Soil and Population Distribution

The soil is one of the greatest natural resources for any country, especially for a country like India where nearly 70% of net domestic product from natural resources is derived from the soil. The physical and chemical properties of soils are the major determinants of water retentive capacity and fertility status of soils and are of immense importance in promoting agricultural pursuits.

Since the mainstay of economy of Birbhum district is agriculture, the factors that govern the distribution of population are expected to be closely related to those that promote good agriculture. The depth, texture and fertility of soil are some such factors and may have guided the distributional pattern of population in the district.

11.1 Soils

On the whole the surface of the district is undulating and irregular, the trend of such undulations being from northwest to southeast. Hard crystalline rocks, basaltic rocks, laterites and alluvium cover the district. The soils developed on such surfaces reflect the lithological characteristics inherent to the area.

The western part of the district to the south of the Mayurakshi river, embracing the blocks of Khoyrasol, Rajnagar and Suri (in part) are covered by gneissic (colluvial) soil. This kind of soil is also found in the Dubrajpur area. It contains large amount of sand and gravel and is characterised by a low concentration of organic matter, available phosphate, bases and other nutrients. It has a pH value of 6.5-7.2. Due to undulating topography and high porosity, the tracts covered by such soils are susceptible to gully erosion. Cultivation is difficult except in low-lying areas and needs application of manure and fertiliser.

The gneissic soil is followed in the east by laterite, which covers a major portion of the central part of the district, south of the Mayurakshi river in Sainthia, Bolpur-Sriniketan and eastern part of Suri block. The lateritic soils are light in texture, porous, acidic in nature (pH 4.8-6.5) and poor in organic matter, available phosphate and bases. Hard structures of iron and aluminium oxides are present in the subsurface (Photo 18 & 24). Kaolinite is the principal clay mineral. For profitable agriculture heavy application of organic manure is needed. In spite of low soil fertility, paddy yield is relatively high because of good drainage and response to fertiliser application. High yielding dwarf variety of paddy and wheat can also be raised in this type of soil.

The Eastern Railway line (erstwhile Sahibgunge Loop) more or less forms the boundary of the laterite soils with the Vindhyana type of alluvium occurring further east in parts of Sainthia and Bolpur-Sriniketan as well as Nanur and Labpur blocks (Photo 32). The Ahmadpur-Labpur tract south of the Ahmadpur-Katwa branch railway line forms a high land, compared to areas further north. The Vindhyana alluvium is formed from deposits brought down mainly by the Mayurakshi river system and is characterised by mildly acidic to neutral soil (pH 5.5-7.2), low to medium iron...
content and other bases which increase with depth. Mottlings are present in sub-surface. The soils are low in organic matter and have medium concentration of available phosphate and potash. They are responsive to fertiliser application. Rice is the principal crop but potato, jute, sugarcane and vegetables can also be raised.

North of the Mayurakshi river the western part of the district underlain by basaltic rocks in Mahammadabazar, Rampurhat, Nalhati and Muraroi blocks have Gondwana type of alluvial soil. Similar soil is found in the southern part of Khoyrasol block. This type is followed in the east by red soil, followed by Vindhyan alluvium further east. Thus the eastern part of Rampurhat, Nalhati and Muraroi and the Mayureswar blocks in full are covered by Vindhyan alluvium. The red soils are mildly acidic in reaction (pH 5.4-6.6), low in organic content, bases and available phosphate. They are again responsive to fertiliser application.

The various types of soils and their suitability for growing different crops are described in the next section. *Entel*, (which literally means sticky) a brownish clay is a very poor soil. It becomes very sticky when wet and gets hard and cracks in long fissures on drying. It can grow rice if manured, but is not suitable for *rabi* cultivation. *Metel* is a clay soil, which can retain moisture and is best suited for *aman* rice, sugar cane, wheat, gram and *kalai*. *Bagha entel* is a heavy reddish soil, which becomes very sticky when wet and extremely hard when dry. It can retain moisture for longer period than any other soil. Like *entel* it is also a poor soil and capable of producing paddy only if manured. *Palimati* is alluvial deposition. It is a very rich soil and well suited for sugar cane, wheat, gram, potato, cabbage and other vegetables. With assured irrigation it can produce *rabi* crops in abundance. *Bindi* is a sandy soil, which improves with continued cultivation. It is reddish, loose and friable with very little water holding capacity. It is capable of producing paddy and can produce *rabi* crops with irrigation. *Doansh* is a mixture of clay and sand forming a blackish, loose and friable soil. It is not so rich in fertility but can grow rice and is also suitable for almost all sorts of crops. It is not ordinarily suited for *rabi* cultivation. *Kankar* is a reddish, loose and friable laterite soil containing ferruginous concretions in it (Photo 2 & 22). It is a poor type of soil capable of growing bajra, maize, peas etc. It will also grow *rabi* crops with irrigation. *Bele* is a whitish, loose and friable soil not retentive of moisture. It is a poor soil suited only for paddy and vegetables. *Bastu*, a rich black soil with low water holding capacity, can grow fine rice, wheat, sugarcane, peas, tobacco etc. with proper manuring and irrigation.

For the sake of correlation analysis between soil and population distribution, the crude percentage of four principal soil nutrients, e. g. N (nitrogen), P (phosphorous), K (potassium) and C (carbon) have been obtained for each block of the district from the District Agriculture Office at Suri, Birbhum. The data relates to the soil samples collected mostly in the post harvest period, thereby indicating the natural nutrient content of the soil. The sum of the percentage of N, P, K and C for each block may be considered as an index of soil fertility of that block. These values are represented in a choropleth map showing the soil fertility of the district on the basis of aggregate percentage of N, P, K and C (Fig. 31).
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Fig. 31: Soil fertility (NPKC) map

SOIL FERTILITY
(1999 - 2000)
BIRBHUM DISTRICT

Legend
NPKC in %
- 1.5 - 1.75
- 1.25 - 1.5
- 1.0 - 1.25
- 0.75 - 1.0

Scale

Fig. 31: Soil fertility (NPKC) map

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11.2 Impact of soil fertility on rural population density

An examination of the soil fertility map reveals that except in the northern and southwestern part of the district there is no definite pattern in the spatial variation of soil fertility in terms of aggregate percentage of N, P, K and C. The values range from 0.87 in Mayureswar I block to 1.7 in Labpur block. The blocks in the northern part of the district have consistently high values of soil fertility. In the southwest it appears to be fairly low in Rajnagar and Khoirasol blocks, around 1.1, but appears to increase eastwards in Dubrajpur, Illambazar, Bolpur-Sriniketan, Labpur and Nanur. In the central part of the district in Sainthia, Mahammadabazar, Suri II blocks however soil fertility is not high and ranges from 1.16% to 1.21%. The map of rural population density on the other hand exhibits a more regular pattern. There is a steady increase in population density from west to east in the whole district. In the north the change from 400 persons / sq. km. to more than 800 persons / sq. km. takes place within a relatively short distance. In the south however the pattern of change is much more diffused. From less than 300 persons / sq. km. in Rajnagar in the west to more than 600 persons / sq. km. in the northeastern part of Labpur block in the east. Thus there is some difference in the spatial distribution of the two phenomena. For example, soil fertility appears to be fairly low in the central part of the district but this is not adequately reflected in the population distribution. Because of the lack of any marked trend in the spatial distribution of N, P, K and C (aggregate percentage), visual comparison between the two maps of population distribution and soil fertility remains inconclusive. To describe the general relationship between the two variables in quantitative terms or to map the varying degree of correspondence between the two, statistical analysis is found to be a better choice.

As an initial step towards such analytical study, the regression of density of rural population on soil fertility has been employed. Fig. 32 shows a scatter diagram in which rural population density i.e. D values have been shown along the Y-axis and soil fertility i.e. O values (obtained from the choropleth map of soil fertility at the areal center of the C. D. blocks) have been shown along the X-axis (Appendix 1, Table H). The values of D and O at the areal center of each block have been taken as paired values for the scatter diagram and subsequent regression analysis. Paired values whose locations in the scatter diagram show graphical correlation between the variables have been utilized here to draw the regression line, i.e the straight line of best fit. The regression line obtained by the method of least square is $D_c = 300 + 201 \times H$, which shows the linear relationship of soil fertility (H) with rural population density (D). Stated in statistical terms according to this relationship a C. D. block in Birbhum district with soil fertility in terms of aggregate percentage of N, P, K and C of 1.0 is expected to support a rural population density of 501 persons per sq km approximately ($D_c = 300 + 201 \times 1.0 = 501$ approx.).

In a similar manner, the 'expected' ($D_c$) rural population density is computed for each block. The values, thus obtained may be plotted at the areal centre of blocks and isopleths are drawn through them. If such an attempt were made there would be two population density maps, one showing the actual distribution and the other depicting what the density distribution pattern would be if it were entirely dependent on soil fertility as defined by the regression line. In order to find out the
Fig. 32: Scatter diagram (soil fertility and rural population density)
strength of relationship, i.e., the degree of association between rural population density and soil fertility, the Pearson product moment correlation coefficient has been employed. This shows that the correlation coefficient (r) is 0.28. The value of r is obtained thus:

\[
r = \frac{\sum N (HD - IH)(ID)}{\sqrt{\left(\sum N (IH)^2 \right) \times \left(\sum N (ID)^2 \right)}}\]

where, \( r \) = Correlation coefficient  
\( H \) = Independent variable, i.e., soil fertility  
\( D \) = Dependent variable, i.e., rural population density  
\( N \) = Number of pairs of observed values.  
\( \Sigma \) = Summation

Since the value of r is very low it is apparent that there is very feeble association between the two variables. The critical value of r for a sample size 19 at 5% level (two sided) is 0.456 and 0.389 at 10% level. Hence the calculated value of r is not significant. In other words, the null hypothesis that the correlation coefficient is zero is accepted. The Student's t test has also been applied to test the significance of the r. The value of t works out as follows:

\[
t = \frac{r \sqrt{(n-2)}}{\sqrt{1-r^2}} = \frac{-0.28 \sqrt{(19-2)}}{\sqrt{1-(0.28)^2}} = 1.20
\]

The critical value of t with 17 degrees of freedom at 5% level (two sided) is 2.11 and 1.74 at 10% level. Hence the calculated value of t is not significant. Since the correlation coefficient value (0.28) indicates only a weak positive relationship between rural population density and soil fertility, the maps showing the 'relief' of actual population density and 'soil fertility – population density' will not coincide in most cases. This is supported by high departure values (D-Ds), of the 'actual population density surface', D from the 'soil fertility - population density' surface, Dc. The mapping of the residuals (D-Ds) in order to show the correspondence between soil fertility and rural population density in the district would appear to be redundant in such a case. Even if such a map is prepared it will depict the same lack of closeness of relationship between the two variables. Hence further analysis is considered unnecessary.

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Photo 17. Mixed forest with sal predominating near Bakreswar in Dubrajpur block.

Photo 18. Land degradation by gully erosion near Dubrajpur.
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Photo 19. Afforestation along newly constructed state highway near Suri

Photo 20. Tank (dighi) with high embankment stores rainwater. Poor quality soil is used in brick making.
Photo 21. Unproductive land with scattered trees near Dubrajpur

Photo 22. Coarse texture of soil on 'danga' land
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Photo 23. Soil erosion in 'khowai' near Shantiniketan

Photo 24. Deep gully erosion and leached soil near Bolpur
Photo 25. Kopai canal near Bolpur with unmetalled road running beside it. Akashmoni and eucalyptus planted to check soil erosion

Photo 26. Extensive soil erosion and gullying beside canal sluice near Bolpur