



Population Distribution in Karachi City

S. AKHTAR, M.R.DHANANI*

Department of Geography, University of Karachi, Karachi, Sindh, Pakistan

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Abstract: Like other cities of the world population distribution varies within Karachi city. This has attracted researchers to find out patterns of intra-city population distribution. The general pattern of population distribution is that population density declines with increasing distance from the city centre. This has developed various population density gradient models. In Karachi during the period of 1981 to 1998 massive flight of population from the central city took place. As a result central density sharply declined. Due to sharp decline of central density and peripheral growth of population the population density gradient of Karachi City has developed a gentle slope.

Keywords: Population, density gradient, density crater, density rim, central density

1. INTRODUCTION

Intra city population distribution has attracted researchers for a long period. Bleicher (1892) was the first to document the exponential decrease in population with increasing distance from the city centre. Clark (1951) studied a large number of American, European and Asian cities and confirmed the view of Bleicher. He showed that population density declines exponentially outward from the city centre in the form of a first degree negative exponential curve (Fig 1). This observation was further supported by Stewart and Wartz (1958) who studied cities of United States and Britain. Subsequent studies of population densities of cities all over the world supported Clark's argument. Berry, et al (1964) provided a theoretical rationale for Clark's formula by stating that the negative exponential decline of densities is a logical outcome of urban-land-use theory. They noted that the city centre is the most desirable area for business. Therefore due to least commuting cost concentration of population is high near to the city centre. As this advantage diminishes outwards, decline of residential densities should be expected. They claimed that density gradient and degree of compactness diminish as city size increases. As Western cities grow they experience suburban sprawl which is not true for many non-Western cities. The Clark's density gradient model was also successfully applied by researchers on many non-Western cities like Tennant (1961) on Tokyo, Manila and Jakarta, Atiqullah and Khan (1965) on Dacca, Kar (1963) on Calcutta, Hassan (1976) on Hyderabad, Shakila (1983) on Karachi and Han (2005) on Tokyo are important.

An alternate model of urban population densities was developed by J. Tanner and by G. Sherratt (1963). This model suggests that densities decrease

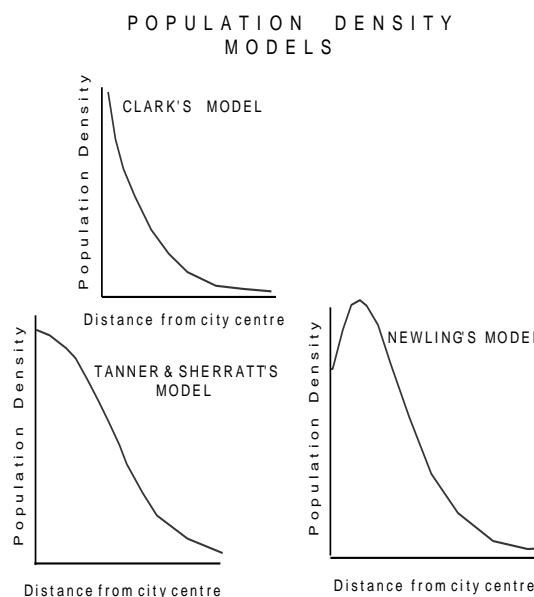


Fig 1: Population density gradient models

rather slowly a few kilometers distance outward from the city centre, then the decline accelerates appreciably until the outer margins of city are approached (Fig 1). The model of Newling (1966) is a further extension of the model of Tanner and Sherratt, and also shows a relatively low density near the centre of city, forming a density crater with densities increasing away from the crater and reaching maximum density some distance away from the city centre where it forms a density rim or crest, which surrounds the density crater. Outward from the density rim, the densities decline in a negative exponential manner towards the outskirts of city.

++Corresponding author. M. R. Dhanani, E-mail: mrdhanani@gmail.com Cell. No. +92-3453541162

*Department of Geography, University of Sindh, Jamshoro, Pakistan

Karachi is the largest city of Pakistan. The city started its growth as a walled city in 1729 with a population of 1000 and an area of 0.12 km² (Shakila, 1983). In 1941 the population of Karachi city increased to 386,655 and its area expanded to 115 km² (Census, 1951). In 1951 Karachi with a population of 1.6 million became the largest city of Pakistan (Census, 1951). In 1961 its population increased to 1912598, while in 1972 it reached to 3498614 with an area of 640 km² (Censuses, 1961 and 1972). The population and areal growth of Karachi city continued. Its population increased from 5,153,000 in 1981 to 9,280,000 in 1998 (Censuses, 1981 & 1998). It was estimated that in 2010 population of Karachi increased to 1.5 million and its area extended to about 1,200 km². Urban growth in Karachi is different from Western cities where suburban growth is an important feature of sprawl. Therefore it is worthwhile to investigate the spatial pattern of population distribution and changing pattern of population density gradients in Karachi City.

2. MATERIALS AND METHODS

In this study population distribution in Karachi City was examined by two methods. The dot method was used to explain population distribution in Karachi City. For this purpose charge-wise population data of last population census which was held in 1998 was used. To investigate the pattern of population density gradient, models of Clark (1951), Tanner and Sherratt (1963) and Newling (1966) were applied to the population census data of 1998. These models can be mathematically expressed by following expressions.

Clark's Model

$$D_x = D_o e^{-bx}$$

Sherratt and Tanner's Model

$$D_x = D_o e^{-bx^2}$$

Newling's Model

$$D_x = D_o e^{bx - cx^2}$$

Where D_x is population density
 D_o is density at the city centre or central density
 x is distance from the city centre
 e is base of natural logarithm
 b and c are rates of change of density from the city centre or density gradient

The changing density gradient patterns in Karachi City were analysed by applying Clark's model on the population census data of 1951, 1961, 1972, 1981 and 1998. For computing population density at different distances from the city centre ward-wise population census data were used for the census years, 1951, 1961,

1972 and 1981. In 1998 Population Census of Pakistan introduced a new term of charge-wise population. In 1998 Karachi was divided into 5 districts and 7 cantonments. Excluding District Malir all other four districts were dominated by urban population. District south was divided into 32 urban charges and 5 cantonments. District West, District East, and District Central were comprised of 42 charges and 1 cantonment; 47 charges and 1 cantonment and 48 charges respectively. In computing population density, population dot map of Karachi city was drawn in which each dot represents 5,000 persons (Fig 2). Concentric circles for each 0.5 km distance from the city centre were drawn on the dot map. Dots were counted and converted in number of persons within the areas of concentric circles. The areas of concentric circles were calculated by $2\pi r^2$.

3. RESULT AND DISCUSSION

The distribution of population within Karachi city is affected by its land uses. The city comprises various non-residential land uses like city centre, industrial, educational, commercial, air ports, parks and playgrounds etc. It is evident from the dot map of the city that these non-residential land uses show very low concentration of population (Fig. 2). Similarly lagoon and marshy areas are vacant (Fig 2).

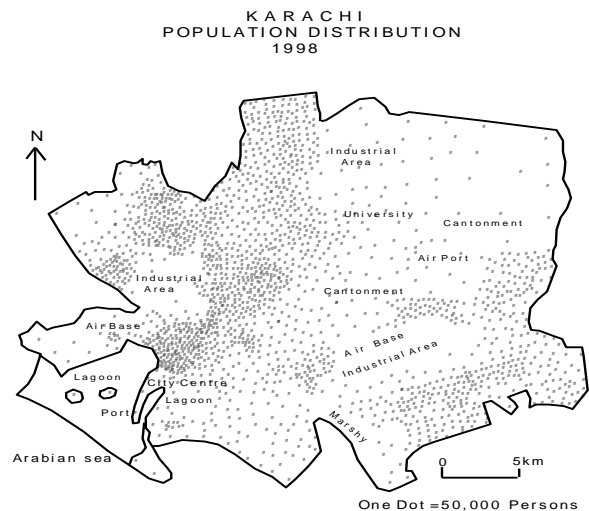


Fig 2: Population distribution in Karachi City

There are three main areas where population is highly concentrated. The old city area which is adjacent to the city centre and people live in apartments, the others are the central area and north-western areas where plot size is relatively small.

To investigate the pattern of population density distribution in Karachi city the three well known

population density gradient models, the Clark, the Sherratt - Tanner and the Newling were applied. The graph of population density and distance relationship reveals that generally population density declines exponentially with increasing distance from the city centre (Fig 3).

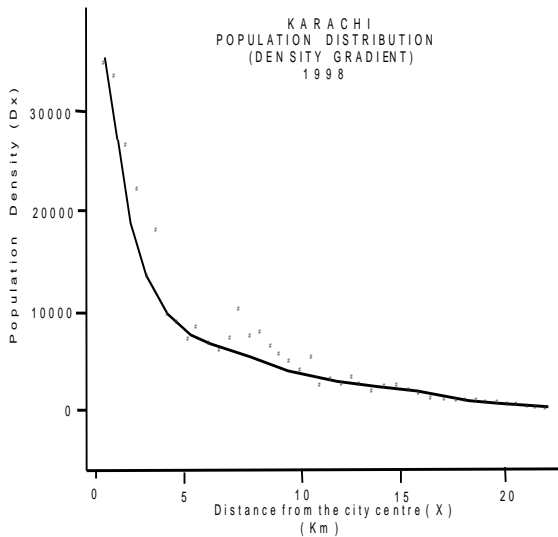


Fig 3: Population density and distance from the city centre relationship

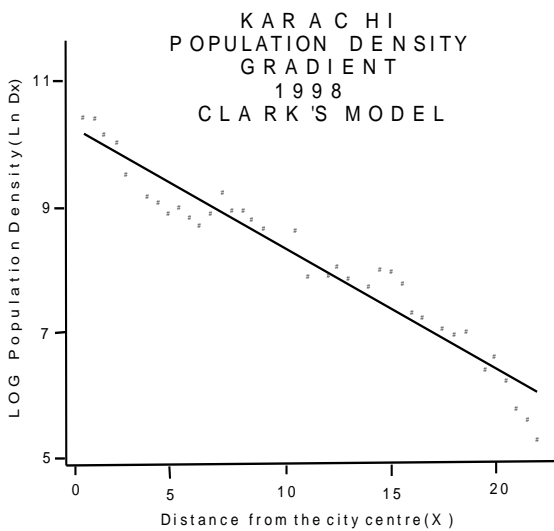


Fig 4: Population density gradient model (Clark's model)

CLARK'S MODEL
 $\ln Y = 10.3 - 0.196 X$

Predictor	Co-eff.	St. Dev.	T	P
Constant	10.3005	0.0957	107.58	0.00
X	-0.19558	0.0074	-26.39	0.00

 S=0.3122 R-sq. = 94.35%

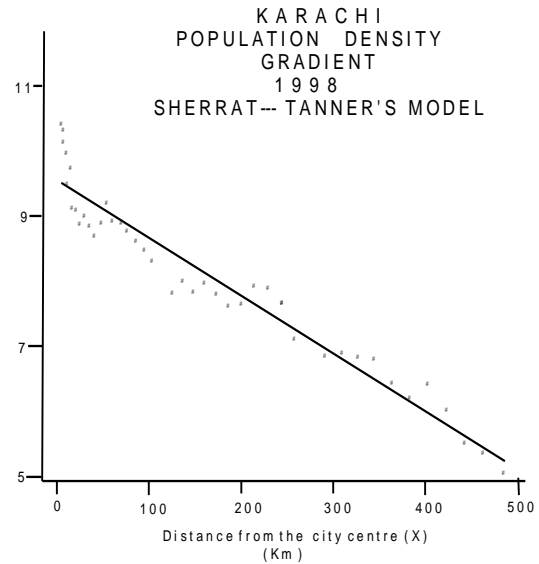


Fig 5: Population density gradient(Sherratt-Tanner's model)

SHERRAT—TANNER'S MODEL
 $\ln y = 9.49 - 0.00835 X$

Predictor	Coef.	St. Dev.	T	P
Constant	9.49290	0.08180	116.08	0.00
X	-0.00834	0.000367	-22.71	0.00

 S= 0.359 R-sq = 92.5 %

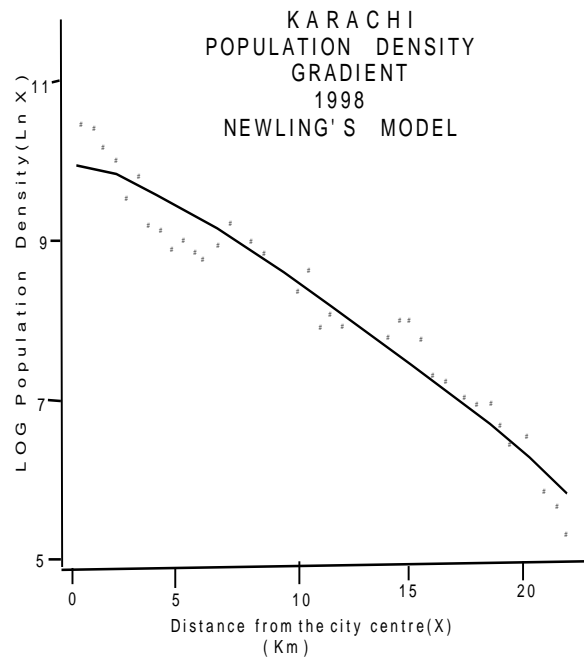


Fig 6: Population density gradient (Newling's model)

NEWLING'S MODEL
 $\ln Y = 10.0505 - 0.13037 X - 0.0029 X^2$
 R-sq= 0.95

Table 1: Result of Clark, Sherratt-Tanner and Newling Population Density Models, 1998

	Do	B	C	R
Clark	10.3005	-0.19558	---	0.9695
Sherratt-Tanner	9.42901	-0.00835	---	0.9617
Newling	10.0505	-0.13037	-0.0029	0.9646

The graphs and values of correlation coefficient (Figs 4, 5, 6 and Table 1) clearly indicate that Clark’s model is the best fit to the population distribution of Karachi City. Thus it is concluded that population density falls exponentially with increasing distance from the city centre.

To examine the changes in the pattern of population density in Karachi City during the period of 1951—1998, population data of 1951,1961,1972,1981 and 1998 census were used. The graphs (Fig 7) and values of density gradient (b) and values of central density (Do) (Table 2) of Clark’s model indicate that population density gradient and central density continuously declined.

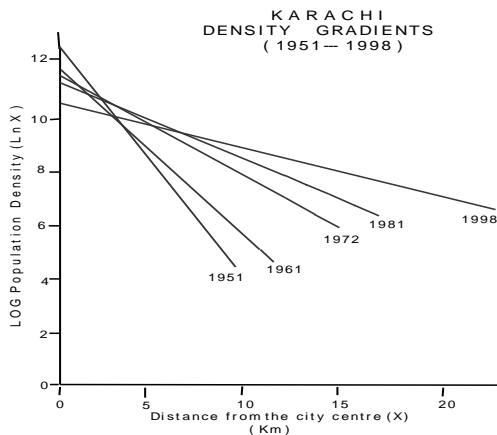


Fig 7: Population density gradients in Karachi City (1951—1998)

Table2: Result of Clark’s Population Density Model, 1951, 1961, 1972, 1981 and 1998

Census Year	Central Density Do (Persons per sq.km)	Central Density Ln Do	Density Gradient (b)	(r)
1998	29,747	10.3005	-0.19558	0.9695
1981	102,867	11.5412	-0.37101	0.9717
1972	114,955	11.6523	-0.45542	0.9846
1961	160,075	11.9834	-0.69845	0.9881
1951	300,228	12.6123	-1.16211	0.9878

Source: Computed by Authors

The reason was because before 1947 Karachi was a small city. In 1947 Pakistan came into existence and Karachi was chosen as a first capital of the country. Due to influx of about 1 million populations in Karachi from India, rapid growth of population and areal expansion of the city took place. Therefore the density gradient decreased from 1.37 in 1931 to 1.16 in 1951. However, central density continued to rise from 11.63 in 1931 to 12.61 (Shakila, 1983), mainly due to lack of rapid transportation and poor economic condition of people who could not afford commuting cost. Diesel tram was introduced but the whole network confined in between Saddar to Tower (the present city centre of the city), resulted further concentration of population at the centre. In the period 1961--1981 due to development of automobile transport system like buses, rickshaw, taxi and intra city railway urban sprawl started with deconcentration of population. As a result of the movement of population from the centre population density gradient and population density decreased. In 1961 the density gradient was 0.699 which decreased to 0.3654 in 1981 (Table 2). During the period of 1981 to 1998 the pattern of population density distribution changed significantly. The population of Karachi City expanded from 5.15 million in 1981 to 9.28 million in 1998 which mean the city had grown about double of its population during 17 years. Similarly its sprawl was also remarkable. The city expanded from 800 km² in 1981 to 1,200 km² in 1998. Many new housing schemes like Taiser Town, Khuda Ki Basti, Halkani, Shah Latif Town were developed during this period as well as many new squatter settlements came into existence in the outskirts of the city. Population of peripheral residential areas which were developed in 1980s like Gulistan-e-Jauhar, North Karachi, Gulzare-Hijri, Surjani, Baldia and Orangi had increased significantly. It was observed that a considerable number of residential populations moved from old city area and central part of the city to these areas. The development of roads and flyovers had played an important role in sprawl of the city. It was also observed that due to improvement in economic condition of people of the city on one hand number of private cars and motorcycles had increased significantly while on the other hand a large number of rapid commuter mini-buses were introduced. These development encouraged shifting of population from central city to peripheral residential areas. As a result of these developments in Karachi City population density gradient declined sharply from 1981to1998.

Table 3: Distance-wise population density distribution in Karachi City,1981.

Distance from the city centre (Km)	Population Density (persons per sq. km)	Distance from the city centre (Km)	Population Density (persons per sq. km)
1.0	87012	9.0	4298
2.0	44934	10.0	3032
3.0	19866	11.0	2176
4.0	17632	12.0	1220
5.0	16733	13.0	920
6.0	12749	14.0	530
7.0	9772	15.0	230
8.0	9300	16.0	98

Source: computed by Authors on the basis of 1981 Census

Table 4: Distance-wise population density distribution in Karachi City,1998

Distance from the city centre (Km)	Population Density (persons per sq. km)	Distance from the city centre (Km)	Population Density (persons per sq. km)
1.0	33970	12.0	3021
2.0	22273	13.0	2560
3.0	18229	14.0	2216
4.0	8910	15.0	2134
5.0	8210	16.0	1415
6.0	7389	17.0	1093
7.0	7029	18.0	1032
8.0	6456	19.0	732
9.0	5551	20.0	523
10.0	4165	21.0	307
11.0	3592	22.0	183

Source: computed by Authors on the basis of 1998 Census

It is evident from tables 3&4 that up to 8 kilometers from the city centre the population density declined in 1998 as compared to 1981. From 9 kilometers from the city centre population density increases significantly in 1998 as compared to that of 1981 (**Tables 3 and 4**). This clearly shows that population deconcentration continued in the period of 1981-1998 with rapid pace. In 1981 population density at 1km distance was 87,012 persons per km^2 which was reduced to 33,970 persons per km^2 which means during 17 years population density reduced to nearly three times from 1981. This is clear indication that the process of urban sprawl continues with rapid pace. Its affect can be seen on the graph of population density gradient which has more gentle slope in 1998 as compared to 1981 (**Fig 7**).

In the period of 1981-1998 remarkable changes took place in central density and density gradient. The

central density declined from 102,867 persons per km^2 to 29,747 persons per km^2 . It means during 17 years of period a huge number of population had moved out from the 8 kilometers radius of the city centre towards peripheral residential areas. As a result central density dropped three times in 1998 as compared to 1981. Similarly as a result of significant population deconcentration and areal expansion the density gradient had become gentle. The value of density gradient (b) declined from 0.371 to 0.195 in 1998. These results clearly support this view that Karachi had experienced rapid pace of urban sprawl during the period of 1981-1998.

4. CONCLUSION

The study of population distribution in Karachi city reveals that distribution of population in Karachi city is affected by its land use. Industrial areas, cantonments, city centre, marshy land, air port and cantonments are non residential land uses have sparsely population while residential areas have high concentration of population. Population density is highest just at the outer edge of the city centre from which it exponentially falls with increasing distance from the city centre. The Clark’s model is best to explain population density distribution in Karachi City, indicating that population density declines exponentially outward from the city centre with increasing distance. Due to flight of central population the central density declined remarkably in 1998. As a result of peripheral growth of population and sprawl of the city the density gradient developed a gentle slope which will become nearly flat if flight of population from central city and sprawl of the city continue with this pace. The growth of population, economic development, political stability and development of modern rapid transport system in the city will play major roles for its future shape of population density gradient.

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