

SPATIO-DEMOGRAPHIC STRUCTURE OF PATNA IN ITS ECOLOGICAL SETTING

With 3 figures and 3 tables

L. R. SINGH and R. D. SINGH

Zusammenfassung: Räumlich-demographische Struktur Patnas in ihrem ökologischen Zusammenhang

Patna, eine indische Hauptstadt, ist während mehrerer Jahrhunderte der Brennpunkt politischer, wirtschaftlicher, gesellschaftlicher und religiöser Bewegungen gewesen und war als solche unterschiedlichen Wachstumsmustern unterworfen, die eine komplexe demographische Struktur ergaben. In dieser Abhandlung bemühen sich die Autoren, diese Struktur im Lichte der theoretischen Forderungen westlicher Gelehrter zu analysieren.

Die Stadt Patna weist eine bestimmte ökologische Ordnung demographischer Attribute auf. Die innerstädtische Bevölkerungsdichte folgt dem Prinzip der Dichteabnahme mit der Distanz: mit der Zone höchster Dichte um den Geschäftskern und relativ weniger dicht besiedelten Zonen an der Peripherie. Die Stadtrandzonen erfahren jedoch höhere Bevölkerungswachstumsraten als die inneren Gebiete mit außerordentlich dicht belegten und auffälligen Häusern. Wegen des akuten Mangels an Wohnhäusern im Stadtzentrum übersteigt die Zahl der männlichen Einwohner die der weiblichen, doch in den Stadtrandzonen ist dieses Verhältnis der Geschlechter entgegengesetzt. Die räumliche Struktur der Bevölkerung zeigt weiterhin, daß der Stadtkern im Vergleich mit den Randzonen sowohl von einer hochrangigen Elite als auch von Geschäftsleuten charakterisiert wird. In Anbetracht dieser Beobachtungen kann man allgemein sagen, daß Patna – wie den meisten indischen Städten – die gesellschaftliche Mobilität und wirtschaftliche Lebenskraft fehlt, die die modernen westlichen Städte bestimmen.

Introduction

Most of the studies in urban geography by Indian geographers deal largely with a few demographic components like growth, trends and migration of population as pertaining to individual towns and there is a lamentable gap in studies on intra-urban spatial structure of population as conceptualised by BRUSH (1977) and other western scholars. It is, therefore, desirable that we should critically examine the concepts and models advanced by western geographers and apply them with caution in the Indian context. In view of this situation, the present study of spatio-demographic structure of Patna has been undertaken having its major objective to determine how this city, compared with other cities of the West has grown on the time-scale and how its intra-city demographic structure is related to its varied and varying ecological setting.

Methodology

For carrying out the study's objective the assumption is that Patna like other colonial cities of the world has experienced a dual pattern of growth. Certain parts of the city have developed demographically and

ecologically along lines similar to the cities of the West, whereas other areas exhibit characteristics more nearly typical of pre-industrial cities of the East.

The analysis of demographic structure of Patna is primarily based on the Census 1971 which provides data for each 37 Municipal wards, Patliputra colony and Phulwarisharif urban areas on population sex-structure, literacy, working force and occupational structure. In order to examine the spatial variations of these demographic characteristics within the city, circles at 0.8 km. apart from the city centre have been drawn. Demographic variables for each ward falling in respective zone and its area have been computed. As far as the determination of the city centre is concerned, there is a practical difficulty in selecting it especially in a linear pattern of city like Patna because of complex internal morphological structure. Although the original nucleus lies within the fort walls in Patna City, the city centre has been placed in the principal commercial area (Muradpur) of the city where about all principal roads and streets intersect and maximum traffic-flow is observed during the business hour (Fig. 1). Land values are also found to be maximum there. For analysing the data on area and components of population according to distance increments, the following linear regression equation has been adopted:

$$\log y = a + bx$$

where y is the population density expressed as log of persons per acre and is treated as dependent variable. The independent variable x is the distance expressed in kms. whereas a is constant and b stands for a parameter, both of which are derived from the density data on a given formula:

$$b = \frac{N \sum x \log y - \sum x \sum \log y}{N \sum x^2 - (\sum x)^2}$$

$$a = \overline{(\log y)} - b \bar{x}$$

Evolution and spatial growth of Patna

Although pre-industrial cities from the point of view of population size, have been in general small. Patna falls into that category of pre-industrial city of about 500,000 population which enjoys the cultural heritage of more than 2,500 years of existence as an urban centre. The city in the early historic period was little more than a simple village (Patligram) (Master Plan, 1962, p. 16), situated at the confluence of the Ganga and the Son. The city so founded at such a commanding and defensive site, attained the dignity of an imperial capital of eastern India. The great

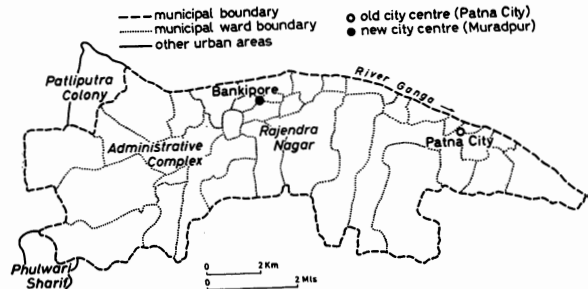
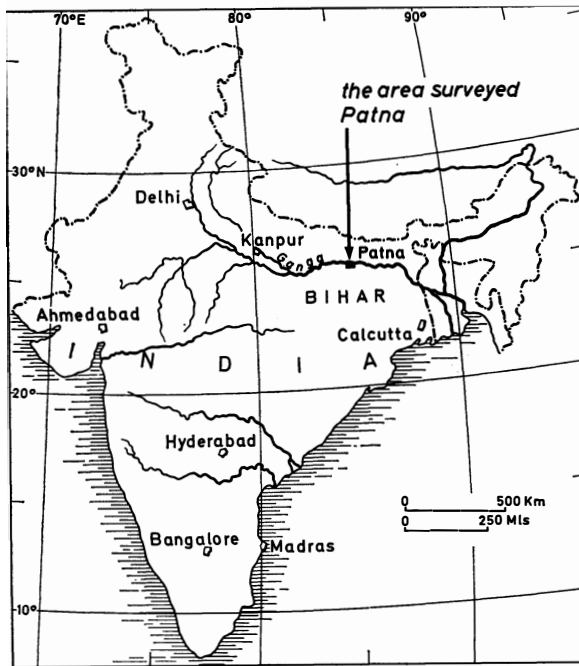


Fig. 1: Base map Patna 1971

opment along the river's bank as far as Bankipore. "The inside of the old town is disagreeable and disgusting and the view of it from a distance is mean. Indeed, at a little distance south of the town, it is not discernible (BUCHANAN, 1811–12, p. 61). SJOBERG also pointed out "Typically almost all the pre-industrial cities are girdled by walls inside of which various sections of the city sealed off from one another by wall and precincts congestion is the order of the day" (SJOBERG, 1960, p. 127).

The changing political fortunes made an idelible imprint on the townscape and caused a shift in its growth axis from east to west. This axial pattern of growth of the city (Fig. 2) was quite natural as the adjacent lowland in the south was vulnerable to flood. As a result of the impact of western culture and tradition, city dwellers were attracted to this new site which later became the focus of concentration of population and economic activities. Under the British rule, from the middle of the 18th century to (the) World War II, certain aspects of Patna's physical structure and pattern of growth have virtually paralleled those of pre-industrial cities of the West. Because of overwhelming representation of native population over the years and reluctance of the Britishers to introduce western innovations which would have placed Patna on the way to becoming industrial society, the city retained many characteristics comparable with those of pre-industrial cities.

The most spectacular growth and development of Patna took place in the post-independence period which brought about significant changes in the morphological and demographic character of the city. Until the late sixties' Patna's southern expansion was almost restricted to the old bypass road, and the city appeared to be a typical crescent shaped linear form. With the construction of the protection embankment (new bypass), an extensive urban sprawl to the south and south-west has emerged on the townscape which has not only modified the linear character of the city but also created opportunities for over hundreds of thousand urban dwellers to seek residence in the developed sub-urban areas.

Indian emperors like Ajatsatru, Chandragupta Maurya, Ashoka and Sher Sah who acceded to the throne successively in Patliputra, are said to have completely transformed it from a tiny village to a garrison and fortified city. The historic fragments of the gigantic stone pillars at Kumhrar built by Ashoka and Pachhim and Purab Darwaja's of the magnificent fortress in Patna city built by Sher Sah remind us of its past glory. "Few indeed are the remains of the splendid buildings of Askoka's capital. The cloud-capped towers, the gorgeous palaces, the solemn temples, have indeed desolved the left not a rack behind" (HOUSTON, 1949, p. 17). From this brief historical account, it is apparent that Patna like other medieval European walled cities started growing rapidly out of the ancient nucleus of fort and fortress which were later replaced and modified in response to immediate growing requirements. "Thus the city passed through many vicissitudes but has shown a remarkable capacity for survival and regrowth (DAYAL, 1968, p. 18).

Patna experienced the most remarkable development during colonial administration in India where the English merchants first came to Patna in 1620 and by 1657 established a Saltpetre factory. "During the early British period Patna enjoyed considerable economic prosperity and it rose to worldwide importance as a source of production and supply of sugar and saltpetre" (DAYAL and THAKUR, 1976, p. 168). Under the influence and power of the British East India Company, the traditional and dilapidated parts of Patna city were displaced and the city extended far beyond the fortified walls resulting in large sub-urban devel-

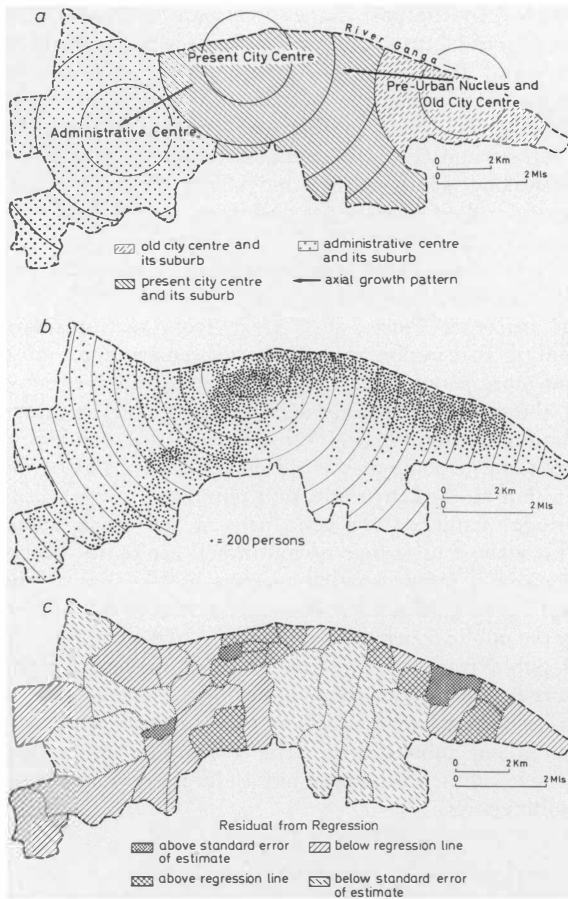


Fig. 2: Patna: a) schematic representation of morphological development; b) distribution of population (1971); c) population density patterns (1971)

Trends of population growth

During the British period, the population of Patna rose from 158,000 (1872) to 170,654 (1881). Much of this growth was a result of the R-U stream attracted by the economic and cultural opportunities. Between 1881 and 1921 the population of Patna suffered a setback as a result of slump in the river borne trade and repeated visitation of epidemics. Sex-ratio also experienced a notable change from almost a balanced structure in 1901 to only 82 females per 100 males in 1921. In 1931 it made a significant recovery and the population rose to 159,690 with an adverse sex balance (73 females per 100 males). However, in 1941 the population which totalled 196,415 exhibited a greater sex harmony.

Since Independence the population curve has constantly looked up. The city experienced a phenomenal growth of population during 1941–51 with an increment of 44.33 percent. Both as a result of sharp decline in morbidity and mortality and also accelerated

Table I: Composition of population

Census Year	Pop-ulation	%/Decade variation	Male	Female	Sex ratio female/100 males
1901	134785	—	67038	67747	101
1911	136153	1.01	70841	65312	92
1921	119976	-11.88	65777	54199	82
1931	159690	33.10	92238	67452	73
1941	196415	23.00	112048	84367	75
1951	283479	44.33	155623	127856	82
1961	364594	28.61	206050	158544	77
1971	491217	34.45	273717	217500	79

Source: Census of India, General Pop. Table (Bihar), 1971

growth of secondary and tertiary activities, the city population rose up. In addition to this, the influx of refugees after the Partition of the country also contributed to the increase of population. The rate of growth in subsequent census decades appears to have slowed down i.e. 28.61 percent in 1951–61 and 34.45 percent in 1961–71; so also the sex-structure has slightly suffered i.e. from 82 females per 100 males in 1951 to 79 in 1971. The emphasis laid after Independence on the uplift of rural economy, decentralisation of administrative machinery and reforms in agrarian and social orders have also to some extent slackened the R-U stream. Patna, as a matter of fact, is a 'parasitic' type of city where about 70 percent of the working force is engaged in non-productive economic activities and has, therefore, limited employment opportunities.

Intra-city growth pattern

The above account of major trends of population growth of Patna does not reflect intra-city population changes. In order to elucidate variations within the city, census population figures of 1961 and 1971 have been examined during which the municipal ward boundaries remained more or less the same. An analysis of the data (Table II) shows some outstanding features of population distribution in Patna, i.e. maximum increase of population in peripheral wards and a relatively low variation in the central tracts. Some of the over-crowded wards in Patna city have experienced notable decrease of population. Being disgusted from the din and bustle of the crowded central city, people, especially of affluent society prefer to reside in the outer zones of the city. The traditional mode of residential crowding in the central city is no longer a fact and the centrifugal tendency appears to have taken the place of the centripetal. The inner wards of Patna (14, 15, 16 & 17) comprising Muradpur, Dariapur, Sabzibagh, Bakarganj, etc. recorded population rise between 10 to 45 per cent during 1961–71 whereas

several outlying census tracts (1, 18, 20, 21, 24 & 25) registered much higher growth i.e. 40 to 100 per cent. The transitional zone lying between 2.4–4.8 kilometres radii from the city centre experienced the largest increases in population during 1961–71. Some of the important residential localities which experienced fairly high increase of population are East Rajendra Nagar, Bahadurpur, Kankarbagh, Lohianagar, Jakanpur, Purandarpur, Gardanibagh, etc.

Turing to apply the ecological concepts of intra-urban growth, traditionalist and revisionist views have been broadly examined here. The spectacular population growth of sub-urban areas and the relative decline of the central city since the Second World War was emphasized by GUEST (1973, pp. 53–69). The traditionalist view is exemplified by the work of HAWLEY (1950) while the revisionist view is represented by WINSBOROUGH (1962, pp. 35–49) and SCHNORE (1958). HAWLEY contented that the urban structure is shaped by the assumption of fierce economic competition for location near the CBD which is attractive to all types of activities because of its accessibility to jobs, transportation node and market.

Table II: Intra-urban variations of demographic attributes of Patna (1971)

Distance from city centre in kilometres	Increase % of pop. 1961–71	Sex ratio females/ 100 males	% of literacy	% of commercial workers
0.00– 0.80	38.10	75.57	61.04	29.45
0.81– 1.60	43.76	77.41	63.70	26.29
1.61– 2.40	54.72	73.05	56.45	23.82
2.41– 3.20	66.76	65.95	55.34	19.80
3.21– 4.00	57.22	76.37	55.40	17.79
4.01– 4.80	57.30	78.38	56.83	17.26
4.81– 5.60	48.28	80.24	54.28	16.69
5.61– 6.40	42.20	80.78	53.93	17.18
6.41– 7.20	40.34	85.70	49.53	17.99
7.21– 8.00	34.95	87.48	47.97	20.60
8.01– 8.80	46.96	88.88	45.18	19.87
8.81– 9.60	48.90	88.80	41.34	17.31
9.61–10.40	50.20	89.25	37.10	15.45
10.41–11.20	52.70	89.56	35.13	14.70

Computation of data by the authors

This process would result in two consequences—the central residential land in particular would be subdivided so that individuals can afford rent. This would result in a general pattern of population concentration around the CBD or to put it in another way population density should decline rapidly with distance from the CBD and in this way the city expands physically by the growth of peripheral neighbourhoods.

The revisionists, on the other hand, propounded that modern trends of cities' growth need not be

matched by the past change in urban structure. With the advent of automobile era and introduction of cheap means of transportation, many urban activities can locate anywhere in the metropolis and still be close to the place of work, market and transportation node. The revisionist view is, thus, based on transportation technology which permits movement of business, industry and other activities and thereby growth of residential neighbourhoods.

In the light of the above ecological concepts, if we examine the pattern of population changes in the census tracts of Patna, it is clear from the aforesaid analysis that peripheral areas have been acquiring more and more people than the central zone and even some of the over-crowded residential tracts have lost population during 1961–71. This reveals that residential crowding in some of the old delapidated tracts of the city has reached the saturation point and shows a centrifugal tendency for residences in sub-urban areas. This view is in favour of traditional ecologists. Moreover, in a large growing metropolis like Patna, the rapid growth of residential neighbourhoods is favoured by the public transportation facilities. The introduction of public transport and greater use of private vehicles have brought about tremendous impact on the growth of secondary commercial centres, industry and residential neighbourhoods. The revisionist generalisation can, thus, be observed in such large growing metropolitan cities.

Spatial patterns of population distribution

Patna has spatial differences and patterns in distribution of population which differ from other pre-industrial cities of the West in view of its distinctive physical and cultural setting, size, history and functions. The most important question is whether the models seeking regularities in urban densities and stating statistical relationships between population densities and urban distances have any relevance in this case. The fact remains that no city totally conforms to the standard patterns of negative exponential decline in density with the increase in distance from the city centre because 'a variety of local disturbing factors'. The concept was first initiated by BLEICHER and later on elaborated by COLIN CLARK (1967, p. 341). BERRY, SIMMONS and TENNANT (1963, p. 389) confirmed its validity by their study of population gradients in some 100 cities in various parts of the world.

TANNER (1961) and SHERRATT (1960) suggested an alternative model according to which "densities decrease rather slowly in the first incremental distance zone outward from the city centre, then, the decline accelerates appreciably until the outer margins of the city are approached, at which distance, the decrease in density slows again". NEWLING (1969, p. 243) has modified the model suggested by TANNER and SHERRATT

because it envisages "a relative low density near the core of the city, with densities increasing in the incremental zone nearest the city centre and reaching maximum density levels some distance from the centre of the city".

The analysis of population density data and scatter diagrams shows that the density-distance relationship has statistical significance and the gradient observed is somewhat in conformity with CLARK's model based on negative decline of density with the increase of distance from the city centre. From Table III it is clear that the models as postulated by TANNER and SHERRATT and NEWLING have no relevance in the case of Patna. The map of population density according to census tracts shows a wide variation of population distribution i.e. from 100 to 250 persons per acre in the central zone to less than 15 in many outlying wards. In contrast with western cities where the CBD is almost devoid of residential population, Indian cities have highly mixed residential and commercial areas and except for the front foot portions of the buildings along roads devoted to commercial uses, the adjacent structure of the same apartments are intensively given to residential purposes. The highest concentration of residential population is found in and

Table III: Spatial distribution of population in Patna, 1971

Variation of population density by distance increment			Regression of population density*)	
Statistical zones	Distance from city centre (in kms.)	Gross pop. density persons per acre	Distance from city centre (kms.)	Population density persons per acre
1.	0.00- 0.80	109.55	0.00	68.80
2.	0.81- 1.60	60.92	1.60	56.62
3.	1.61- 2.40	41.31	3.20	46.56
4.	2.41- 3.20	31.39	4.80	40.17
5.	3.21- 4.00	36.86	6.40	31.56
6.	4.01- 4.80	35.07	8.00	26.00
7.	4.81- 5.60	22.75	9.60	21.42
8.	5.61- 6.40	24.37	11.20	17.63
9.	6.41- 7.20	40.66	*) Estimating Equation -	
10.	7.21- 8.00	47.97	Log y = 1.8377 - 0.0844 x ± 0.6530	
11.	8.01- 8.80	48.94	Coefficient of Correlation 0.67	
12.	8.81- 9.60	30.22	Coefficient of Determination 0.45	
13.	9.61-10.40	12.40	Significance of F. Ratio . . . 0.01	
14.	10.41-11.20	12.20		

Computation of data by the authors

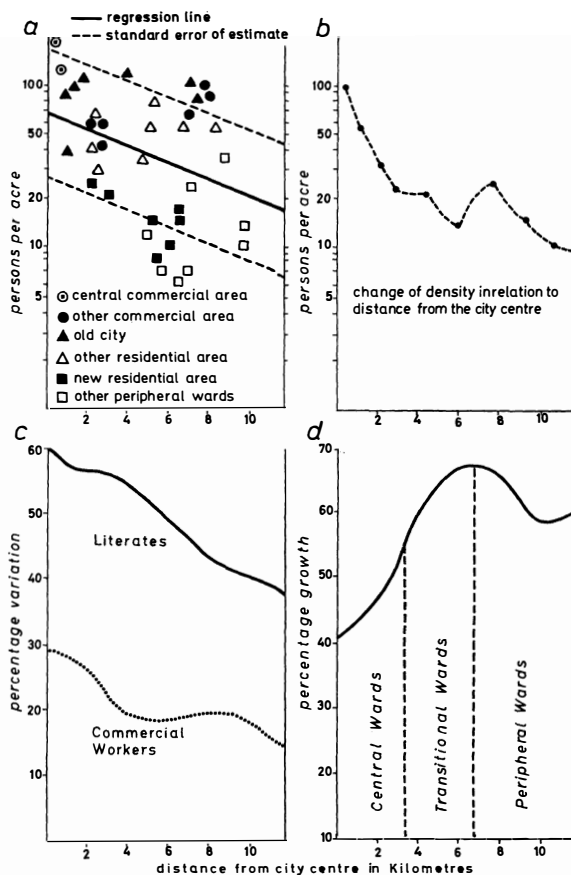


Fig. 3: Patna: regression of population density (by distance increments)

around the principal commercial area (Muradpur, Dariapur, Sabzibagh, Bakarganj) of the city from where the density profile slopes downward and after 4.8 kms. it again goes up because of the existence of a secondary centre of population in Patna city and later flattens down to the city margin. Apparently, this view tends to support BRUSH's observation that majority of British built Indian cities are characterized by dual nuclei of their growth history—the highest centralisation of population around the principal commercial area and a secondary centre a little away in the traditional indigenous area of the city.

The product moment co-efficient of correlation (0.67) and co-efficient of determination (0.45) are relatively low which are indicative of the fact that dispersion rather than concentration has been taking place during the last few decades. The scatter diagram (Fig. 3) also shows that some of the thickly populated central wards are clustered along the regression line within one kilometre radius from the centre while the range of dispersion increases with the distance increment. This indicates that complexity in spatial distribution of population widens as one moves outward

from the principal commercial area of the city. The positive residuals at a distance of 6–8 kilometres from the centre show that some of the most densely settled wards in Patna city having densities between 80 to 150 persons per acre are above the regression line and even above the confidence limit. In contrast, many outlying areas such as Patna administration in the west and some of the underdeveloped areas in the south have so low densities as they fall below the confidence limit. In these areas, owing to the greater proportion of land being given to open spaces, green parks, offices and agricultural uses population densities are extremely low.

Regression analysis of other demographic attributes

As is the case with population distribution, the distance-decay function can also be observed in many other demographic variables such as sex-structure, literacy, occupational structure, etc. (ELLENFSEN, 1962, p. 94). The analysis of data shows that there is preponderance of males in the central and transitional zones of the city i.e. from 75 to 65 females per 100 males. In intermediate zones, the proportion of males fluctuates and declines outwards to become nearly balanced sex-structure. As a result of acute scarcity of residential houses and exorbitant rent, workers engaged in various services are compelled to live alone leaving their family members in their native villages. The predominance of masculinity diminishes with the increase of distance from city centre because of availability of relatively adequate and spacious residential houses and low rent in the outer zones of the city.

In a similar manner, the level of literacy widely varies from inner to outer zones of the city. Owing to availability of greater amount of civic amenities and educational facilities, literacy rate is very high in the central city as compared with the sub-urban areas. The fringe area of the city as a matter of fact, also includes a large number of rural enclaves ('Busties') from where workers mostly derive resources for their livelihood from primary occupation and considerable illiteracy as in the countryside exists.

From the stand-point of occupational structure of the working force, Patna like most pre-industrial cities, exhibits much less specialisation. Both under the British rule and now as a regional capital of a sovereign state, Patna incorporates all the functions ascribed to a societal community, namely, political, commercial, educational, agricultural, industrial, etc. Working force of these functions widely varies from one sector of the city to another. For making any generalisation of their spatial variation, dependence on commercial function, as an instance, has broadly been examined. The Table II reveals that there is on an average maximum concentration of commercial workers (29.45%) in the innermost wards of the city. The degree of dependence on this function drops gradually and

comes down to 14.70 percent in sub-urban wards. As a result of high degree of centralisation of commercial activities, workers engaged therein reside close to the work place. Thus, there is very close association between commercial establishments and workers dependent on it so far as spatial variation within the city is concerned.

The concentric zone model as suggested by BURGESS (1925) is not applicable in the case of Patna. BURGESS theory is based on the study of American cities (especially of Chicago) which were rapidly growing due to high degree of technological innovations. The degree of development of concentric zones of residence, commerce and industry was a process of social and economic readjustment to city growth and especially to competition for land. As BURGESS assumed mobility and mechanisation as the core concepts, it implied growth of capitalistic economy under which American cities could assume forms. Mechanisation, which has been so powerful in the growth of western cities, has hardly been of any importance in the development of Patna. Although there is marked centralisation of commercial activities in the centre, the CBD lacks that intensity of land use so characteristic of the U.S. cities. Working men for the most parts live in or close to the commercial areas. There is also a conspicuous absence of industry in the zone surrounding the CBD as postulated by BURGESS for the American cities. In fact, owing to the absence of any sizable middle or upper class residential areas and highly mixed low and high income class houses, there is practical difficulty in delineating successive residential zones in Patna. There are few residential zones in the city having determined by economic status and can be better explained by Hoyt's sector model of urban growth.

Ethnic or racial segregation very often so common to both industrial and pre-industrial cities of the West, is not evident in Patna but there are communal segregations. The various communal groups inhabiting Patna viz. Muslims, Hindus, Christians, Sikhs, etc. exhibit some residential segregation. In Indian cities each and every civil ward is identified by predominance of some cultural groups—castes, community and minority groups, etc. Although there is marked economic competition, yet it has not gained sufficient strength to overcome these social prejudices. In view of these fundamental differences, there does not appear to be successive concentric zones of the city structure.

Conclusion

The historical city of Patna is a socio-cultural entity and a large regional urban centre in eastern India. Being largely influenced by political, religious and social factors, the city experienced differential growth patterns resulting in complex internal demographic and morphological structure. The spatial patterns of demographic variables though widely different from

western cities, are common to most Indian cities. Moreover, the components of population in urban areas are not distributed at random, instead, they tend to conform to some definite ecological settings. Analysis of data confirms that peripheral zones of the city have registered relatively higher population increase than the central zone. The traditional unplanned central city is characterized by extremely congested and dilapidated houses which at places represent horrible slum and blighted residential areas. Population densities are almost balanced in some newly planned residential colonies. As a result of acute shortage of residential housing especially in the core of the city, there is preponderance of males over females whereas it tends to diminish outwards. Likewise, the areal distribution of literacy exhibits centralisation of literate people as compared with the outlying areas. In view of the above observations, it can be generalised that Patna like most Indian cities lacks the social mobility and economic vitality of American cities and, therefore, the processes involved in the physical expansion and in the ecological patterning of cities of the U.S.A. are not equally effective in India.

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BERICHTE UND MITTEILUNGEN

BEWÄSSERUNGSGEBIETE UND BEWÄSSERUNGSPROJEKTE IN SÜDOSTITALIEN¹⁾

Begleitworte zu einer Karte

Mit 2 Abbildungen und 1 Karte als Beilage XIII

KLAUS ROTHER

Summary: Irrigation areas and irrigation projects in south east Italy

A new map of irrigation areas is designed for the hydraulically-disadvantaged areas of Apulia and Lucania on the

basis of new source material and fieldwork carried out by the author. It shows that the area under irrigation remains small and near the coast. The changing principles of the water procurement policy and the increase in the demand for water after World War II are discussed, and modern irrigation schemes - largely limited to those of the coastal lowlands (Tavoliere, Metapontino) - are described in detail in the example of the Sinni Aqueduct.

Im südöstlichen Italien, zu dem man die Regionen Apulien und Lukanien (= Basilicata) zusammenfassen

¹⁾ Das Material für diesen Bericht wurde bei agrargeographischen Untersuchungen in den süditalienischen Küstenebenen im Frühjahr 1979 gesammelt. Der Deutschen Forschungsgemeinschaft danke ich auch an dieser Stelle für die Unterstützung der Forschungsreise.