Journal of Basic and Applied Sciences Vol. 7, No. 2, 117-121, 2011 ISSN: 1814-8085

DIRECT-GLOBAL AND REVERSE-GLOBAL ASPECTS OF TOWN WISE DISTRIBUTION OF KARACHI KATCHI-ABADIES

Shaheen Abbas* and Muhammad Rashid Kamal Ansari*
Mathematical Sciences Research Centre, Federal Urdu University of Arts Sciences & Technology,
Gulshan-e-Iqbal Campus, Karachi, Pakistan

Abstract

From the administrative point of view previously Karachi was divided in five districts which is now divided in eighteen towns. This change over has greatly altered the distribution pattern of KKAs. So it seems necessary to analyze the situation anew. This study analyses the distribution of 200 KKAs in this new scenario. There are two aspects of these analyses the local and the global. The local aspect refers to the mutual relationship of KKAs in a town whereas; the global aspect refers to the relationship of a KA of a town with the KAs of all the other towns. This study is particularly concerned with the global aspects of the town wise distribution of KAs of Karachi. Two techniques, the Direct-Global technique (DGT) (utilizing the densest KAs) and the Reverse-Global technique (RGT) (utilizing the least populated KAs) are developed in this regard. In addition, we have also studied the population density distribution of KKAs. For this purpose we have developed the Global Flatten Gradient Density Model (GFGDM) an enhancement of our flattened gradient density model (FGDM) developed earlier. The appropriateness of FDGDM is tested with the help of Log-Linear Transformation Model (LLTM) and Log-Exponential Transformation Model (LETM). The later one appears to be more appropriate.

Keywords: Karachi Katchi-Abadies (KKAs), Pivot, Reverse-Global (RG), Direct-Global technique (DGT), Reverse-Global technique (RGT).

0. I NTRODUCTION

This study analyses the distribution of 200 KKAs of 18 towns of Karachi. Earlier, in [Abbas and Ansari (2010)] is performed for 100 KAs distributed among 5 districts of Karachi (old magistracy system). This local analysis refers to the mutual relationship of KKAs in a district. In contrast, in case of town wise distribution of KAs the present study performs global analysis which refers to the relationship of a selected KA of a particular town to particular KAs selected one from each of the remaining towns. The global analysis can be performed in two ways. The Direct-Global (DG) method that utilizes the densest KA among all the towns as pivot (the DG pivot) and the Reverse-Global (RG) method that utilizes the least populated KA among all the towns as pivot (the RG pivot). This study also develops the Distance Gradient Density Model (FDGDM) for the analysis of the population density distribution of KKAs. This is an enhancement of the flattened gradient density model (FGDM) developed in [Abbas (2007)]. The appropriateness of FDGDM is tested with the help of Log-Linear Transformation Model (LLTM) and Log-Exponential Transformation Model (LETM). It is shown that LETM is more appropriate than LLTM.

In section 1.1, we have first developed DG and RG techniques and then the DG and RG analysis is performed. To forecast a better population density distribution of the KKAs in the towns FDGDM is developed in section 1.2. The construction of FDGDM involves the distances between densest or least populated KAs of the towns and the respective pivots. In section 1.3, the appropriateness of the model is checked with the help of Log-Linear Transformation Model (LLTM) and Log-Exponential Transformation Model (LETM). Reverse-Global technique appears to be more appropriate than the Direct-Global technique.

1. MATERIALS AND METHODS

The material consists of the population and area data (population data, aerial photograph of Katchi-Abadies of Karachi and maps of Katchi Abadies of Karachi) of 200 Katchi-Abadies of Karachi procured from the publications of Orangi Pilot Project [Orangi Pilot Project 2006, 2009]. The Microsoft excels and ARCVIEW (3.2) were used to arrange these data and maps and to determine the distances between the Katchi Abadies of Karachi. On the basis of these calculations population densities of KKAs under consideration were determined. The data such generated analyzed with the help of gradient density models developed with the help of DGT and RGT. A discussion of DGT and RGT and gradient density models is as follows.

1.1 Direct-Global and Reverse-Global Techniques (DGT & RGT)

As said earlier, DG and RG approaches describe the distribution pattern of KAs with respect to the DG pivot (densest KA) and the RG pivot (least populated KA).

---

*Corresponding author: E-mail: mathscfuuast@yahoo.com

1.1.1 Direct-Global technique (DGT)

Let $D_{T_1} \ldots D_{T_{18}}$ be the densest KKAs of towns $T_1 \ldots T_{18}$ respectively ($D_{T_1} > D_{T_2} > \ldots > D_{T_{18}}$). The densest KA among $D_{T_1} \ldots D_{T_{18}}$ is the DG pivot represented by D_{DGP} (D_{T_1} in our case). DGT is based on calculations with respect to DG pivot. The distances (D_{DGP}, D_{T_i}), (D_{T_j}, D_{T_k}), i, j, k = 1…18 and population densities $d_i = p_i/a_i$ (p_i and a_i are the population and area of D_{T_i} respectively) are determined. These results are depicted in Table 1.1 ((D_{DGP}, D_{T_i}), d_i) describe the town wise DG pattern of the distribution of KK as depicted in Fig. 1. The curves in Fig.1 reveal the characteristic settlement patterns of KA_S $D_{T_1} \ldots D_{T_{18}}$.

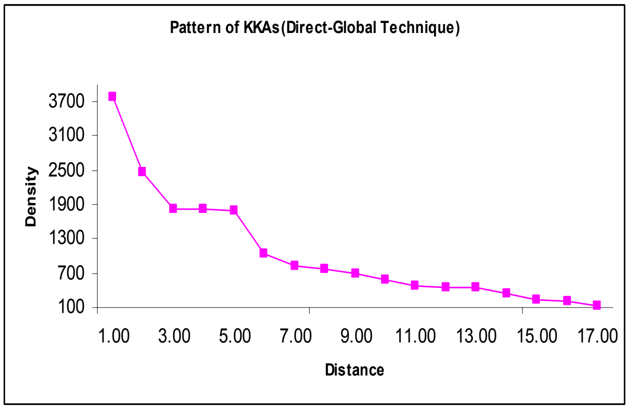

Fig. 1.1. Town-wise Population Density Pattern of KKAs by DGT

1.1.2. Reverse-Global Technique (RGT)

In contrast to DGT, the RGT utilizes the least populated KAs. KA among all the dense. Let $LP_{T_1} \ldots LP_{T_{18}}$ be the Least Populated KKAs of towns $T_1 \ldots T_{18}$ respectively ($LP_{T_1} > LP_{T_2} > \ldots > LP_{T_{18}}$). The Least KA among $LP_{T_1} \ldots LP_{T_{18}}$ is the RG pivot represented by LP_{RGP} (LP_{T_1} in our case). RGT is based on calculations with respect to RG pivot. The distances (LP_{RGP}, LP_{T_i}), (LP_{T_j}, LP_{T_k}) i, j, k = 1…18 and population densities $d_i = p_i/a_i$ (p_i and a_i are the population and area of LP_{T_i} respectively) are determined. These results are depicted in Table 1.2. The curves in Fig.1.2 reveal the characteristic settlement patterns of KA_S $LP_{T_1} \ldots LP_{T_{18}}$.

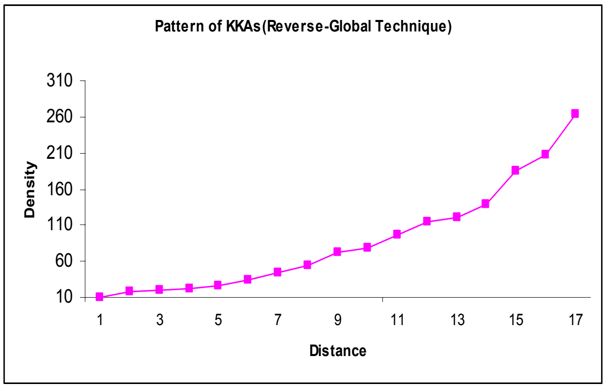

Fig. 1.2. Town-wise Population Density Pattern of KKAs by RGT

1.2. Gradient Density Models

Gradient Density Models basically forecast the population density distribution with respect to distances between their locations. Such models for the case of district wise distribution pattern of KKAs were developed earlier in [Abbas and Ansari (2010)]. These models are in fact, Negative Exponential Models (NEM) represented by $D(x) = D_0 e^{-bx}$ [E.S.Mills and J.P.Tan (1995), F. Wang and J.M Guldmann (1996) and G. M. Robinson (2001)]. to study the distribution of density these models utilize a gradient coefficient b with respect to a fixed location. FGDM developed in [Abbas (2007)] modifies these models by using various values of β to determine the population density.

1.2.1. Flatten Gradient density model (FGDM)

In [Abbas (2007)] mono-pivotal and multi pivotal Flatten Gradient Density Model (FGDM) were developed. A mono-pivotal model is applied on a KA of a district [Abbas and Ansari (2010)]. We first determine the densest KA of the district under consideration. Then the distances of all the remaining KA from the densest KA are calculated. Then considering the densest KA of the district as pivot the population density of a KA is forecasted with the help of the calculated distances and the gradient coefficients β ranging over (0.2, 0.5, 1, 1.5, 2) [A. S. Fotheringham (1993), A. S. Fotheringham (1993), M. G. Boarnet (1994) and David A. Plane, Peter A. Rogerson (2001)]. Then the behavior of the associated density curves is studied with the help of the formula. The flattest curve represents the best distribution. In a multi-pivotal model, the same formula is used to forecast the population density of a KA but instead of using the density of the pivot, the density of KA under consideration is used. The multi-pivotal model appeared to be better than the mono-pivotal model.

$$D(r) = D_0 e^{-\beta r} \qquad (1.1)$$

Where

$D(r)$ = Population density of a KA at a distance r

Table 1.1. Town wise Population Density Distribution of KKAs by Direct-Global Technique

KKA$_S$ ($D_{DGP}\ldots D_{T18}$)	Locations ($D_{T1}\ldots D_{T18}$)	Radius $\lvert D_{DGP}-D_{T18}\rvert$	Density $d_i = p_i/a_i$	Distance B/w Two Locations $\lvert D_{Ti}-D_{Tj}\ldots\ldots-D_{Tk}\rvert$
Ashraf Colony ($D_{DGP} = D_{T1}$)	Orangi (Central)	0.0	5318.0	0.0
Lassi Goth (D_{T2})	Gadap (West)	3.8	3774.0	3.8
Hasrat Mohani Colony (D_{T3})	Bin Qasim (East)	4.1	2479.5	0.3
Sharifabad (D_{T4})	Landhi (East)	3.8	1817.4	0.3
Roshan Shah Sakri Colony (D_{T5})	Jamshad (South)	4.3	1821.4	0.5
Essa Goth (D_{T6})	Gulberg (Central)	1.3	1794.2	3.0
Neelam Colony (D_{T7})	Saddar (South)	3.0	1030.3	1.7
Ashraf Colony (D_{T8})	North Karachi (Central)	3.6	818.2	0.6
saindad Goth (D_{T9})	New Karachi (Central)	4.1	767.6	0.5
Bheempura (D_{T10})	Lyari (west)	3.3	687.1	0.8
Rexer colony (D_{T11})	Site (West)	2.7	580.1	0.6
Banarsi Mohalla (D_{T12})	Liquatabad (Central)	3.5	471.6	0.8
Madina Colony (D_{T13})	Malir	2.7	452.0	0.8
Rodad Nagar (D_{T14})	North nazimabad (west)	3.1	439.2	0.4
Siver Town (D_{T15})	Korangi (East)	4.0	347.4	0.9
Azeem Abad No.2 (D_{T16})	Shah Faisal (East)	3.7	243.5	0.3
Nawab Colony (D_{T17})	Baldia (West)	4.3	198.7	0.6
Rehmat Ali colony (D_{T18})	Gulshan-e-Iqbal (Central)	2.8	138.9	1.5

Table.1.2 Town wise Population Density Distribution of KKAs by Reverse-Global Technique

KKA$_S$ ($LP_{RGP}\ldots LPT_{18}$)	Locations ($LPT_1\ldots LPT_{18}$)	Radius $\lvert LPT_{RGP}-LPT_{18}\rvert$	Density $d_i = p_i/a_i$	Distance B/w two Locations $\lvert LPT_i-LPT_j-\ldots LPT_k\rvert$
Fourhundared quarter ($LP_{RGP}=LPT_1$)	Liquatabad (Central)	0	10.437	0
Sindhi para (LPT_2)	Site (West)	4.416	18.535	4.416
Markrami Goth (LPT_3)	Gadap (West)	1.207	20.114	3.209
Hashim Goth (LPT_4)	Landhi (East)	3.081	21.162	0.128
Zareena Colony(LPT_5)	New Karachi (Central)	3.807	26.172	3.679
Miskeenabad (LPT_6)	Gulberg (Central)	0.5	34.73	3.179
Jinnah Colony (LPT_7)	Malir	1.573	44.502	1.606
Abdul Raheem Goth (LPT_8)	Orangi (Central)	1.2	52.772	0.406
Ejaz Colony (LPT_9)	Jamshad (East)	3.39	55.147	2.984
Sikandar Goth (LPT_{10})	Gulshan-e-Iqbal (Central)	1.573	71.638	4.557
Noorani Basti (LPT_{11})	Korangi (East)	3.535	78.125	8.092
M.P.R Colony (LPT_{12})	Baldia (West)	4.201	97.58	12.293
Moosa Goth (LPT_{13})	North Nazimabad (Central)	3.936	114.777	16.229
Mooria Khan Goth (LPT_{14})	Shah Faisal (East)	4.041	120.95	20.27
Risala Police Chowki (LPT_{15})	Lyari (South)	4.183	138.142	24.453
Ghosia Noorani Pahari Basti (LPT_{16})	Bin Qasim (East)	4.301	186.173	28.754
Brohi Mohallah (LPT_{17})	Saddar (South)	2.112	207.676	30.866
Malik Anwar Goth (LPT_{18})	North Karachi (Central)	2.548	264.192	33.414

r = Distance square kilometers
$D0$ = Density at a point
e = Base of the natural logarithm (approx 2.71828)
β = Distance gradient coefficient parameter

1.2.2. Global Flatten Gradient Density Models (GFGDM)

In case of the town wise distribution of the city of Karachi, Global Flatten Gradient Density Model

(GFGDM) is developed for forecasting the population density distribution of the KKAs using global techniques. It is a modified form of the FGDM developed in [Abbas and Ansari (2010) and Abbas (2007)]. GFGDM involves the distances between densest or least populated KAs of the towns providing better forecasts of the population densities of the KKAs. The forecasts based on direct global analysis and reverse global analysis utilize the distances calculated with the help of Direct Global Technique and Reverse Global Technique respectively. These population density forecasts are depicted in Tables 1.3 and 1.4. In view of Figs 1.3 and 1.4 it can be guessed that forecasts based on Reverse Global Technique are more appropriate than the forecasts based on Direct Global Technique as in the reverse case the density curves flatten more than the density curves in the direct case.

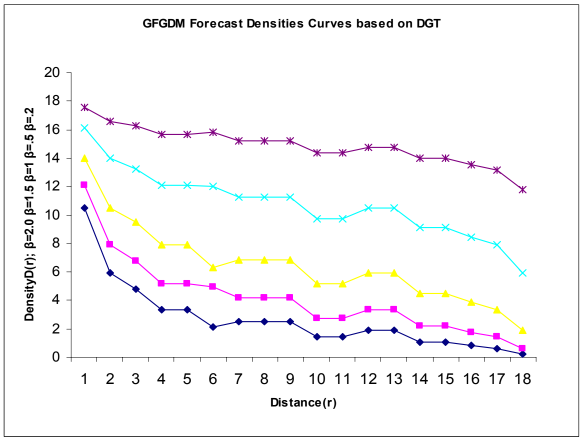

Fig. 1.3. Population Density Curves Based on GFGDM by DGT

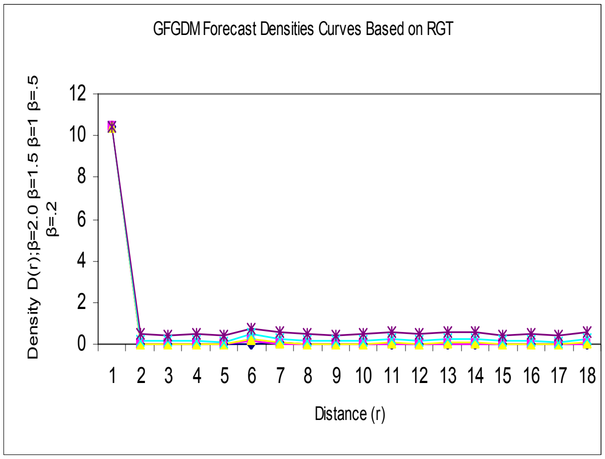

Fig. 1.4 Population Density Curves Based on GFGDM by RGT.

1.3. Appropriateness of (GFGDM)

In this section we will test the appropriateness of the reverse and direct methods by using Log-Linear Transformation Model (LLTM) and Log-Exponential Transformation Model (LETM). The former one is linear in nature whereas the later non-linear.

1.3.1. Log-Linear Transformation Model (LLTM)

This model is represented by

$$\ln D(r) = \alpha + \lambda \ln r \qquad (1.2)$$

where

$D(r)$ = Estimated population density of a KA at a distance r

r = distance square kilometers

α = Constant

Table. 1.3 Population Density Forecasts Based on GFGDM by DGT

β=2.0	β=1.5	β=1	β=.5	β=.2
5318	5318	5318	5318	5318
10.49486	12.10581	13.96404	16.10751	17.54845
5.927993	7.887551	10.49486	13.96404	16.57417
4.825362	6.759411	9.468644	13.26376	16.23656
3.34841	5.13914	7.887551	12.10581	15.65399
3.34841	5.13914	7.887551	12.10581	15.65399
2.516542	4.148247	6.837935	11.27159	15.21323
2.516542	4.148247	6.837935	11.27159	15.21323
2.516542	4.148247	6.837935	11.27159	15.21323
1.421462	2.702793	5.13914	9.771654	14.36861
1.421462	2.702793	5.13914	9.771654	14.36861
1.89134	3.34841	5.927993	10.49486	14.78489
1.89134	3.34841	5.927993	10.49486	14.78489
1.068318	2.181659	4.455261	9.098283	13.96404
1.068318	2.181659	4.455261	9.098283	13.96404
0.802909	1.761007	3.862388	8.471315	13.57087
we0.603437	1.421462	3.34841	7.887551	13.18877
0.192528	0.603437	1.89134	5.927993	11.76496

Table. 1.4 Population Density Forecasts Based on GFGDM by RGT

β=2.0	β=1.5	β=1	β=.5	β=.2
10.437	10.437	10.437	10.437	10.437
0.0006	0.003346	0.022371	0.149569	0.467666
0.0005	0.002133	0.016573	0.128735	0.440432
0.000275	0.003346	0.022371	0.149569	0.467666
0.0005	0.001581	0.013569	0.116484	0.423162
0.000184	0.142274	0.272532	0.522046	0.771052
0.074274	0.011109	0.049787	0.22313	0.548812
0.002479	0.004517	0.027324	0.165299	0.486752
0.000747	0.002133	0.016573	0.128735	0.440432
0.000275	0.007083	0.036883	0.19205	0.516851
0.00136	0.017422	0.067206	0.25924	0.582748
0.004517	0.005248	0.030197	0.173774	0.496585
0.000912	0.017422	0.067206	0.25924	0.582748
0.004517	0.009562	0.045049	0.212248	0.537944
0.002029	0.002479	0.018316	0.135335	0.449329
0.000335	0.003887	0.024724	0.157237	0.477114
0.000611	0.001581	0.013569	0.116484	0.423162
0.000184	0.014996	0.06081	0.246597	0.571209

1.3.2. Log-Exponential Transformation Model (LETM)

LETM is inherently linear model. Inherently linear models are nonlinear but we can be transformed into linear models through a variety of methods.

$$D(r) = e^{\alpha + \lambda r} \quad (1.3)$$

where

$D(r)$ = Estimated population density of a KA at a distance r from the pivot of a KA

r = Distance square kilometers

α = Constant

λ = Distance gradient coefficient parameter

We will linearize the model by taking the logs to get

$$\ln D(r) = \alpha + \lambda r \quad (1.4)$$

Table 1.5 shows the values of DGT and RGT parameters calculated by (1.2) and (1.4). In the reverse case (1.4) gives $R^2 > 0.97$ for β = 1.5 and 2.0. As the distance increases, for these values (larger) of β, the gradient goes on decreasing and the density curves become more and more flat confirming the convergence of the original non-linear model to the linear one.

RESULT AND DISCUSSION

A comparison of the GFGDM developed by DGT and GFGDM developed by RGT shows that in the former case as the distance increases the gradient decreases more rapidly and the density curves become more and more flat confirming the convergence of the original non-linear model to the linear one. Thus GFGDM developed with the help of RGT is better than the GFGDM developed with the help of DGT. We can further conclude that the gradients will become more flattened if the city size increases. This means that the associated density curves go on flattening more and more to finally join in a single straight line.

Table. 1.5 Appropriateness of Population Density Forecasts Based on GFGDM (DGT&RGT) by LLTM and LETM

Appropriateness of GFGDM based on DGT by LLTM			
β	α	λ	R²
2.0	4.5	-1.26	0.842
1.5	2.15	-0.38	0.852
1.0	25.75	-9.75	0.902
0.5	1.433	-0.14	0.948
0.2	1.15	-0.05	0.967
Appropriateness of GFGDM based on RGT by LETM			
β	α	λ	R²
2.0	3.32	-1.16	0.984
1.5	1.61	-0.53	0.986
1.0	0.83	-0.26	0.978
0.5	0.38	-0.12	0.993
0.2	0.15	-0.04	0.995

ACKNOWLEDGEMENT

We acknowledge Orangi Pilot Project for the socio-economic data of more than three hundred KKAs of Karachi and HEC Pakistan for financial support (vide grant #1258) for which the authors are thankful. The contents of this paper will form part of the first author's doctoral thesis.

REFERENCES

Boarnet MG. 1994. The Mono Centric Model and Employment Location, Journal of Urban Economics, 36: 79-97.

David A. Plane, Peter A. Rogerson. 2001. The Geographical Analysis of Population with Applications to Planning and Business, John Wiley & Sons, Inc.

Fotheringham AS. 1993. Spatial-interaction models: The Theory of Competing destinations, Environment and planning A-18:19-26.

Mills ES. and Tan JP. 1995. A Comparison of Urban Population Density functions in developed and developing Countries, Urban Studies. 7: 313-321.

Orangi Pilot Project-Research and Training Institute. 2002. Katchi-Abadies of Karachi, Vol.1. The First Hundred Katchi-Abadies Surveyed, Orangi Pilot Project.

Orangi Pilot Project-Research and Training Institute. 2006. Katchi-Abadies of Karachi Vol.2. The Second Batch of Hundred Katchi-Abadies Surveyed, Orangi Pilot Project.

Orangi Pilot Project-Research and Training Institute. 2009, Katchi-Abadies of Karachi Vol.3. The Third Batch of Hundred Katchi-Abadies Surveyed, Orangi Pilot Project.

Robinson GM. 2001. Methods and Techniques in Human Geography; John Wiley & Sons.

Shaheen Abbas, and Muhammad Rashid Kamal Ansari. 2010. Pattern of Karachi Katchi Abadies Journal of Basic and Applied Sciences, 6(2):1-16.

Shaheen Abbas. 2007. Quantitative aspect of process of Urbanization of Karachi, M.Phil. Thesis.

Wang F. and Guldmann JM. 1996. Simulating Urban Population Density with a Gravity-Based Model, Socio-econ. Sci. 30(4): 245-256, Elsevier Science Ltd.

Received: 31-03-2011
Accepted: 20-05-2011