MISCELLANEA GEOGRAPHICA
WARSZAWA 1992 Vol. 5

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BANGLADESH CITIES ACCORDING TO THE "RANK-SIZE RULE"

Bangladesh is a relatively young independent state organism, since it started its independent history only in 1971. Until 1947 East Bengal was a part of India. In the period of 1947-1971 this area constituted an integral part of Pakistan, as the so-called East Pakistan. Historical experience, coupled with political and economic past connections with Pakistan had undoubtedly a significant influence upon the formation of a less or more definite settlement system. After gaining of independence the process of formation of a sovereign state and economic system went on quite slowly. Today, in spite of 20 years of independence and of constant efforts of the governmental authorities, Bangladesh is one of the poorest countries of the world.

Has Bangladesh some of the attributes characteristic of a developing country? In order to answer this question the method was applied of analysis of correlations between the size of cities and their rank as to size in the hierarchically ordered settlement system of the country. According to the empirically determined rule (Zipf 1949), there is a dependence between the size-defined ranks of cities and their absolute magnitude. This method speaks also of the hierarchy in the system of towns and settlements having supra-local significance.

In the opinion of I.V.Medvedkov (1961) cities as nodes of economic activity create the skeleton of the territorial organization of production forces. He writes that "in the hierarchy of cities the properties of geographical specialization, the degree of economic development, as well as various historical, cultural and political influences are reflected" (p.56).

If we consider the systems of cities of countries whose administrative boundaries have not been changing over a long period of time and whose economic development has not been disturbed by other factors, we can expect that the distribution curve of rank and size of cities in the settlement system will be close to the theoretical straight line postulated by Zipf.

G.K. Zipf discovered the dependence which is represented by formula

$$C_k = C_1 \cdot k^{-z}$$

where C_k denotes the population number of the city ranked as k-th, with k being the rank of the city in the sequence ordered along the decreasing values of city sizes, C_1 is therefore the population number of the largest city in the group considered, while z is the contrasting coefficient, defining the distribution of town sizes in the settlement system. The latter coefficient largely determines the course of the straight line above-mentioned. This coefficient is found with probabilistic methods or via an analytic approach (graphically, from a nomograph, with the method of the average exponents or the least squares method). In the case described here the values of the contrast coefficient were determined via the least squares method (Shryock, Siegel 1976).

Taking logarithms of the expressions in the formula cited above we obtain

$$ln\frac{C_1}{C_k} = z \cdot ln\, k$$

By applying the method of the least squares we can calculate the value of the contrast coefficient of the settlement system from the following formula:

$$z = \frac{\Sigma\, ln\frac{C_1}{C_k} \cdot ln\, k}{\Sigma(ln\, k)^2}$$

Values of z, defining the approximate distribution of city sizes, vary from country to country and also with time.

G.K. Zipf assumed that the value of $z = 1$ means that the settlement system attained a certain ideal state defined by the theoretical distribution of size ranks, the values of z above 1 shows that there is an excessive concentration of population in the greatest towns, while values below 1 indicates that the urban system is polycentric.

The rank-size rule is connected with the theory of central places, and with theory of location of economic activities. In an economic region the magnitudes, numbers and locations of towns result from the functions played by them with regard to the whole of the region. There is a number of explanations for the rule of G.K. Zipf, but only some of them are based upon the spatial concepts and there is just one related to the theory of W. Christaller (1933), whose fundamental assumption is appearance of a system of hierarchically ordered central places in geographical space. Provided that this theory is correct we may expect that the Zipf curve have a stepwise nature with distinct and regular divisions between groups of cities placed on various levels of the hierarchy. Empirical studies make it possible to state a continuous distribution of cities on Zipf curve, especially for the medium sized towns, and a deviation from the straight line approximating the distribution curve for the subset of the largest towns (Berry, Garrison 1958). Explanation of the latter fact can at least partly be provided by the "law of the

primate city" of M. Jefferson (1939), according to which the central town is developing quicker than the other ones because of a number of specific functions which are being carried out in this town. An analysis of Zipf's theory, conforms with the theory of W. Christaller and was presented by M.J. Beckmann (1958). He demonstrated that under certain constraining assumptions there exists a relation between the magnitude of a town and its rank, just as was postulated by G.K. Zipf.

The rank-size rule was verified many times for various regions of the world (Berry 1960-1961), including the case of Poland (Dziewoński 1962). A study of the urban settlement system of Bangladesh in the first decades of the 20th century was performed by K. Maudud Elahi (1972). This study, though, included only an analysis of Zipf curves and their superficial interpretation.

The present author applied Zipf rule to the analysis of Bangladesh cities for three periods: the years 1961, 1974 and 1981, on the basis of the data from national censuses. The subject of the paper were therefore the settlements defined as towns in particular censuses, the numbers of these settlements being in particular periods respectively 77, 108 and 451.

The values of the contrast coefficient calculated for every time instant were:

$$z_{1961} = 1.0296$$
$$z_{1974} = 1.1526$$
$$z_{1981} = 1.2654$$

(calculations for 1981 account only for municipalities, whose number was 75).

Note that the values of z characterize the deviation of a given settlement system from the ideal distribution of city sizes.

The results obtained make it possible to notice the continuous increase of the value of z. This indicates undoubtedly the economic development of the country and an increasing concentration of population in larger cities of Bangladesh, coupled with decrease of population numbers in smaller urban centres. Fig. 1 presents the shapes of curves of ranks and sizes of cities, identified on the basis of population numbers in the years 1961, 1974 and 1981.

The straight lines approximating these curves cross the vertical axis at the point corresponding to population number of the largest town, while the angle of inclination of this line defines the value of the contrast coefficient (thus, the values previously cited correspond to angles of 45°50', 49°05' and 51°40', respectively).

The diagrams presented (see Fig. 1) concerning the town system of Bangladesh confirm the regularity discovered by Zipf. Distribution of cities is conforming with the theoretical straight line in some segments, while in some other segments one can observe smaller or bigger deviations, positive — when towns are placed above the theoretical Zipf line, and negative — when they are placed below this line.

The assumptions behind the rank-size rule are evidently best satisfied in the group of medium-sized towns, while there are usually large deviations from the theoretical distribution in the groups of small and large towns. It can be said that

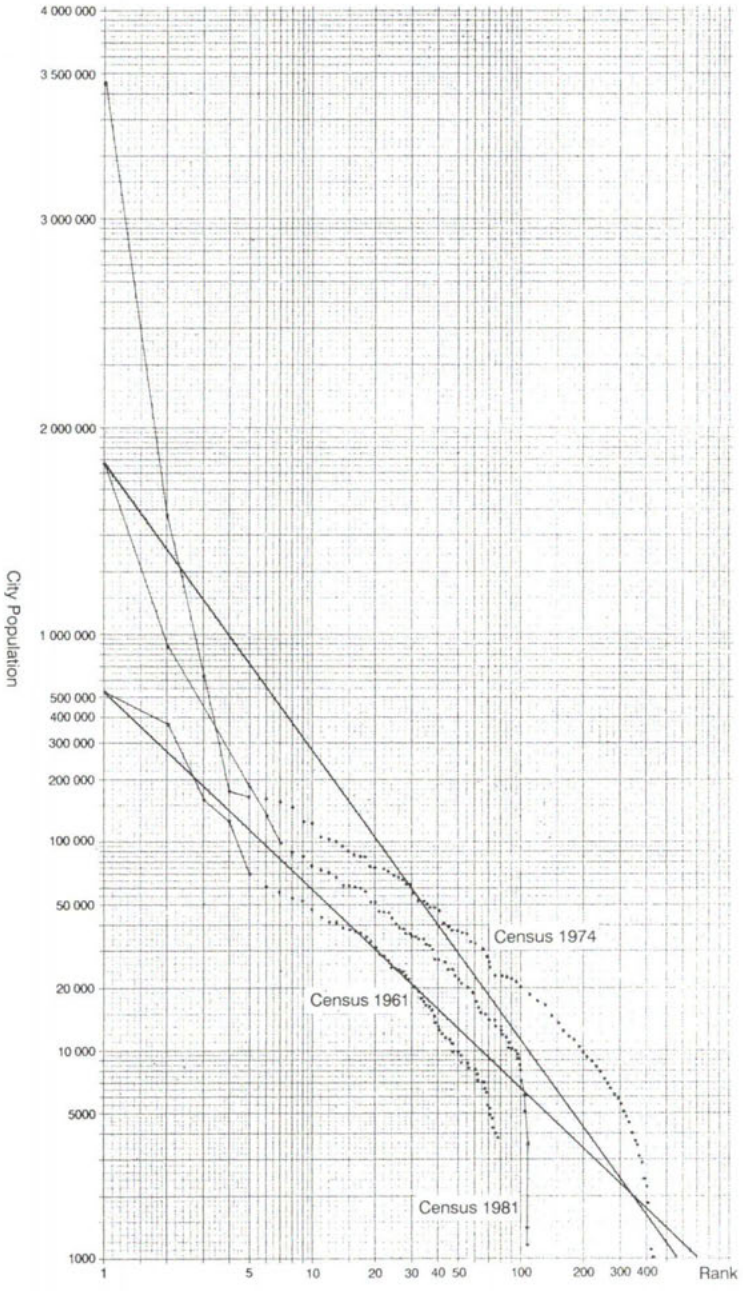

Fig.1. Rank-size distribution of the urban population of Bangladesh in 1961, 1974 and 1981.

too small settlement units, which do not fulfil any important economic functions, are in fact not subject to Zipf's law. This means that wherever the curve is deflected in the diagram, the law is no more valid.

In 1961 the difference between the empirical and the theoretical population numbers in the towns of Bangladesh presents a picture with clearly defined intervals. Thus, towns whose ranks were 3 to 17 (i.e. population of 162 to 43 thousand) had actual population lower than the one expected from the theoretical distribution. Then, towns with ranks 18-31 corresponded, in principle, to the postulates of the rank-size rule. Next, small towns, ranking as 32nd to 47th (i.e. 20-10 thousand inhabitants roughly) exhibited a certain shortage of population number as compared to the theoretical distribution. The differences observed were not great and their range was at about 15%. The deviation from the theoretical distribution curve was getting quite significant in the group of towns below 5 thousand inhabitants, reaching as much as 70%. This results from the character of these centres which should rather be called villages than towns.

The magnitude of the contrast coefficient for 1961 ($z = 1.0296$) is close to the "optimum" value of $z = 1$ and this suggests that in the 1960s there existed in Bangladesh a relatively well-formed settlement system. Hence, we are justified in stating that at that time there existed in Bangladesh an opportunity for creation of coherent settlement systems.

The analysis of sizes and ranks of towns for 1974 demonstrates that there was a certain disagreement of the diagram with the theoretical Zipf line, especially in the range of ranks 3-18 and 70-108. A significant domination of the first city expresses simultaneously a shortage of population in other cities in comparison with the numbers indicated by the theoretical curve. This is especially well seen in the range of town ranks 5 to 14, in which population numbers (200 to 60 thousand) are just a half of the theoretical value. An exception is constituted by the second city of Bangladesh — Chittagong. The theoretical population number of this city is lower than the actual one, which seems to indicate that the role of this town is not directly related to the number of inhabitants. An analogy can be found here to the so-called "surplus of significance" (Christaller, 1933). Chittagong is, besides Dhaka the town playing an essential role in the economic life of the country. The curve of sizes and ranks is characterized by quite high regularity as compared to the theoretical Zipf line for the town ranks 18 to 70, which shows high correlation between the magnitudes and ranks of towns in this group. The curve considered has also a characteristic "tail", i.e. the place of the diagram, starting with which — in the group of smaller localities — the rule of Zipf is no longer valid. This results from the lack of a precise definition of a town, which causes that some countryside centres are included in the town category. Towns of farther ranks (70-108), and therefore of lower place in the hierarchy, are not the locations of important economic functions. Negative deviations attain in the group of smaller towns 50-52%, that is — their population numbers would have to be bigger by 50-52% in order to better approximate the theoretical curve of Zipf.

The actual setting of magnitudes and ranks of towns in 1981 indicates a clear domination of the first town — Dhaka — which results, as previously in 1974, in a significant shortage of population numbers in other urban centres in relation to the numbers resulting from the theoretical distribution. Towns whose ranks are 4 to 16 attain just 30-40% of their theoretical population numbers. A majority of medium-sized towns demonstrate negative deviations of some 50-60%.

Similarly, the shortage of population numbers in towns is well seen for the ranks 381-451, with the urban centres ranked 420th-451st having the actual population numbers 8 or even 10 times smaller than the theoretical ones. These settlements require in particular a special economic activation and total social transformation. The magnitude of deviation of the empirical curve from the theoretical one postulated by Zipf increases in consecutive years analysed, even for towns with very high pace of growth and occupying leading positions in the settlement hierarchy.

On the basis of the analysis conducted we can therefore state that the actual setting of size and rank magnitudes of towns in Bangladesh cannot be considered conforming with the law of Zipf.

The comparison of the values of the coefficient of contrast of the settlement system for the years considered confirms the hypothesis of the deepening lack of coherence in the urban network of Bangladesh, coupled with the increase of domination of the largest town. The existing distribution of towns in Bangladesh has its specific justification. It is a consequence of a number of factors, including the influence of the colonial period, the political divisions, the low degree of urbanization and a weak economic development level of the country.

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