CHAPTER IV

Relief and Population Distribution

4.1 Rural population density

As a first step towards the study of rural population distribution the population density of each C. D. Block has been calculated from the census report of Birbhum district of 1991. Customarily, the population density of a block is the ratio between its population and its geographical area. Here only the rural components of both have been considered. The density values have been rounded off to the nearest whole number. Although the average rural population density of the district is 519 persons per sq. km there is considerable variation in the distribution among the 19 C. D. Blocks. More than half of the district shows lower density than the district average. At least eleven blocks have population density below 520 persons per sq. km. These blocks lie to the west and south of the district. The blocks along the eastern boundary as also the northern ones have density above 520 persons per sq. km. The highest density of population is found in the north of the district, in the Rampurhat subdivision. Here Nalhati II has 840 persons per square km, followed by Nalhati I, Muraroi I and II and Rampurhat II. The two southern sub-divisions have lower population density. Suri I in the Sadar subdivision has the highest density of almost 800 persons per sq. km. Rajnagar block has 280 persons per sq. km., which is the lowest in the whole district. To map the density distribution of rural population of Birbhum district each density value is placed at the areal centre of the corresponding block and isopleths are drawn at selected intervals, (Fig. 3).

From a preliminary study of this map it appears that rural density of population ranges from below 300 persons per sq. km. in the west to more than 800 persons per sq. km. in the northeast. It is also seen that density is higher in the northern part of the district than in the southern. Density values increase steadily from west and southwest to north, northeast and east. The pattern of change is more regular in the north and east than in the southern blocks of the district. Highest rural density of over 800 persons per sq. km. is seen in the northeast in Nalhati II block and also in the eastern part of Muraroi II and northeastern part of Rampurhat II. Rural population density of less than 400 persons per sq. km. occurs in the western part of the district – in Rampurhat I, Mahammadbazar and Rajnagar and also in adjoining parts of Dubrajpur and Suri. In general rural population density is higher in the blocks of Rampurhat subdivision than in those of Sadar or Suri sub-division and the newly created Bolpur sub-division.

4.2a Distinguishing relief features - General configuration

The district is a triangular tract of country with its apex situated not far south of the point where the Ganges and the hills of Santhal Parganas begin to diverge, the hills trending away to the southwest and the river to the southeast. The river Ajay forms the base of the triangle thus formed. Its western boundary follows the line of the hills at a short but variable distance from its foot.
Fig. 3: Rural population density (1991)

RURAL POPULATION DENSITY
(1991)
BIRBHUM DISTRICT

Legend
Persons / sq km

- ≥ 800
- 700 - 800
- 600 - 700
- 500 - 600
- 400 - 500
- 300 - 400
- < 300

Scale

5 0 5 10 15 km

Fig. 3: Rural population density (1991)
CHAPTER IV
The eastern boundary is also separated from the Ganges by a strip of country some fifteen to twenty kilometres broad on its western bank.

The geological formations of Birbhum are Archaean gneiss, sedimentaries of the Gondwana system, laterite and Gangetic alluvium. The gneiss belongs to the Bengal gneiss group. Carbonaceous shale and poor quality coal represent the Gondwana system in the southwest and in the Mayurakshi basin. Ferruginous laterite occupies large tracts in the valleys of the Ajay and Mayurakshi rivers. The country in the southeast of the district is an alluvial plain with a soil of varying composition from dark clay to sand. Further west, where the land gradually rises, are found calcareous nodules locally called ghuting, laterite in the form of gravel and of rock and granitic and gneissic rocks. A curious mass of granite occurs at Dubrajpur (Photo 1). The laterite in the middle west is found on the surface in some places (Photo 2).

Throughout almost the entire length of the district the surface is broken by a succession of undulations with a general trend from northwest to southeast. Near the western boundary they rise into high ridges of laterite, separated by valleys a mile or more in width. To the southeast these upland ridges become less pronounced and gradually merge into the broad alluvial plains of the Ganges delta. The larger ridges are covered with thick sal forest, only the valley bottoms being cultivated. As they become less steep, rice is grown in terraces up the sides and only the broad, flat and usually dry summits are left untilled forming scanty pasture grounds in the rains. The minor undulations are terraced up to the summits, (Fig. 4).

The rapidity with which hills and ridges change into undulations (Photo 3 & 4) and undulations into level country varies considerably. In the extreme north of the Rampurhat subdivision the ridges are high and rise to above 100 metres but they cease abruptly and throughout the greater part of Nalhati and Rampurhat blocks the surface is only slightly undulating. The unbroken deltaic plain however lies beyond the eastern boundary of the district. In the Nalhati blocks there are eight detached hillocks of basaltic formation the highest of which is known as Mathurakhali Pahari. The western portions of Mahammadabazar and Suri I blocks are covered with high ridges extending far to the southeast. On the south of the Mayurakshi valley they sink into undulations, and after nearly disappearing, swell into well-raised uplands near Sainthia block. Along the north of the Ajay, to the south of Labpur and Bolpur, the country is absolutely flat, (Fig. 5). To the north of 24°20' north, in the Muraroi block the land slopes north-northeast as is evident from the flow of the Pagla Nadi and its tributary the Suri Nadi. Further north the Bansloi Nadi also flows north-northeast. This direction of slope is in marked contrast to the east southeasterly flowing streams of Birbhum. The Gamri-Pagla interfluve is the divide from where the change of slope occurs. This divide itself has no noticeable relief. As evident from the meandering course of the Pagla, the slope is very gentle. These northeast flowing streams have formed several swamps within Birbhum. The highest point in Muraroi blocks is only 70.71 m at Dhuria Pahar. In Nalhati the highest point is 80.16m near the state border. The general slope of the Rampurhat blocks is from west to east dominated by the east flowing left bank tributaries of the Dwarka. The slope of the Mayureswar blocks north of 24° north latitude is northerly...
CHAPTER IV

Fig. 5: Drainage
Selected Physical & Socio-economic Determinants of Rural Population Distribution in Birbhum

and south of it easterly. These two different slope directions begin from the Mahammadbazar block where the Dwarka takes a northeasterly bend and the Mayurakshi throws off a distributary, the Manikarnika. The interfluve between these two master streams is only 4.83 to 6.44 miles broad at a point and is dominated by the 45 m contour line. The existence of large water bodies and the Manikarnika distributary, in the southwest of the Mayureswar block, point to the flatness of this interfluve.

4.2b Distinguishing relief features - Physiographic divisions

On the basis of its physio-geographic considerations, the district has been divided into four micro regions. Each one exhibits distinctive population characteristics of its own.

(i). Nalhati Plain

The region represents the northern portion of the district comprising Muraroi and Nalhati blocks. The region is characterised by some ridges, which are at places as high as hills, along the western boundary with the state of Jharkhand. The ridges are the extensions of the low Rajmahal hills. The highest points in this region are in the range of 70 to 80 metres. The greater part of the region is however, plain with slight ridges. The slope is towards north and north-east as is evident from the flow of the Pagla and Bansloi rivers. The region has laterite soils mixed with recent alluvium.

The region has 205 villages and one urban centre covering a total area of 512.7 square kms. It has a population of 305,939 of which 290,866 are in rural areas and 15,073 are in urban areas. The rural and urban populations work out to 97.07% and 4.93% respectively. The region has rural density of 575 persons per square km. and urban density of 2250 persons per square km.

(ii) Brahmani-Mayurakshi Basin

The region as river basin lies between the Brahmani river on the north and the Mayurakshi river on the south. The surface configuration is uneven throughout. The general slope of the region is from west to east. However the Dwarka takes a northeasterly bend and the Mayurakshi a southeasterly bend in Mahammadbazar and Mayureswar. On the south of the Mayurakshi the land sinks into undulations and then to plains (Photo 5) further eastward. The land between Dwarka and Mayurakshi and to the extreme southwest of Mayureswar, is flat and there exists large water bodies also due to the flatness of the interfluve. The region has red sandy and red loamy soils of older alluvium (laterite-gravel). The soils are loose and friable with very little water holding capacity.

The region has 811 villages and 2 urban centres in 11 community development blocks. It has a total population of 763,802 of which 705,128 (92.32%) live in rural areas and 58,674 (7.68%) in the urban areas. The region has an area of 1,456.5 square km. and its density is 484 persons per sq. km. in rural areas and 4,513 persons per square km in urban areas.

(iii) Suri-Bolpur Plain

The region extends over the southeastern part of the district. A rolling upland topography is the characteristic feature of this micro-region (Photo 4). The general slope is from
northwest to southeast. To the south the Ajay river dominates the landscape with its sandy bed, (Photo 6) kilometres wide at places. The Sal or Kopai and the Bakreswar rivers drain from west and northwest to southeast. The right bank tributaries display widespread gully erosion resulting in extensive badland topography to the north of Binuria, Sri Niketan, Surul, Santiniketan and Makarampur. Towards the southeast the upland ridges slope gradually, the valleys become progressively shallow and merge into the alluvial plains of the Ganges delta. The spurs and the ridges are covered with sal forests interspersed with scantly grass on broad flat and dry uplands. To the north of the Sal lies the cultivated areas studded with numerous tanks and other water bodies. The soil found in this region varies from red sandy, red loamy and older alluvium in the southwest to brown and recent alluvium in the central and southeastern part.

The region falls in seven community development blocks comprising 940 villages and 2 urban centres. It has a total population of 840,709 in an area of 1,624.6 square km. Of this total, the region recorded 733,651 persons or 87.26% as rural population and 107,058 persons or 12.73% as urban population. Its rural density is 451 persons per sq. km. and urban density is 4,735 persons per sq. km.

(iv) Bakreswar Upland

This region covers the western portion of the district from Khoyrasol to Mahammadbazar and Rampurhat, which lies at the base of the heavily dissected plateau of Santal Pargana project south and south-eastward (Photo 3). These highlands are located on hard impervious crystalline rocks of Archaean period (Photo 7, 8). Near the western boundary of the district these projecting spurs rise into high ridges capped by laterite and separated by wide valleys. These ridges are 78 to 110m above mean sea level. With Rajnagar at the centre, river valleys radiate in all directions except the northwest where the high plateau provides a natural fortification. The highest point in the district is reached in the Nunbil - Siddheswari interfluve where the summit of a hillock measures 159 metres above mean sea level. The larger spurs are covered with stunted sal (sorea robusta) forest while the valley floors are cultivated. Proceeding eastward these projecting spurs become mere undulations. The principal rivers of the region, Dwarka, Mayurakshi, Bakreswar, Ajay and its tributaries - the Hingla and the Sal, all drain to the east and southeast indicating the slope. The soil of the region is lateritic mixed with alluvium. It is reddish in colour and loose and friable in texture often with ferruginous concretions. On the whole this region has low soil fertility.

This region embraces over six community development blocks, which comprise 508 villages and 2 urban centres. It has a total population of 345,983 persons living in an area of 931.6 sq. km. Of the total population 317,601 or 91.79% live in rural areas and 28,382 or 8.2% live in urban areas. This region has a rural density of 341 persons per square km and an urban density of 1,165 persons per square km.

4.3 Relative Relief

The relief of Birbhum is depicted in the Survey of India topographical sheets with the help of contour lines. These can be analysed in different ways to extract more information about...
terrain conditions. The physiography of the district has been discussed in a general way in the
previous section with the help of the relief and drainage maps. With the help of Survey of India
topographical sheets of scale 1:50,000 covering the Birbhum district a relative relief map has been
prepared following Smith, G. H. (1935) to bring out local relief conditions. This involves drawing
isopleths depending on the difference between highest and lowest contour values in any limited area.
The district map has been divided into rectangles of five minutes of latitude and longitude, (Fig. 6).
Maximum height difference in each rectangle is obtained from the above-mentioned topographical
sheets. These values, expressed in metres, have been placed at the central point of the rectangles,
and isopleths have been drawn to prepare the relative relief map.

The relative relief map of Birbhum (Fig. 7) reveals some interesting details. Relative
relief appears to increase from east to west - from less than 15m to more than 60m. In the north this
transition is accomplished within relatively short east-west distance than in the south. Maximum
relative relief of 60m occurs in the western part of blocks Nalhati I, Rampurhat I, Mahammadbazar
and Rajnagar. The eastern blocks on the whole have relative relief less than 15m. The blocks Muraroi
I, Nalhati I, Mayureswar II, Labpur, Nanoor and Illambazar have relative relief below 15m. A relatively
small area in Bolpur block has values higher than 15m. This condition of relative relief is closely
linked with the geological structure and local fluvial geomorphology.

4.4 Impact of relative relief on rural population density

From the above account it may be said in a general way that rural population density
is high wherever relative relief values are low. Visual comparison of the two isopleth maps reveals
that the alluvial plains of the east and southeast with low relative relief have high rural population
density. Thus, low relative relief areas appear to support from 500 to 800 persons per sq. km. even
though altitude may be 20 to 80m. However, the slightly higher relative relief of 15m does not make
any noticeable difference in the distribution of population. In the west the density declines with rising
relative relief and where it crosses 45m some of the lowest density in the district is recorded. In the
Suri subdivision population density above 500 persons per sq. km. is found where relative relief is
less than 15m except in the northwestern part of Sainthia block. In the southern part in both Suri and
Bolpur subdivisions relative relief seems to have little impact on rural population distribution. Most of
this area in Rajnagar, Dubrajpur, Illambazar and Bolpur blocks of the district has density between
400-500. In parts of Suri, Sainthia, Labpur and Nanoor it rises to 500-600 persons per sq. km. A
superficial assessment of the two maps of relative relief and rural population density thus reveals that
there is an inverse relationship between the two variables. But it would be impossible from visual
inspection alone to state the relationship in any quantitative terms or even to map the varying degree
of correspondence between the two.

To measure the strength of relationship and also to map the distribution of varying
degree of correspondence between density of rural population and relative relief, the regression of
rural population density upon relative relief may be employed. A scatter diagram has been drawn
Fig. 6: Grid location and relative relief

CHAPTER IV

Page 20
Selected Physical & Socio-economic Determinants of Rural Population Distribution in Birbhum

Fig. 7: Relative relief map

CHAPTER IV

Page 21
showing rural population density, i.e. D values along the Y-axis and relative relief, i.e. R values along the X-axis (Appendix 1, Table A). The values of relative relief have been obtained by linear interpolation from the isopleth map of relative relief at the areal centres of the C. D. blocks. The population density and relative relief are taken as paired values for the scatter diagram and subsequent regression analysis, (Fig. 8). The paired values, whose position in the scatter diagram show the graphical correlation between the variables, have been utilised to draw the regression line, i.e. the line of best fit. The regression line is obtained by the least square method where \( D_c = 653.11 - 9.42 \times R \), which shows the linear relationship between rural population density (D) and relative relief (R). According to this relationship a C. D. block in Birbhum with a relative relief of 60 metres is expected to support a rural population density of 88 persons / square km and a relative relief of 10 metres is expected to support 559 persons / square km.

In this way the "expected" \( D_e \) rural population densities are computed for each of the 19 C. D. blocks. If a second isopleth map of expected rural density is drawn with such values it will depict what the density distribution would be if it were entirely dependent on relative relief as defined by the trend line. In order to find out the strength of the relationship, that is, the degree of association between the rural population density and relative relief Karl Pearson's product moment correlation coefficient has been employed. This shows that correlation coefficient \( r \) is - 0.67.

The value of \( r \) is obtained by Pearson's product moment correlation method:

\[
r = \frac{N \sum RD - \sum R \sum D}{\sqrt{(N \sum R^2 - \sum R^2)(N \sum D^2 - \sum D^2)}}
\]

where, \( r \) = correlation coefficient

\( R \) = independent variable i.e. relative relief

\( D \) = dependent variable i.e. rural population density

\( N \) = number of pairs of observed values

The critical value of \( r \) at 1% level (two-tailed) for a sample size of 19 is 0.575. Hence the calculated correlation coefficient is significant. Therefore the correlation has not occurred by chance and the null hypothesis that correlation does not exist is rejected. The Student's t test has also been employed to test whether the correlation coefficient is significant

\[
t = \frac{r \sqrt{(n-2)}}{\sqrt{1-r^2}} = \frac{-0.67 \sqrt{(19-2)}}{\sqrt{1-0.67^2}} = -3.694
\]

and the value is 3.69. The critical value of \( t \) with 17 degrees of freedom at 5% level (two sided) is 2.11. Hence the calculated value of \( t \) is significant. Taking the Pearson's correlation coefficient the percentage of explained variation is equal to \( r^2 \times 100 = 0.67^2 \times 100 = 44.53 \). Thus it may be said that the variation in relative relief accounts for 44.53% of the total variation in rural population density distribution.
Fig. 8: Scatter diagram (relative relief and rural population density)
Since the coefficient value (-0.67) obtained earlier does not indicate perfect negative relationship between relative relief and rural population density the actual population density map and the population density map as influenced by relative relief will not coincide wholly. They will differ from each other to some extent. Such departures i.e. \((D - D_c)\) values indicate how far the 'actual population density' \((D)\) differs from the 'population density related to relative relief' \((D_c)\). From these absolute residuals \((D - D_c)\), standardised residuals are calculated. Plotting these at the areal centre of each block another isopleth map has been prepared to illustrate the correspondence between the prevailing population density and relative relief, (Fig. 9). The shade difference in the map represents the graded values of standardised residuals.

The impact of relative relief on population distribution is stronger in the white areas of the map. Such areas lie in the middle and south west of the district in Rampurhat, Mayureswar, Santhia, Suri, Mahammadabazar, Bolpur, Khoyrasol, Illambazar and Rajnagar blocks. These white areas stand for very low departures from zero and show that with all other factors remaining constant the density of rural population remains the same as expected from relative relief alone. The darker the shading the weaker is the correspondence between relative relief and population distribution. In the Rampurhat subdivision in the north positive departure values rise to more than 2 as in the Nalhati I block. This means that actual population density of this block is hardly influenced by relative relief. In the south in Suri and Bolpur subdivisions negative values indicate that according to relative relief alone higher population density is possible.
Fig. 9: Relationship between rural population density and relative relief

Legend
Standardised residuals $(D-D_c)/SE_D$

+ 2.0
+ 1.5
+ 1.0
+ 0.5
0
- 0.5
- 1.0
- 1.5

$D-D_c = \text{Number of persons / sq km more or less than normal}$
$\text{Normal is } D_c = 553.11 - 9.42R$
$D = \text{Population density (D) relative relief (R)}$
$SE_D = \text{Standard error of estimate}$

Fig. 9: Relationship between rural population density and relative relief

CHAPTER IV
Page 25
Selected Physical & Socio-economic Determinants of Rural Population Distribution in Birbhum

Photo 1. 'Mama-Bhagne Pahar' - an eroded granite hill in Dubrajpur block

Photo 2. Erosion of laterite gives rise to poor quality soil

Photo 1. 'Mama-Bhagne Pahar' - an eroded granite hill in Dubrajpur block

Photo 2. Erosion of laterite gives rise to poor quality soil
Selected Physical & Socio-economic Determinants of Rural Population Distribution in Birbhum

Photo 3. Undulating rocky terrain in the Bakreswar Upland in Rajnagar block

Photo 4. Upland topography in Bolpur block in the Suri-Bolpur region
Photo 5. Rice fields with hay stubs in the eastern flats

Photo 6. Ajay River near Kenduli in Illambazar block. Sand excavation from riverbed in winter. High-tension cables bring electricity from Burdwan district