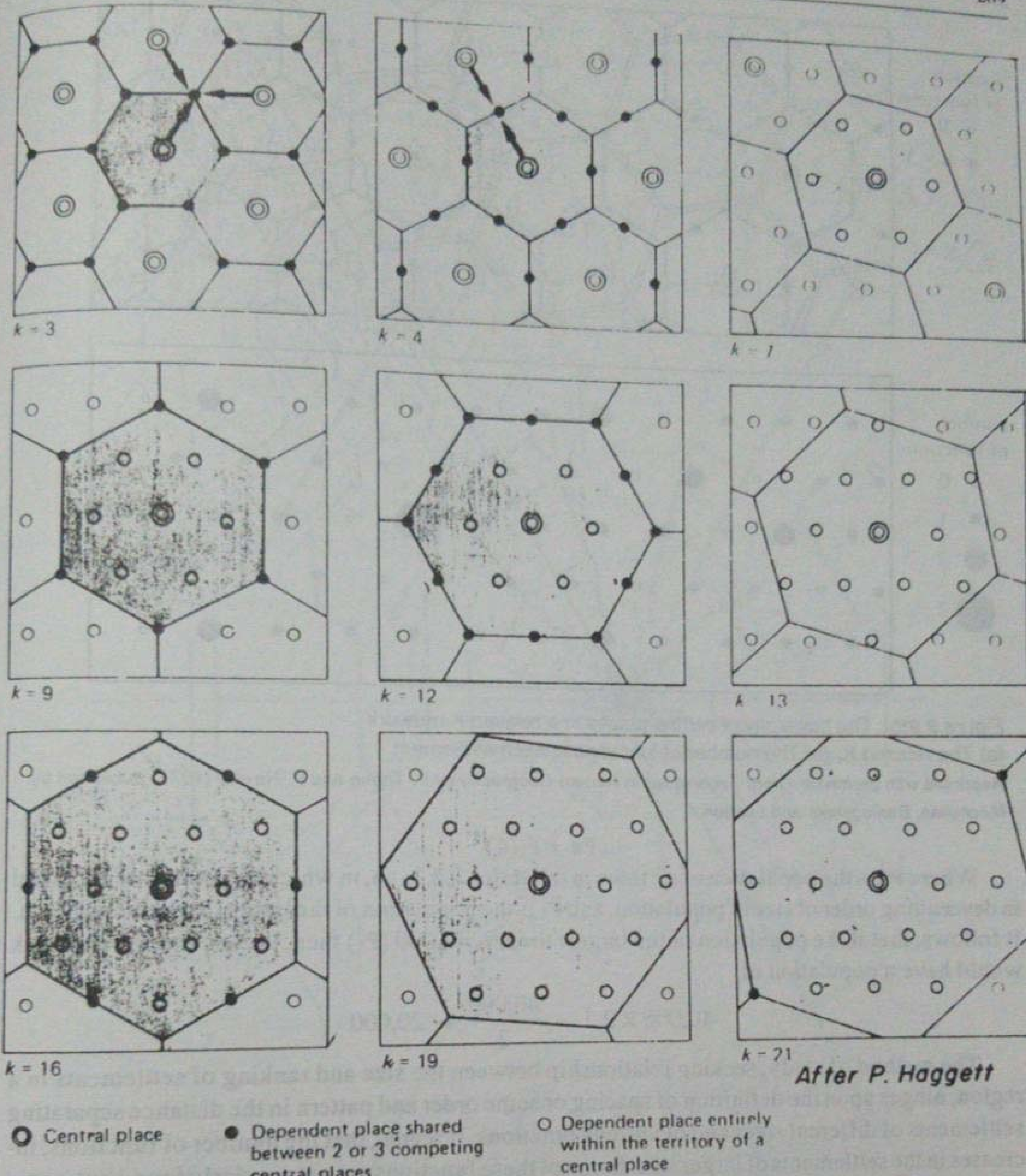
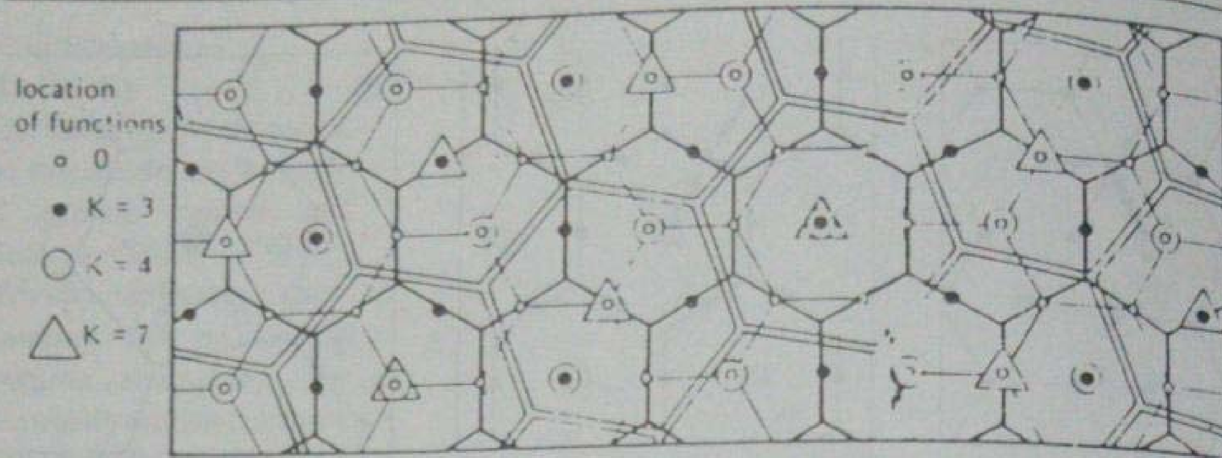


Figure 9.9(a): Nine smallest hexagonal territories in a Löschian landscape.
Source: Lösch, 1954, p. 118.

another of different level, was sought by many scholars at the dawn of 20th century. Zipf and Averbach, in their study discovered such a relationship, which is stated formally as *rank size rule* as shown by the following formula:



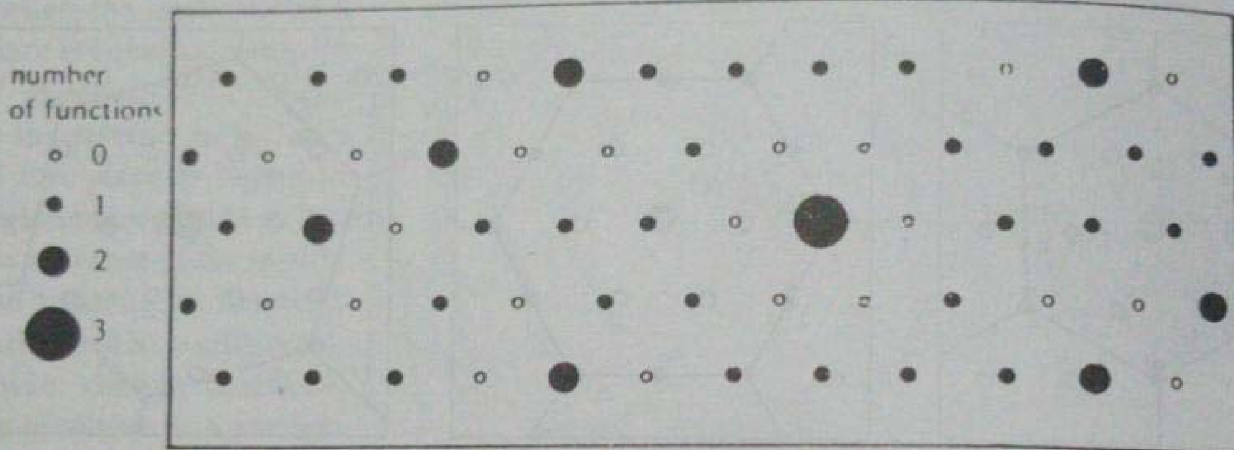


Figure 9.9(b): The hierarchy of central places in a relaxed K network
(a) The relaxed K, (b) The number of functions in each settlement
Reprinted with permission from *Techniques in Human Geography* by P. Toyne and P. Newby (1971) published by Macmillan, Basingstoke and London.

$$Pn = P_1(n)^{-1}$$

Where Pn is the population of n^{th} town in the series 1,2,3,...n, in which the towns are arranged in descending order of size of population, and P_1 is the population of the largest and primate town. It follows, that if the population of the largest town is 40,000 (P_1) then, the second town in rank would have a population of

$$40{,}000 \times 2^{-1} = \frac{40{,}000}{2} = 20{,}000$$

The method of study, seeking relationship between the size and ranking of settlements in a region, hinges upon the definition of spacing or some order and pattern in the distance separating settlements of different sizes and of various functions. It seems, that the number of functions, increases in the settlements of larger size. Some of these functions are not regularly found but, some may be selected as best indicators of settlement hierarchy, i.e., primary school, post office, number of shops etc. Thomas and Gibbs, investigated the problems regarding some towns, and showed a positive association between the logarithms of distance and population size. King (1961), however, in his study of 162 towns and non-central places, discovered that spacing of the latter was less predictable. Similar studies have been made by Stafford (1963)[12], Berry and Garrison (1958) and by Gunwardena (1964) in Sri Lanka. The problem of continuous variation,

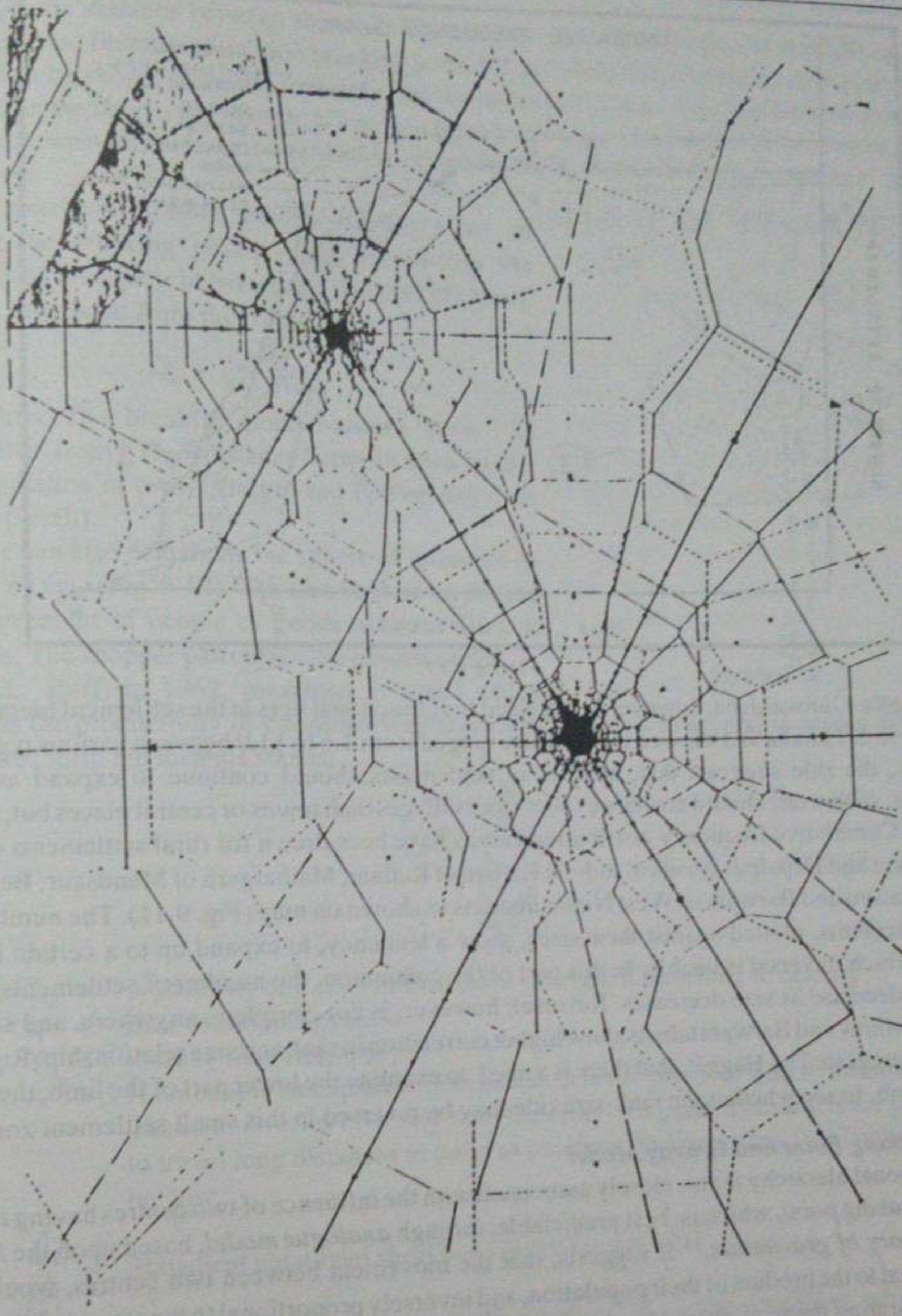


Figure 9.10

found between village and hamlet functions, has been discarded by Hagget and Gunwardena,[13] who suggest that one may view the threshold of any function as the middle point of its *entry zone*. This technique was used by Gunwardena for a number of settlement functions in the southern part

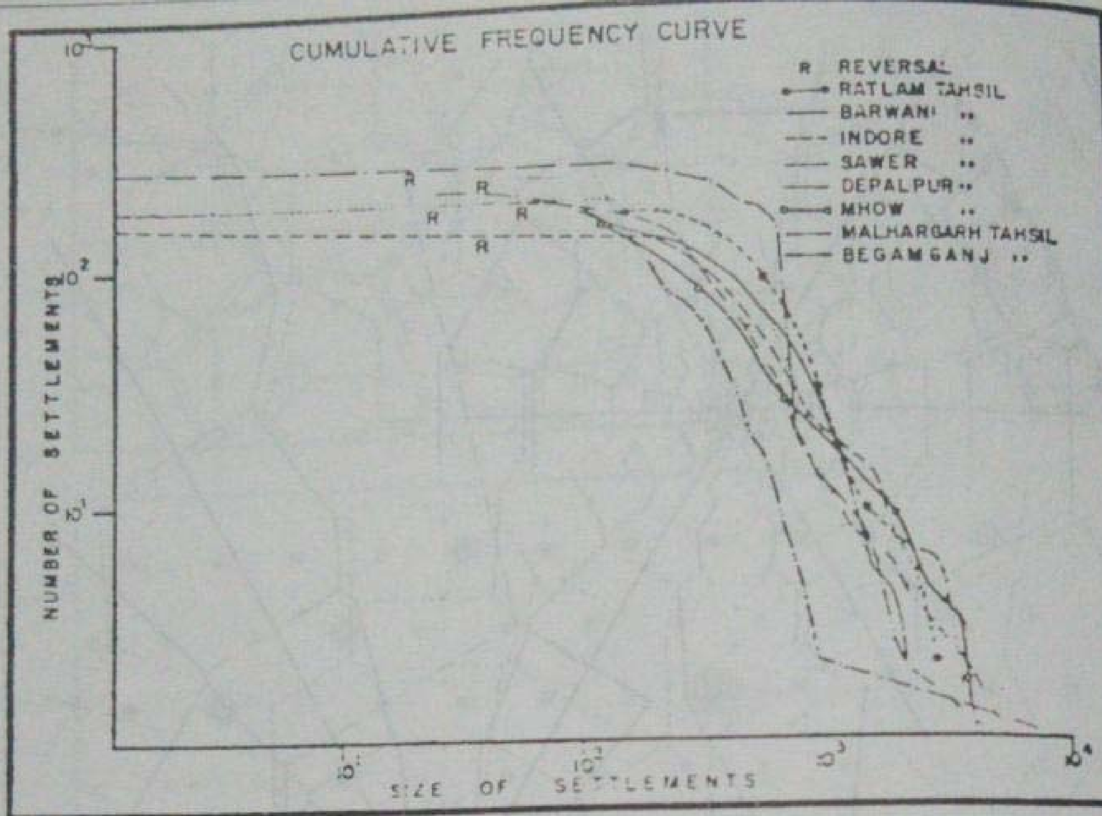


Figure 9.11

of Sri Lanka. Gunwardena, however, recognized four functional tiers in the settlement hierarchy, in southern Sri Lanka and showed that K-value ranged from 1.6 to 11.0 between various regions.

Thus, the rule suggests that, number of settlements should continue to expand as size decreases, so that one should not only expect more villages than towns or central places but, more hamlets. Cumulative frequency distribution curves have been drawn for rural settlements of Indore, Sawer and Depalpur tahsils of Indore; Ratlam of Ratlam; Malhargarh of Mandsaur; Begamganj of Raisen and Barwani of West Nimar districts as shown on map (Fig. 9.11). The number of rural settlements, plotted against their sizes, show a tendency, to expand up to a certain limit, beyond which, reversal is visible. In this part of the continuum, the number of settlements continues to decrease as size decreases. Reversal, however, is not complete, anywhere, and settlements of Mhow and Barwani tahsils show higher correlation in rank and size relationship. Rightly has been suggested by Hagget, that there is a need, to examine the lower part of the limb, the sub-village limb, to see whether the rank-size rule may be reversed in this small settlement zone.

(ii) Breaking Point and Gravity Model

The functional hierarchy is also closely associated with the influence of two centres having *interaction breaking point*, which is, best predictable, through *analogue model*, based upon the *Newtonian theory of gravitation.*[14] It suggests, that the movement between two centres, would be proportional to the product of their population, and inversely proportional to the square of the distance, separating them, as shown by the given formula:

$$M_{ij} = \frac{P_i P_j}{(d_{ij})^2}$$

Where, M_{ij} is the interaction between two centres, i and j, of population P_i and P_j respectively,