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MICRO-GEOMORPHIC REGIONS OF THE LOWER CHAMBAL VALLEY

by

DR. HARI SHANKAR SHARMA*

The Lower Chambal Valley, the area chosen for the present investigation, comprises of a fairly large area lying between 24°45′ - 26°45′ North and 75°20′ - 79°20′ East (Fig. 1). Covering an area of

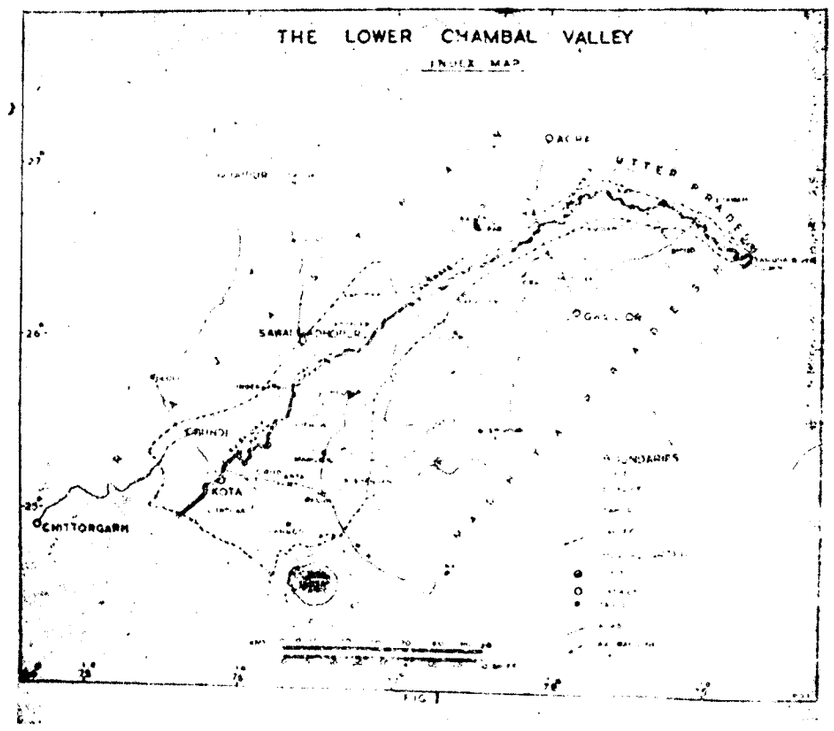

Fig. 1.

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entirely carried to north-west, where on meeting the plain level, they flow along strike valleys to the north-east into theBanas The subsequent streams which descend from the south-eastern face of these hills directly join the Chambal at approximately right angle. Thus as a whole it may be suggested that the drainage pattern is irregular. Around Sawai-Madhopur in the hilly section streams are mainly guided by the strike of the Gwalior formations.

(iii) The Mukandwara Hills

The main characteristic features of these hills are the same as mentioned in connection with the Bundi Hills. The boundary of these hills on the south is marked by the Ahu river, a tributary of the Kali-Sind. On the north-east it faces Kota Plateau.

These hills are composed of the Upper Vindhyans. There are three strike ridges, which run almost parallel from west to south-eastern direction. The beds dip from 5° to 50° in the north-east direction. Between the strike ridges longitudinal valleys have been carved out in regions of shales.

The streams of these hills are mainly guided by the strike of the country rocks. The Ahu river flows parallel to the strike of these hills in west to east direction. The Kali-Sind at Gagroan cuts through these hills in the direction of the dip and forms a transverse valley. Considering this course of the Kali-Sindh it may be stated that the direction of the river was established when Deccan Trap[1] covered the area upto the Mukand. wara Hills, and that the Deccan Trap surface determined the direc tions of the river.

2. THE PLATEAU SECTION

The plateau section also appears in the Valley into two detached parts; one in the north-eastern portion called the 'Dangland' and other in the western part - called the Kota Plateau.

(iv) *The Dangland*

The range characters of the above mentioned hills become less prominent to the north-east of the Banas water gap, and here the 'Dangland' or plateau is met with. The Chambal scarp marks the southern termination of this plateau. To the north-west it is bounded by the Karauli hills along the Boundary Fault, In the east it continues upto Dholpur and thence it gradually merges into the Trans-Yamuna Plain.

The whole 'Dangland' is composed of gently tilted-Upper Bhander sandstone underlain by shales. The Lower Bhander sandstone along the Boundary Fault are vertical and form the strike ridges. The structure of the plateau is very simple. Where the sandstone formations are horizontal, broad plateaus terminated by vertical scraps have resulted. Where these formations are dipping, strike ridges are common. The longitudinal valleys are in the regions of Sirbu shales.

As suggested that the inclination of the plateau is towards north-west, the maximum height of 475 metres is on the southern edge On the north-west the elevation decreases to 300 metres. The surface is dissected into flat topped hills. The mesas of the plateau represent the middle - Miocene erosion remnants.

The alignment of the streams is both towards north-west and north-east. The streams are non perennial. The Chambal scarp forms the watershed between the two drainage system, *viz.* the Banganga and the Chambal systems. The subsequent streams which descend from the southern edge are small but due to their erosive capacity the Chambal scarp has been dissected into 5 terraces. The general drainage pattern seems to be linear.

[1] The Deccan Trap is found few miles south of the Mukandwara Hills.

The Chambal scarp: The long dissected wall like scarp extending for a length of nearly 112 kilometres from the Banas water gap to Dholpur, paralleling the Chambal river is known as the Chambal scarp. Throughout the length the scarp retains an average elevation of over 456 metres above mean sea level. From the Chambal lowland it appears like an abrupt vertical cliff rising to an elevation over 180 to 210 metres within a distance of 4 to 5 kilometres. The scarp forms the dividing line between two erosion surfacee *i.e.* the lowlying pleistocene surface and a partially peneplained plateau over 150 metres belonging to the middle-Tertiary period. The general inclination of the plateau is towards north where it is terminated by the Great Boundary Fault of Rajasthan. This area falls beyond the Chambal Valley in the north-west.

The whole of the Chambal scarp is formed of gently dipping stratified Upper Bhander sandstone underlain by Sirbu shales and limestone. The resistence of the Upper Bhander sandstone has accentuated the relief and the scarp appears in the form of a steeply cut wall facing the Chambal river. The Sirbu shales are characteristically dark red to alive in colour, and easily erodable. The lowland is formed of Recent to Sub-recent deposits with small outcrops of Upper Bhander limestone in the bed of the Chambal.

Chatterjee and Bagchi (1957) are tempted to say that the Chambal scarp is a fault scarp and it defy any explanation provided by fluvival morphology. But the present author has investigated the fact in the light of present day knowledge about erosion cycle, scarp formation and retreat. These facts reveal that any explanation that the Chambal scarp is the result of faulting is not adequate. The reason is that the Great Boundary Fault runs about 52 kilometres northward and along the base of the scrap there are no evidences of faulting. Thus the scarp has nothing to do with faulting.

The genesis of the Chambal scarp can only be explained satisfactorily by the action of fluvial processes. The Chambal flows at the base of the scarp paralleling the strike of the northward dipping Upper Bhander sandstones and Sirbu shales. Due to friable nature of the sandstone and shales the scarp, however, has been dissected by an innumerable number of ravines which cut across the bank testify to the vast amount of ravine erosion. The shalving bank on the opposite side has also been a victim of ravine erosion, a character which manifest right up to the confluence with the Yamuna. Further more, it seems that the Chambal in this zone has presumably been forced northward into the Upper Bhander sandstone and Sirbu shales by low dipping Bhander limestone, which has been exposed in the bed of the river. Thus the river is a clear cut example of a *strike velley* and a scarp of a *erosional scarp*. Besides, the region experienced upheaval during the Tertiary period due to which the Chambal got extra power for erosion and it seems that the scarp has been produced by increasing under-cutting of the river. On these assumptions the

The geomorphic and structural evidences prove that the Ramgarh Dome has been formed by the deep seated igneous activity. The upheaval of the domal structure most probably begun sometimes during the early-Tertiary pe.iod and continued down to the mid-Tertiary (Sharma, H.S, 1970).

(viii) The Ravine Belt

The degree of dissection down stream from the confluence of the Parbati river increases and on this basis the Ravine Belt has been demarcated. The boundary of the Ravine Belt upto Dholpur is marked by the Chambal scarp and thence the watershed of the Chambal itself forms the ravine boundary.

The main topographic feature is the ravine. From the Banas water-gap to the Yamuna the noticeable features in this zone are flood plain bluffs and alluvial-knolls. The intensity of ravine erosion seems increasing as we proceed down-stream along the Chambal.

The field study in this zone reveals that there are four stages of ravine evolution, viz. swallow-hole stage, tunnelling stage, collapsing stage and recession stage. At most of the places headward erosion is also responsible for the evolution of many of the deepest and widest ravines particularly where the sub-surface soil is soft and easily worn away, This phenomenon is also responsible for the branching of many ravines-the cutting out of tributaries, which have their beginning at vulnerable points along the side scarps.

The mudflow also gives a helping hand to lateral encroachment of ravines in the agricultural land in a way that it supplies loose and unconsolidated materiel down slope, to be eroded-off by the subsequent floods. This process is common in the lower reaches of the Chambal around Dholpur, Barhi and Ater during the rainy season.

In pointing out the peculiar favourable conditions for ravine formation in this region, it should be remembered that ravines are a type of mature dissection with a drainage pattern of fine texture. The studies reveal that fine texture of drainage occures only where the deepening process of the river is greater than deposition. The alluvial knolls in the midst of the ravines and other geomorphic features like, pot-holes, rapids, gorges and water-fall in the middle Valley are a clear evidence of the slow lowering of the local base level of erosion of the Chambal. This seems the major cause of ravine genesis (Sharma, H.S., 1969).

CONCLUSION

The study of landforms must aim at recognising the various landform types and this exercise must endeavour to make comprehensive studies of the origins of the diverse forms of the entire terrain. Such an approach must emphasize more study of the forces that mold the landscape. In the present paper, an attempt has been made to give a geographical meaning of a large and diversified topography. The author hopes that this account will give more substance to our knowledge of the geomorphology of the Valley.

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TABLE II

Major Characteristics of Mirco-Geomorphic Regions of the Lower Chambal Valley

Geomorphic Sections	Micro-Geomorphic regions	Major structures	Age of rocks and lithology	Drainage pattern	Age of erosion surfaces	Character of topography and elevations	Major Geomorphic features
1	2	3	4	5	6	7	8
The Hilly Section	Bundi Hills	Steeply dipping rocks towards north west and folded Great Boundary Fault and other faults.	The Gwaliors and Upper Vindhyans Intrusives sandstone, quartizites shales, and limestone	Trellis pattern generally streams follow strike direction.	Pre-Cretacious to middle Teritary	Highly rugged and undulating 300 to 540 metres above sea level.	Strike ridges, longitudinal valleys, eroded anticlines, and synclines. Fault line scarps and composite scarps
	Rantham-bhor Hills	Low to steeply dipping rocks synclines. Boundary Faults and other minor faults	Mainly the Gwalior Quartzite and shales, intrusive dolerites, The Vindhyans and Upper and Lower	Irregular drainage pattern	Pre-Cretacious to middle-	Highly rugged and undulating 300-480 metres	Fault scarps, composite scarps. rounded table lands and doleritic topography
	Mukrndwara Hill	Highly to low dipping rocks	Upper Vindhyans Kaimur, Rewa and Bhander sandstones and shales	Trellis pattern	Tertiary Middle-Tertiary	Rugged 300-450 metres	Strike ridges, and valleys - Kali - Sindh transverse gorge
Plateau Section	The Dangland	Low to gently dipping towards north west and north east	Upper Bhander sandstone and shales	Sub-parallel pattern and linear pattern	Middle Tertiary	Dissected 300-450 metres	Rounded mesas. The Chambal scarp, and 5 terraces along the the base of the Chambal scarp.
	Kota Plateau	Gently tilted beds and horizontal	Upper Bhander sandstones and shales	Sub-parallel pattern	Pre-Cretacious to middle-Tertiary	Dissected and rugged	Rounded mesas with steep cliffs, gorges, rapids and waterfalls along the Chambla.
The Low Land Section	Harawati Plain	-	Unconsolidated alluvial deposits clays to clay loams	Dendritic pattern	Pleistocene	Level but intensive dissections along the Chambal	Ravines and gullies, 20 to 30 metres depth generally V-shaped ravines
	Ramgarh Dome	Domal structure with quaquaversal dip	The Upper Vindhyans Ganurgarh shales, limestones, and lower Bhander sandstones	Radial centripetal and annular	-	Topographic depression	Circular basin
	Ravine Belt	-	Unconsolidated alluvial deposits, clays and sandy loams	Rectangular pattern	Pleistocene and Recent surface is developing	Dissected by ravines	Ravines, flood plain-buffs and alluvial knolls, swallow-alluvial tunnels etc. Depth of ravines upto 50 metres.

Contd.....

MOMENT ANALYSIS AND CENTROGRAPHIC STUDY OF AREA, URBAN SETTLEMENTS AND POPULATION OF THE KRISHNA AND GODAVARI DELTAS

By

N. B. K. REDDY

By means of moment analysis, a Centrographic study of the spatial distribution of the Urban Settlements and their Population with reference to the geographical centre of the area of the Krishna and Godavari Deltas is here contemplated. The distributional changes of the urban settlements and their population is reflected by their locational changes through the previous ten decennial census years beginning from 1871 to 1961 too are explicated.

Evolution, scope and status and methodology of centrographic studies:

Prior to the actual study of the problem, a brief discussion on the evolution, scope and status and methodology of the centrographic analysis is but appropriate to provide a sound theoretical background to the study. The seed of the centrographic method was perhaps sown by Johnson* (1892) in his study of the deviation of bullet marks from a target. However, centrography as a "science" was primarily developed by an active and energetic group of Russian geographers lead by E. E. Sviatlovsky. It was extant as a mere trend of thought just before the Russian Revolution. But, with meteoric speed, it developed into an independent, applied field of science in a short span. Its activities spread very widely into many fields including regional and national planning. Despite its promising postures, soon it suffered a severe set-back, never to recoup again. A revival of centrographic studies involves the risk of recrudescence. The tragedy is evidently due to political reasons as well as the preposterou over-enthusiasm displayed by the protogonists of centrography. They erred in advocating that it was a panacea for all the problems of regional analysis. The long and short story of centrography in Russia was that the centrographic laboratory named after the famous Russian Scientist, D. J. Mendelev, which was founded by the Russian Geographical Society in 1925 and established in Leningrad, was wound up in December 1394. Notwithstanding this tragedy, the reflorescence of the centrographic studies elsewhere is indeed heartening. Recently, keen interest has been evinced in centrographic analysis in the United States. Israel is another country in which extensive application of this "science" is being tried in economic plans.

What is centrographic method?

Sviatlovsky (1934) stated, "centrographic method is an ensemble of graphic procedures, a

* Haggett (1965), p. 230

statistical calculus", and it discerns "in a convenient way the geographic and historic character of human activity" (Porter, 1960, p. 225). The study purports to describe centrality and dispersion of areal distributions by means of statistical theory and the three cardinal statistical parameters* of central tendency, namely, the mean (α), median (β) and mode (γ). For this purpose, the statistical measures of central tendency are transformed into spatial or locational vectors. Centrographic study aims to discover the laws of distribution of geographical phenomena through an analysis of the spatial and historical changes of the "centres of gravity" of the distributions. Thus it is nomothetic in approach. Centrographic study is a study in "social physics". Analogous to the principle of mechanics in physics, the 'moments', that is, the quantities of the product of mass and distance are calculated, and from them the "centres" are computed. Here, the mass is substituted by the magnitude or quantity of the distributed element at each point or area. The method is useful in investigating the spatial distributions, pertaining to the entire field or economic geography, e.g., distribution of populations, settlements, mining, manufacturing and agriculture.

A review of literature has revealed that considerable theoritical work related to centrographic analysis has been accomplished by various scholars. Warntz and Neft (1960) explained how the statistical mean, median and mode could be transformed into spatial mean, median and mode. Spatial mean is the "centre of gravity, a single point at which objects on a weightless surface will balance". They defined the spatial mean, that is the mean centre of a distribution as the point where, $\int R^2.G.\ (dA)$ is at its minimum. The median centre of a distribution was defined as the point where $\int R.G.(dA)$ is minimized. The centre of a distribution too may be defined in terms of the position of the high point on the density surface. In the above formulae, G is the density of population over a very small part of area dA, or the Quantity of a distribution at each point, and R is the distance from each part or point to the mean or median centre.

Hart (1954) suggested a procedure for computing another important centre, similar to the spatial mean, median and mode, termed the point of minimum aggregate distance or centre of convergence. He followed a heuristic method in that, its location involved a series of trial and error approximations in which a transparent annuler mesh was used to count the population at specified distances from the centre of the graph.

Porter (1963) provided a speedy procedure called "least square" analysis earlier discussed by Johnson (1892), to compute the point of minimum aggregate access. But it is prone to considerable errors in locating the point. The centre may be used advantage with time-series maps to explain the extent and nature of locational changes or persistence.

Besides the statistical measures of central tendency, are the measures of deviation. Stewart and Warntz (1958) introduced

*Aparameter is a decisive number distinguishing that particular population.

the "dynamical radius" of population to measure dispersions. They defined this by the expression $\sqrt{\{\sum(p.d^2)\}/P}$, where p is the population of a small area, d is the distance from the mean centre, and P is the total population. The formula is simply another form of the Standard Deviation formula.

The mean centres of area, urban settlements and urban population of the Krishna and Godavari Deltas

An analysis of the locational characteristis of the "mean centres" of the urban settlements and their population of the Krishna and Godavari Deltas and their changing pattern during the period beginning from 1871 to 1961 is here attempted. The study is intended to base heavily on the locational changes of the spatial mean, although a brief account of the location of the medium and mode centres too is included in the discussion at a later stage.

Explication of Certain Implications of the Mean Centres:

Before accomplishing the centrographic analysis, it is necessary to understand fully the implications of (i) the geographical centre of the area or the mean centre of the area (C_a) (ii) the mean centre of the urban population (C_p) (iii) the mean centre of the urban settlements (C_s), with which we are primarily concerned in the present study. The problem of spatial distribution of any element exists by virtue of the distributional departure of that element from the theoretically expected distribution (uniform distribution). If the distribution is uniform, the problem of spatial distribution vanishes. It implies that the problem exists because in reality, distributions are seldom uniform. It is explicit that the present problem is one concerning with the distribution of area, urban settlements and urban population. To elaborate, a uniform distribution, temporary or perpetual, is hypothetical, and such a uniform distribution is supposed to be extant in an "isotropic plain" True isotropic plains do not exist ; so too perfect uniform distributions. A uniform is a concept, a theoretical proposition or a desirable situation. Such a distribution absolves all the geographical problems of distribution. Hence, it is useful as a standard of reference to study the real distributions which frequently show up spatial and temporal diversities. To explain the variations of distributions, it is necessary to measure the departures from a standard reference, and uniform distribution is eminently suitable for this purpose.

Coming to the problem proper, if all the urban settlements are of the same size, and their distribution is uniform, then the mean centre of the area (C_a), the mean centre of the urban settlements (C_s), and the mean centre of the urban population (C_p) must coincide. So, it is logical to conclude, that the variation in size and variation in distribution effect the latter two centres to move away from the mean centre of the area which is relatively stable for long periods.

* Hagerstrand described "isotropic plain" as "an elementry, abstract, geographical space that has no difference from place to place or in one direction to another" (Nystuen, 1968, p. 37)

The Unique Trio :

The three spatial mean centres, C_a, C_p and C_s, form a unique trio, which by their characteristic relative location express the kind of distribution of the area, urban population and urban settlements of any region. Their relationship in terms of distance and direction from each other or in relation to the mean centre of area is of paramount importance in the study of the respective distributions. These three centres may together form into (i) a single point, when the distribution of urban settlements and their population is uniform, (ii) a straight line, when the distributions vary in the same direction or opposite direction and (iii) a triangle, when the distributions vary in different directions. However, the relative positions are liable to changes through time because both C_p and C_s are sensitive to the variations of the number of settlements and their population size. As area is normally a stable factor while C_p and C_s are variabes, C_a remains stationary and C_p and C_s change their positions in proportion to the changes of the number of urban centres and their size. in a developing economy, frequent fluctuation of the positions of C_p and C_s is very likely.

The Vectors $\overline{C_a-C_s}$, $\overline{C_a-C_p}$ and $\overline{C_s-C_p}$ ihdicate varience in the distribution of area, settlements and population, and it is measured away from C_a for the Vectors $\overline{C_a-C_s}$ and $\overline{C_a-C_p}$, and from C_s for the Vector $\overline{C_s-C_p}$.

How to locate the centres C_a, C_p C_s?

C_a :— The geographical centre of gravity of area or the spatial mean centre of area (C_a) is considered to be a static centre in that it remains constant for a given area and configuration, because change of areal extent either due to political or administrative exigencies is normally not frequent. In fact, the position of the mean centre of area is determined by configuration of the area than the extent of the area itself. For instance, if the area of a region is increased equally in all directions, the position of C_a remains unaffected. Instead, keeping the area constant, if the shape of the area is changed, then the position of C_a changes. A line passing through C_a divides the whole region into two equal portions.

To obtain the spatial mean of the area, an outline map of the area is drawn on a fairly thick card-board paper, and it is cut along the outline. The map is now placed on a table which has a plane surface and sharp edges, and it is partially moved out on the table until it is exactly balanced at the edge of the table. At this position, a line is drawn on the map along the edge of the table. Similar lines are drawn changing the positions of the map and repeating the same procedure. The intersecting point of these lines gives the geographical centre of the area.

C_p :— The mean centre of the urban population is the most important point of the trio. It is a "dynamic" centre and an important region-forming factor. A line passing through C_p divides the entire distribution of urban population into two portions so that the sum of the "moments" on either side will be equal. C_p is more important than C_s because the former gives an idea of the population-size of

the settlements as well as the spacing of the settlements. It provides a contemporaneous and comprehensive view of both the settlements, and population distribution. Besides this it gives a historical view of the changing pattern, that is, it demonstrates how the influence of differential growth is contingent upon constant boundaries. C_p coincides with C_a and C_s, if all the urban settlements are of the same size and distributed equally in all directions. The C_p is conditioned by the spacing of the urban settlements, their number and size, and hence sensitive to the changes of these factors. The locational change of C_p is egected both by the variation in number of the urban settlements and the variation in the size of urban settlements arising due to the differential growth. Further, it is susceptible to greater changes than C_s because the former is sensitive to the population growth and evolution of new settlements. Vector $\overline{C_a - C_p}$ indicates how the population distribution varies from the territorial distribution, while the Vector $C_s - C_p$ indicates the variation of the settlement size for the same settlement spacing.

For locating the mean centre of urban population (C_p), the X-axis just below the area and the Y-axis just to the left of the area, are drawn. Each urban centre is then listed by name or by number in a table, together with its population P. For each, the distance 'd' from the urban centre to the Y-axis is measured and recorded. Urban population times distance (P.d) which is called "moment" is calculated for each of the urban centre, and the product is recorded. The products are then added up and the sum total ($\sum$P.d) is divided by the sum total of urban population ($\sum$P) of the urban settlements. The resultant quotient is the distance the Y-axis must be to the right. Following similar procedure, the distance measurements are taken from each individual urban centre to the X-axis, and calculations are made as before. The obtained quotient is the distance that the X-axis to be moved up. The intersecting point of the two new axes is the mean centre of the urban population.

C_s :— The mean centre of the urban settlements is a variable. In computing C_s, the spacing of the urban settlements alone is considered and their size is ignored. Hence the position of C_s remains constant when the already existing urban settlements grow in size, rather than evolution of new settlements. In a developing economy, the possibility of springing up of new settlents will be considerable and hence C_s tends to shift its position in the direction of the newly evolved concentrations of settlements. That is, its shift is effected when new urban settle ments spring up more in one direction. C_s coincides with C_a if the urban settlements are distributed uniformly throughout the region or if their pull is equal in all directions. Locational variance between C_a and C_s points out that there is more concentration of urban settlements in one direction. The magnitude and direction of its variance is indicated by the vector $\overline{C_a - C_s}$ measured from C_a to C_s. An analpsis of the locational changes of C_s for various years reveals the general direction, extent and nature of the distribution of new settlements. The line passing throngh C_s bifurcates the distribution of urban settlements in such a way that on either side the average spacing of the settlements will be equal, The measurement of the variations of C_s and C_p indicates the impact of urbanism

with reference to the variations in spacing, and differential growth of urban settlements.

Location of the mean centre of the urban settlements is simple. Here, the size of the urban settlements is not taken into consideration. Hence, a value of '1' to each settlement is assigned so that the moment of each settlement is equal to the distance from its respective axis. Consequently, the mean distances of the settlements from the X-axis and the Y-axis, indicate the position of the new axes. The intersecting point of these new axes, provides the mean centre of the urban settlements.

Area, Urban Settlements and Urban Population of Krishna and Godavari Deltas

Location Aspects of C_a :

The spatial mean centres or the geographical centres of the regions of the Krishna and Godavari Deltas as a whole, as well as Krishna Delta, and Godavari Delta as individual regions, have collinear situations. The C_a of the Krishna and Godavari Deltas lies almost midway on the line, connecting the C_a of the Krishna Delta and the C_a of the Godavari Delta. It shows that the Krishna Delta, and the Godavari Delta are almost territorially equidimensional. The C_a of the Krishna Delta, lies near the right bank of the Krishna River; similarly the C_a of the Godavari Delta too lies to the right of the Godavari River revealing that there is more areal concentration towards the right side. However, the C_a of the Krishna and Godavari Deltas as a whole is situated in the area of the confluence of the two Deltas.

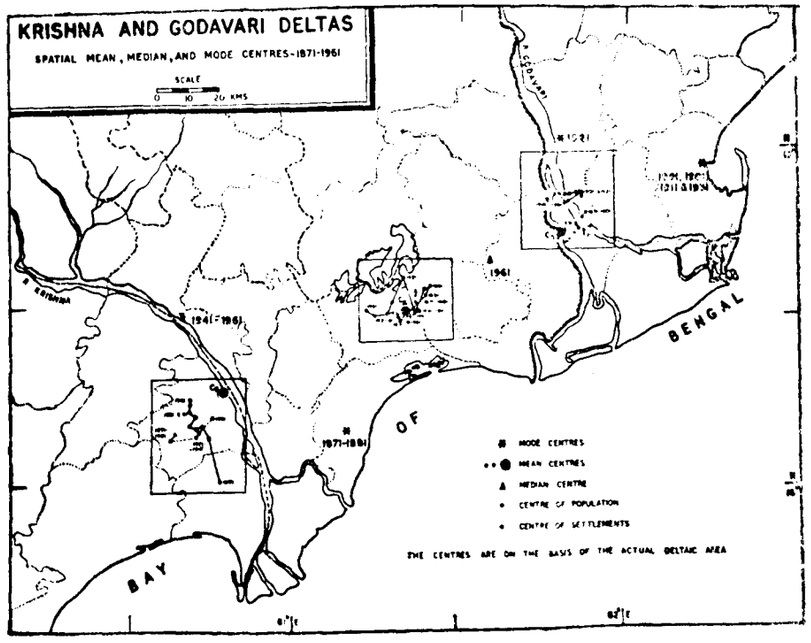
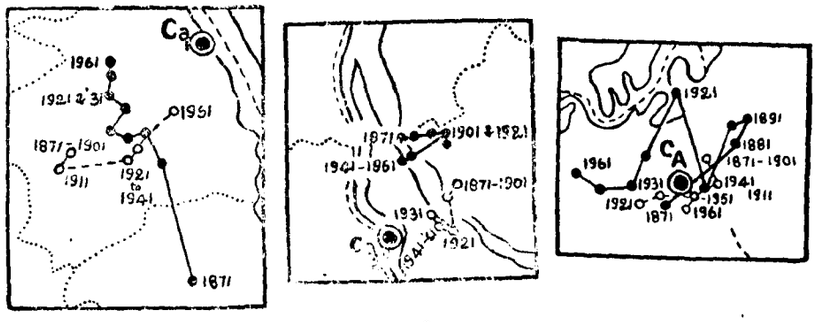


Fig. 1.



Flg. 2.

Locational Aspects of C_s.

The three spatial centres of distribution C_a, C_s and C_p with which we are exclusively concerned here are located to the south of the Kolleru lake, throughout the period from 1871 to 1961. In fact, the area of their location coincides with the area of the confluence of the two Deltas. The over-all distributional effect of Urbanism as represented by C_s and C_p is not very much divergent from the geographical centre of the area of the region at any time during the entire period of study. The region is an almost homogeneous, deltaic plain; and an approximately uniform distribution of urban settlements and population is expected to be prevalent in the regions of this type. The study has revealed that this conjecture has some substance. In spite of this broad, visible trend, certain vicissitudes in the relative distribution ot the three spatial mean centres are discerniable under close examination.

The over-all pull of the urban settlements of the Krishna and Godavari Deltas was to the north-east of C_a in the decennial census years of 1871, 1881, 1891 and 1901. Later, the centre moved about C_a in diverse directions and varying magnitude, so that, eventually the pull was slightly to the south of C_a in 1961. However, it was never very much pronounced during the period for which the study was made. The centre of gravity of the urban settlements in 1911 had practically identical location with C_a, indicating a balanced distribution of the urban settlements in all directions, The location of C_s during 1871 - 1931 was about 6 Kms. to the north-east from the geographical centre of the area. It was due to the relatively more concentration of the urban settlements in the upper position of the deltas. The persistence of C_s in the same position for four decennial census periods was obviously due to the fact that the number of original 20 urban settlements remained constant during this period. That is, urbanism in terms of number of settlements remained constant throughout this period, With the addition of 3 more urban centres (Nidadavole in Krishna Delta, Tanuku and Penugonda in Godavari Delta), the centre of the urban settlements moved to the southwest so that it was at a vicinable distance from C_a. In 1921, with the evolution of as many as 7 new urban centres (Repalle, Chebrolu, Pedana, Bhattiprolu and Vuyyur in the Krishna Delta, and Nidadavole and R.C. Puram in the Godavari

Delta), the centre of the urban settlements of the region drastically moved further to the south-east getting a location at about 100 Kms. from C_a. In 2931, two more urban settlements (Bhimavaram and Kovvur, both in the Godavari Delta) sprang up, and as a result, the centre of the settlements retreated and brought C_s again closer to C_a. With the addition of another four urban settlements (T.P.Gudem, Machavaram, Maruter and Razole, all in the Godavari Delta) in 1961, the mean centre of the urban settlements moved to the north-northeast securing a location at about 5 Kms. distance to the east of C_a. In 1951, four more urban settlements (Tadepalle and Avanigadpa in Krishna Delta, and Anaparti and Draksharam in the Godavari Delta) emerged in the region, shifting C_s to the southwest. Finally in 1961, the urban settlements increased by another two in number (Gannavaram and Kaikalur in the Krishna Delta) swelling the total to 42, and effecting the centre of gravity of the urban settlements of the region to move slightly to the west-southwest, with its location at about 4 Kms. to the south ot the geographical centre of the area. Thus, the net result during the entire period from 1871-1961 in consequence of the addition of 22 urban centres (10 urban settlements in Krishna Delta and 12 urban settlements in Godavari Deltas) to the original 20 urban centres, was that the centre of the urban settlements which was initially located at about 6 Kms. to the northeast of C_a was shifted to the south-southwest for about 10 Kms. As a result, C_s got a location at about 4 Kms. distance to the south of C_a in 1961.

In the Krishna Delta, the deviation of C_s from C_a as well as the locational shifts of C_s from 1871-1961, are relatively more ostentible. In 1871, 1881, 1890 and 1901, the centre of the urban settlements was persistent in location, and it was at about 20 Kms. distance to the south from the geographical centre of area of the Krishna Delta. This is obviously due to the fact that there was no increase in the number of urban centres of the area during the period. However, in 1911, the centre was shifted to the southwest maximizing its distance from C_a. In 1921, the centre of urban settlements registered a large shift to the east for a distance of about 8 kms. Consequence of the

TABLE—1

Census year	Krishna Godavari and Deltas		Krishna Delta		Godavari Delta	
	No. of urban centres	Addition per Decade	No. of urban centres	Growth per Decade	No. of urban centres	Addition per Decade
1871	20	—	9	—	11	—
1881	20	Nil	9	Nil	11	Nil
1891	20	Nil	9	Nil	11	Nil
1901	20	Nil	9	Nil	11	Nil
1911	23	3	10	1	13	2
1921	30	7	15	5	15	2
1931	32	2	15	Nil	17	2
1941	36	4	15	Nil	21	4
1951	40	4	17	2	23	2
1961	42	2	19	2	23	Nil
1871 to 1961	Total =		—	10	—	

TABLE—2

Census year	Krishna and Godavari Deltas		Krishna Delta		Godavari Detla	
	Urban popul-ation	Growth	Urban popul-ation	Growth	Urban popul-ation	Growth
1871	218,977	—	99,405	—	119;572	—
1881	244,483	25,506	100,914	1,509	143,562	23,997
1891	308,869	64,386	126,242	25,328	182,627	39,058
1901	362,785	53,916	153,595	27,353	208,190	25,563
1911	464,120	101,335	200,254	46,659	263,866	55,676
1921	558,399	94,279	262,749	62,495	295,650	31,784
1931	697,623	139,224	333,469	70,720	364,154	68,504
1941	881,967	184,344	429,087	95,618	452,880	88,726
1951	1,261,341	379,374	651,488	242,401	609,853	156,973
1961	1,678,262	416,921	903,264	251,776	774,990	165,137

evolution of five new urban settlements; and in its new location, it remained stationary upto 1941. In 1951, it moved to the northeast for about 2 Kms., and in 1961 by another 8 Kms. in the same direction. As a result, the C moved nearer and nearer to the entre of the area. To sum up, the centre of the urban settlements of the area had a persistent location considerably of the region upto 1911; but later, away from the geographical centre the centre gradually moved towards C_a. In the process, there were intermittent changes in direction and magnitude of deviaton with reference to C_a e.g. the centre of the settlements which was situated to the southwest of C_a at about a distance of more than 20 Kms. in 1911, moved close to C_a; and in 1961, it was situated at about 8 Kms. to the south-southeast of C_a. A striking feature of the location of C_a, C_s and C_p, was that they remained in the western portion of the delta throughout the period (1871—1961), revealing that the deltaic portion of Guntur District exerted more urban pull than the deltic portion of the Krishna District. Further, the three centres C_a, C_s and C_p are tending to move nearer to each other, minimizing distributional divergences of urban settlements and urban population. It is quite possible that they are likely to attain uniformity in all directions.

In the Godavari Delta, the three spatial centres, C_a, C_s and C_p show relatively much less locational variance indicating that the over-all effect of the concerned distributions is approximately equable in all directions. The maximum recorded deviation of C_s from C_a was about 10 Kms. during 1871 — 1901, and the minimum deviation of 5 Kms. during 1931 — 1961. Initially, the centre of gravity of the settlements was to the northest of C_a. Since 1921, however, it was to the east, and later to the north-northeast of C_a. The centre of the urban settlements has shown the tendency to move closer to C_a. indicating that the distribution was attaining equibalance in all directions. The salient feature is that

C_a remained stationary during the periods 1871 — 1901, and 1941 — 1961. In general, the magnitude of deviation as well as the locational fluctuation of C_s were insignificant in the Godavari Delta, while they were slightly more in the Krishna and Godavari Deltas, and most pronounced in the Krishna Delta. Another interesting feature to be noted is, that the C_s and C_p of the Krishna and Godavari Deltas, moved about C_a in different directions; the C_s and C_p of the Krishna Delta, together with C_a remained on the right-side of the river throughout, in spite of considerable shift: the C_s and C_p of the Godavari Delta had persistent location on the left side of the river while the C_a remained on the right side. Further, the pattern of the shifts in the Krishna and Godavari Deltas as a whole, or in the Krishna Delta and the Godavari Delta separately, has certain differences. In general, the over-all tendency shown progressive attainment of commensuration.

Locational Aspects of C_p :

A study of the magnitude and direction of the variance of the spatial mean centre of urban population of the region from C_a and C_s, as demonstrated by the vectors $\overline{C_a - C_p}$ and $\overline{C_p - C_s}$ is of crucial importance. — The mean centre of the urban population of the region presents a contemporaneous spectacle of the spatial distribution of the urban settlements as well as the population-size of the settlements, and thus of their territorial distributional divergence.

Even a casual glance at the map clearly points out that the variation in the locational divergence of C_p from both C_a and C_s has been more spectacular and frequent than that of the locational divergence of C_s. The reasons are not far to seek. First, the population is more variable than the number of settlements. Secondly, even the variation of the number of settlements which introduces changes in the spacing of settlement distribution has its reflection in the location of C_p. Thus, the locational variance of C_p is effected by both the factors of urbanism i.e. variation of urban population as well as the variation of the number of urban settlements. The C_p of the Krishna and Godavari Deltas, in 1871, was situated at about 4 Kms. southwest of C_a. In 1881, the extent of the shift to the north-east was indeed considerable (as much as 15 Kms.). In 1891, there was further shift of C_p to the north-northeast. In the next decade, it moved slightly to the southeast. In 1911, it again registered a pronounced shift (about 10 Kms.) to the south-southeast, moving closer to C_a. In 1921, the centre recorded, perhaps the maximum shift, and it was to the northwest quite away from C_a. In 1931 and 1941, the centre moved to the southeast moving again closer, but to the west of C_a. From this position, it moved further to the west in 1951 and again in 1961, maximizing divergence from C_a. To sum up, the centre of population in 1871 was to the south-southwest of C_a at a distance of about 3 Kms; in 1891, to the northeast of C_a at a distance of about 14 Kms; in 1921 to the north of C_a at about 15 Kms; in 1931, to the west of C_a at about 5 Kms; and in 1961, to the west of C_a at about 16 Kms. Thus, the centre of urban population witnessed dynamic and drastic locational changes both in magnitude and direction. It shows that the variation of the degree of urbanism in the region did not show up any persistent pattern. None-the-less, it is possible to discern certain broad tendency. In 1871 and 1921, the urban population distribution in both deltas

showed up equipollent character. Between 1871 and 1921, there was more concentration of urban population in the Godavari Delta than in the Krishna Delta, and the position was just reversed since 1931, despite the fact that the Godavari Delta still had more urban centres (23) than the Krishna Delta (19). It is quite ostentatious, that the rate of growth of urbanism in the Krishna Delta has been much greater than in the Godavari Delta. From 1881 to 1911, there was considerable concentration of urban population in the Godavari Delta. But the position was completely reversed since 1931.

In the Krishna Delta, the centre of the urban population, throughout the period between 1871 — 1961, remained to the right side of the C_a as well as to the right side of the River Krishna. It unequivocally expresses that the distribution of the urban population of the region was always overwhelming in the deltaic portion of Guntur District than in the deltaic portion of Krishna District. Without contravening this tendency, the centre of population which was located about 28 Kms. to the south of C_a in 1871, gradually moved up in north-northwestern direction, and thus eventually obtained a location almost to the west of C_a at a distance of about 11 Kms. It is obvious that initially the urban population was heavily concentrated in the lower half of the delta, but gradually the upper half of the delta not only improved its position but also surpassed the lower portion of the delta in urban concentration by registering a faster rate of urban growth. This is the factor that effected a northward shift of the C_p. In 1871, the C_p was to the south of C_a showing up a maximum deviation, and since then it moved closer to C_a. In 1961 it recorded a minimum deviation from C_a. The distributional disparities of the area, urban settlements and population are tending to become less Now, they are very much equiponderate.

In the Goravari Delta, the mean centre of urban population was always situated in the eastern part of the Delta. It amply points out that the deltaic portion of East Goravari District has been more urbanized that its counterpart in West Godavari District throughout the period. Since 1871, the pull exerted by the urban centres of the eastern part the Delta was to some extent accentuated upto 1921, and since then, its effect relatively de celerated Albeit, there were frequent locational fluctuations of C_p and C_s during 1871 — 1961, the magnitude of the variation has never been really very significant. The settlement distribution appears to exert comparatively more pull to the south, while the urban population exerts comparatively more pull to the north. On the whole, both C_p and C_s have been moving closer to C_a demonstrating that the distributional disparities of the territory, urban settlements and urban population are getting eventually reduced.

Spatial Model Centre of the Urban Population:

The spatial mode centre of the urban population is indicated by the urban centre with the largest population From 1871 to 1881 the spatial mode of the urban settlements was situated in Bandar, in 1891 it was shifted to Kakinda and remained there till 1911; in 1921 it moved to Rajahmundry, and in the next census, in 1931, it moved back to Kakinada; and finally it was shifted to Vijayawada in 1941 and since then it remained stationary. No other centre has shown so much

of instability. The variation it exhibited in magnitude and direction was stupendous. It is very likely that the mode centre will remain at Vijayawada for a long time to come.

The Median Centre of the Urban Settlements:

The spatial mean of the urban settlements which had shown the tendency to lie in the Godavari Delta since 1871 started showing gradual shift towards the Krishna Delta. However, still it lies in the Godavari Delta. Throughout the period, the Godavari Delta had an upper hand by containing more urban settlements than the Krishna Delta, except in 1921 when both regions had the same number of urban settlements. On the whole, the movement of the spatial median of the urban settlements had not shown worthwhile changes in its location.

Conclusion

The study has revealed that the locational divergences which reflect the distributional disparities were not serious in the case of urban settlements and urban population of the region. However, in the case of the Krishna Delta, the divergence of both C_s and C_p from the centre of the area was more pronounced. The disparities are getting reduced gradually in the Krishna and Godavari Deltas as a whole, and in the Krishna Delta and the Godavari Delta as individual units. The centre of population has moved away from the Godavari Delta to the Krishna Delta since 1931 pointing out that the Krishna Delta had surpassed the Godavari Delta in urbanism since 1931. The mode centre has shown how it moved from port towns to the deltaic head towns. There were only four places which attracted the mode and they were Bandar, Kakinada, Rajahmundry and Vijayawada of which the first and the fourth are situated in Krishna Delta, and the middle two in the Godavari Delta. There is, practically, no correspondence between the mode and mean centres. These two are widely apart in their location. The mode centre which was shifted to Vijayawada in 1941, has shown a sign of stability and in all probability it will remain as the mode centre in the long foreseeable future. As for the median centre, it never moved out of the Godavari Delta during the period 1871—1961. To sum up, the mean, median and mode centres of the distributions discussed in the study have shown great divergence in their relative location indicating certain unconformities and inconsistencies in the urbanism of this homogeneous region.

An important point to be noted is that the study of the mean centres of distributions, though indicating the over-all effect and the tendency the general pull of the distributions, does not present a complete picture of the distribution. The location of these centres in the map supplements but does not provide a supstitute to the location of the actual distributions. A study of the centres as well as the distribution of the actual settlements is both, that is, the distribution of necessary to gain a real insight into the problem of distributions.

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GROWTH OF POPULATION
IN
THE LOWER GANGA-GHAGHRA DOAB

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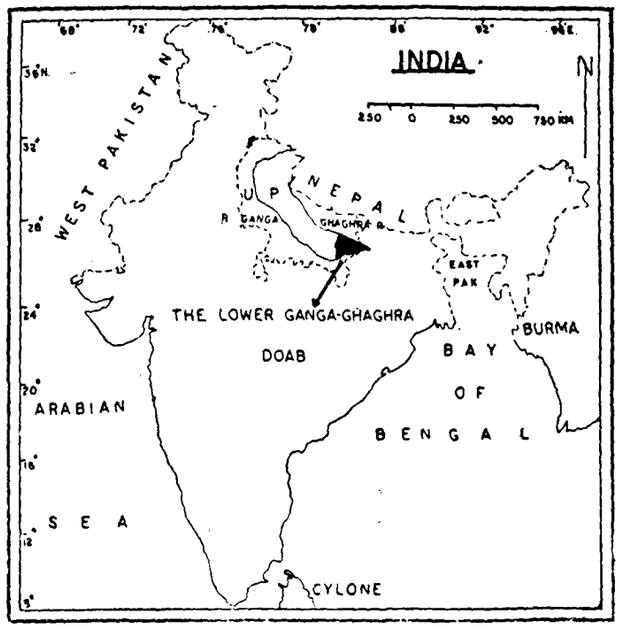
Geographical Background

Location: The word 'Doab' is a Persian word consisting of 'Do' (two) Ab (water) which means the land between two waters. The Lower Ganga-Chaghra Doab is, therefore, the area between two principal rivers namely the Ganga and the Ghaghra. It enjoys a commanding position in the northern India and stretches between 25°6' and 26°28' north latitudes and 82°6' and 84°41' east (vide Figl) latitudes. The



Doab has roughly a traingular shape and continental location and covers an area of 13725.6 Sq. Km. Thus, the Lower Ganga-Ghaghra Doab is bounded by Ganga and Ghaghra rivers in south and north respectively. On the east of the Doab, lies the Bihar State and the

western boudary is demarcated by Faizabad district, Jaunpur and Bhadohi tahsils of Jaunpur district and Varanasi tahsils of Uttarpradesh.

Extent: The Lower Ganga-Ghaghra Doab is a part of the alluvial deposit of the Indo-Gangetic plain. Broadly the whole Doab may be embodied into two main physical divisions on the basis of its origin such as the khadar land or new alluvium and bhangar land or older alluvium. Further, the older alluvium or bhangar land may be divided into two sub-divisions namely (i) Northern bhangar land (ii) southern bhangar land. The Northern bhangar is covered by loamy soil and the southern is characterised by clay-usar soils and ill defined drainage.

Simultaneously the Khadar region also may be divided into three main regions for instance, (i) the Ganga khadar, (ii) the Ghaghra khadar and (iii) the Diara or Doab region. A new layer of fertile alluvium is deposited every year over the entire khadar region whose crop producing capacity is, undoubtedly, higher than that of bhangar soil. Consequently, the pressure of population is high over the khadar land in comparison to central bhangar land due to it's high population carrying capacity. Monsoon type of climate also is responsible for quick growth of man and animal both. In summer season, 'Loo' usually blows and June is the hottest month of the year. August is the rainiest month in the season and the month of December is regarded as coldest month because 'sheet lahari' '(western coldwaves), generally, flows in the entire region. Thus, the physiographic conditions are quite favourable for human multiplication.

Crowth of Population

The Lower Ganga-Ghaghra Doab demographically is a land of unique character. There are a few agricultural districts in the world which can be compared with it in population density. It surpasses the other agricultural tracts of the world except the main land of China and agricultural belt of Japan with an overall density of 725 persons per Sq. Kilometre where agricultural density is 1087 persons per Sq. Kilometre.[1]

The Early Census Records

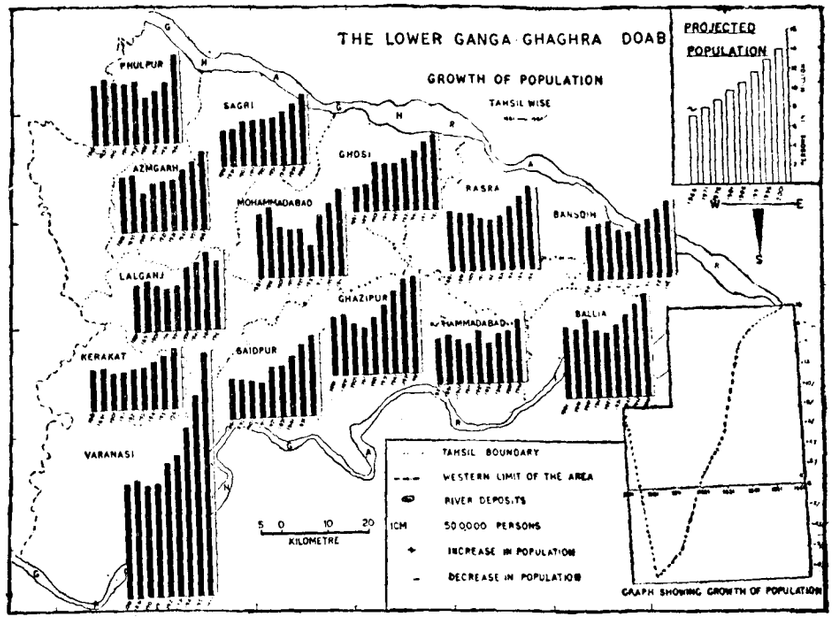
It is very difficult to have a correct understanding of the population growth prior to 1826 because past records were neither properly maintained nor preserved.

The first attempt to ascertain the population growth of the area under study was made in 1826 on the basis of village count. According to previous estimate its total population of the Doad was 3995865 persons. But when next enumeration was taken in 1865 its population was found to be 3048163 Persons. In this census its population showed a decline due to the deaths during freedom movement in 1857 and the shortage of food-grains. But its population again increased to 3177042 persons in census of 1872.

Period from 1871 *to*1891:

At a glance in Fig. 2, it is clear that the Lower Ganga-Ghaghra Doab recorded a tremendous increase in population growth within this period. There were 3899363 persons in the whole of Doab during 1871 enumeration. No doubt, the population of the Doab increased but its exact percentage of increase can not be ascertained

because it was the first regular census. So far as the tahsilwise population distribution in the Doab is concerned it is notable that all the tahsils show four distinctive categories—Varanasi tahsil which recorded maximum (563 thousand persons) growth of population, comes under first category; the tahsils of



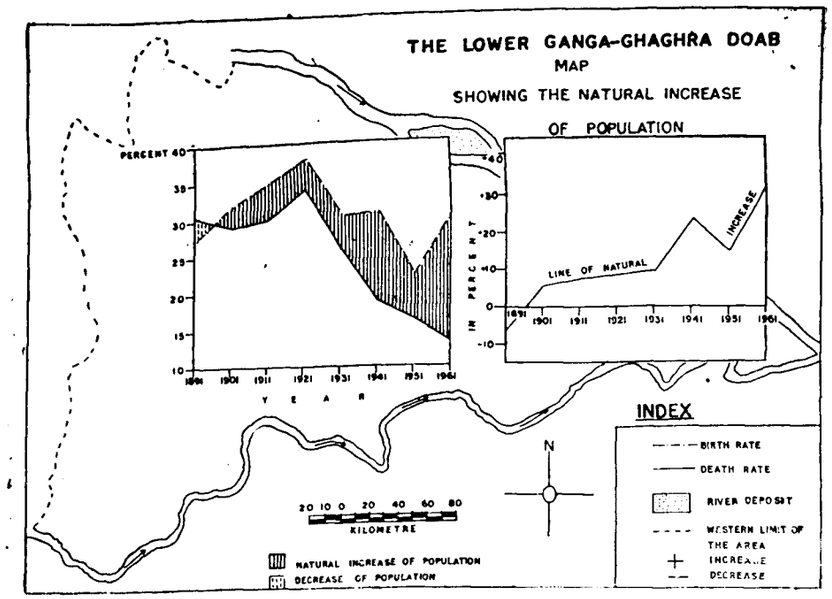
tahsils which had recorded minimum growth of population (below 2 lakhs persons) during 1881 in the whole of Doab form the fourth category such as Saidpur, Ghosi and Sagri tahsils because of notorious nature of Ghaghra river and the absence of communication. From above discussions it has become quite clear that population of the Lower Ganga-Ghaghra Doab remained increasing without any break during succeeding decade. In 1891 enumeration, the population of the Doab overall recorded 8.04% increase, thus it became 4071966 persons with a net addition of 172260 persons. Table shows that in every parts of the Doab, population decreased by 2.30% and 0.5%s. respecively in the whole Doab due to crop failure and food scarcity. In the entire Doab, Ghosi tahsil recorded maximum (11.11%) increase followed by Phulpur (11.09%), Lalganj (10.60%) and Mohammadabad (10.01%) tahsils. Mohammadabad tahsil of Azamgarh District (9.96%), Sagri (6.04%), Azamgarh saelar (3.90%), Saidpur (3.38%) and Varanasi tahsils (3.13%) recorded considerable growth. The tahsils of Bandsih (2.70%) and Ghazipur (1.56%) also showed increase in population. Rasra Mohammadabad, Lalganj, Rasra and Ballia whose populaton is nearabout 300—350 thousand persons are in second category and Kerakat, Bansdih, Ghazipur, Mohammadabad, Azamgarh and Lalganj tahsils are in third category because their population is between two lakhs to 3 lakhs and lastly the

tahsil recorded minimum (8.80%) increase in entire Doab. But as a matter of fact the population of Ballia and Kerakat tahsils declined by 0.10% and 0.50% respectively because of severe famine, heavy flood and isolation of the Doab from other important places of the country due to undeveloped transport system.

Period of Decline : The downward trend of graph line (in vide Fig. 2) exhabits that during the period 1891 to 1921, the population of the Lower Ganga-Ghaghra Doab constantly declined. Table also depicts that the total population of the Doab decreased by 8.55% or 175414 persons whereas the population of U.P. showed an increase of 1.90%. But India, overall recorded a loss of 0.02% during 1891 to 1901. In the whole Doab Ghazipur tahsil, recorded maximum less of 16.40% followed by Lalganj (15.10%) and Mohammadabad tahsil (14.70%) respectively. The tahsils of Saidpur (10.80%), Ghosi (10.80%), Sagri (10.20%) and Mohammadabad (10.0%) of Ghazipur district too showed a loss of about 10-11% respectively. The population of Phulpur (9.40%), Azamgarh (8.80%), Rasra (6.30%) and Kerakat (6.90) tahsils decreased above 5% and below 10%. Ballia tahsil showed lowest (0.10%) decrease in population followed by Varanasi (3.90%) tahsil. There was only Bansdih tahsil in the whole Doab which recorded increase in population of 4.40% because the region was not affected by crop failure. But the principal reasons for the decrease in the population during this decade were famine and natural calamities. There was also scarcity of foodgrains over a considerable area in the eastern U.P. and the neighbouring states. "In 1898 a weak monsoon led to crop failure in eastern districts of the United Provinces, Central Provinces and Bihar". During 1899, the monsoon failed again, and therefore, the results were more disastrous. Although, during 1896-97 population slightly increased yet the rise was negligible. The drought was more severe. People had not yet recovered from the previous attack of droughts and famines. Ghaghra Doab had uneven distribution of rainfall in early years of the decade. "There was a severe outbreak of malarial fever, which in 1894 raised the death rate to an exceptional height and sapped vitality of the people to such an extent that birth rate in 1895 was unusually low."[5] The decline in the population of the Doab was continued upto next succeeding 10 years. Consequently the population of the Doab remained 3716034 persons recording a decrease of 5.93% when U.P. recorded 1.0% decrease only. But India showed the growth of 5.73% in its population during this decade. The highest decrease of 16.2% was recorded by Ballia tahsil followed by Bansdih (13.9), Mohammadabad (12.9%) and Rasra (12.2%) thsils. Ghazipur (7.5%), Phulpur (2.1%) and Saidpur (2.0%) tahsils. But owing to the fact that the less in population during this decade is rather less pronounced than preceeding decade. Lalganj tahsil showed lowest percentage of decrease i.e. 0.5% followed by Sagri (1.6%). In the entire Daob there were only Varanasi and Kerakat tahsils recording increase of 1.2% and 2.6% in their population. The main causes of decline in population were famine, plague, cholera and other calamities which have already been explained previously.

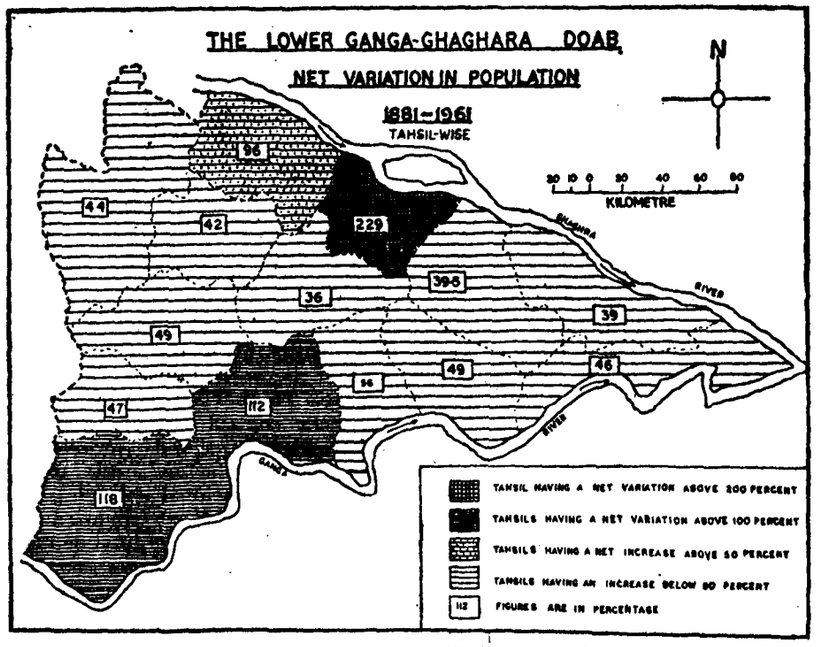
Rapid Growth of Population:

The period from 1921 to 1961 may be considered as the period of rapid growth in the Lower Ganga



Ghaghra Doab. Although during 1921 enumeration the Doab showed least increase (0.97%) yet from 1931 it recorded an amazing increase of population upto 1951. As a matter of fact that during 1911—1921 in the entire Doab only few tahsil recorded increase in population but the less was smaller and the gain was greater. Therefore, the population of the Doab recorded overall increase of 0.97% whereas U.P's and India's population decreased by 3.10% and 5.72% respectively. Fig 2 reveals that more than two-third of the entire area under study regained their loss of population. Among all the tahsils Phulpur recorded maximum (5.1%) increase followed by Lalganj (4.6%), Azamgarh (2.7%) and Kerakat (2.6%) tahsils. Mohammadabad tahsil recorded lowest (0.1%) increase. But in four tahsils namely Ballia (2.4%), Bansdih (2.3%), Rasra (0.2%) and Ghazipur (0.9%) population declined due to drought, famine, diseases and insects etc. The influenza and epidemic were common during this decade. "Monsoon from 1915 to 1918 were weak in the Ganga plain hence the production of chief food crops declined heavily and prices went up. Influenza at the time of crop failure affected the whole of Uttar Pradesh, therefore, its population declined by 1.43 million. But most of the area of the Doab showed an increase in the population due to increase in the population due to the little control over malaria and other diseases. Food production was also satisfactory due to increased irrigational facilities. In 1951 the whole Doab recorded an increase of 5.4%. Its total population became 4118622 persons with a net addition of 122016 persons. The tahsils of Mohammadabad (6.9%), Varanasi (6.1%) and Kerakat (6.0%) also showed similar growth af population with little variation. In Azamgarh (5.5%)

and Mohammadabad (4.5%) tahsils, population increased considerably. Saidpur tahsil showed lowest (0.9%) population growth in the entire Doab. But there were still population declination in Phulpur and Lalganj tahsils by 1.2% and 0.9% respectively due to unhealthy climate and continuous food shortage. Further Fig. 2 shows an upward trend in population growth, this is mainly due to the fact that people enjoyed better life. The wages of the agricultural labourers rose and the prices of the commodities were little controlled during the first seven years. Moreover, epidemics and other calamities were also little controlled which resulted a high decrease in death rate. The mean decennial birth rate was 30.56% whereas death rate was 25% in the Lower Ganga-Ghaghra Doab. According to Sir Turner "The outstanding feature of the decade has been its freedom from epidemics in a serious form and the relatively high general standard of public health. At the opening of the decade the vitality of the population and the proportion of persons, especially females at the reproductive ages had been materially lowered by the epidemics of the previous ten years, especially by influenza. The death rate was lowering for the last three decades, hence there was a large increase in the population." Further at a glance of Fig .2 it is clear that during succeeding decade population growth was more rapid and all the tahsils of the Doab showed the maximum growth. Table



depicts that with a net addition of 817816 person or 16.64%, the total population of the Doab became 4936438 persons upto 1941. This rate of increase was more than three times than that of the last decade. It is also higher than U. P's (13.6%) and India's

(14.2%) population increase. The population of the Lower Ganga-Ghagra Doab has an uniform growth with little variation. Mohammadabad tahsil of Azamgarh district recorded highest (21.3%) increase of population followed by Mohammadabad of Ghazipur district (20.3%) and Varanasi (20.1%). The tahsils of Ghazipur (19.7%), Saidpur (18.5%) and Rasra (18.1%) too showed approximately equal growth Azamgarh, Ghosi (18.8% each) and Ballia tahsil (16.3%) gained similar growth. Sagri and Ghosi tahsils also recorded equal (13.3% each) population growth. Phulpur tahsil (11.2%) showed minimum (11.2%) growth of population followed by Kerakat (11.5%) and Bansdih (11.8%) in the whole Though reaching upto 1941-51 the previous rate of increase in population declined little yet overall, population of the Doab increased and became 5738109 with a net addition of 801671 persons or 14.5% while U.P. (11.80%) and India (13.3%) both showed low rate of population increase. But as a matter of fact that in every part of the Lower Ganga-Ghaghra Doab, population recorded increase. The gain of Saidpur (18.83%) and Mohammadabad (18.57%) of Azamgarh district is roughly equal showing maximum increase followed by Phulpur (16.62%) tahsil in the Doab. The tahsils of Sagri (15.79%), Ghosi (15.32%) gained considerable and roughly and Mohammadabad (15.26%) equal showing maximum increase followed by Phulpur (16.62%) tahsil in the Doab. The tahsils of Sagri (15.79%), Ghosi (15.32%) and Mohammadabad (15.26%) gained considerable and roughly equal growth in the Doab. Bansdih (14.58%), Rasra (14.44%), Ghazipur (14.13%) and Azamgar (13.32%) tahsils also recorded uniform growth. Ballia (11.09%) tahsil had lowest rate of increase in the whole Doab followed by Kerakat (11.40%) and Varanasi (11.32%) tahsils. The main cause of low rate of increase during the decade was agitation against British Government and food scarcity in the area. But in succeeding census, the Lower Ganga-Ghaghra Doab increased her tempo of progress. Its total population became 6315935 persons with an extra burden of 577826 persons or 15.9%. It is 0.50% higher than last census. When we compare its increase with the increase of India and U. P.'s population we find that it is little less than India's (21.5%) and roughly equal to U.P's (16.7%) rate of increase. This rate of increase in population of the Lower Ganga-Ghaghra Doab is absolutely alarming and puts a serious problem before our food resources because our food resources are as the same as they were in past time. Among all the tahsils of the Doab, Phulpur tahsil attained surprising (42.3%) growth in the whole of Doab followed by Mohammadabad (20.4%) tahsil. The gain of Varanasi (18.4%) tahsil is also considerable. Saidpur (15.8%). Ghosi (15.3%) and Kerakat (15.1%) attained uniform population growth with little variation. Mohammadabad tahsil of Ghazipur district shows lowest (7.0%) increase of population in the entire Doab followed by Azamgarh (8.7%). The tahsils of Bansdih, Ballia, Sagri and Lalganj have more or less similar growth in the Doab. The main causes of the rapid increase were the development of trade, improvement in educational and medical facilities and comparatively peaceful atmosphere. In addition to these causes, there were some

other features which accelerated the growth of population. "The rural development scheme was enforced in 1935. Its main activities were economic improvement, rural health and sanitation and cultural improvements. The U. P. Tenancy Act 1939, was brought in force to help the tenants."[5] Improved seeds, impilments, fertilizers and strong bulls were distributed to the cultivators through the Department of Agriculturral Researches in potatoes sugarcane and other crops were also encouraged by Imperial Council of Agricultural Research. Large number of irrigational schemes were introduced for better yield hence population of the Doab increased its tempo. Moreover after the World War II, the fallow land of eastern U.P. and Bihar attracted the attention of the Government as the uprooted landless cultivators from Pakistan, ex-servicemen and political sufferers were to be resettled and hungry becoming millions were to be fed."[6] The Doab was also affected by the British empire. That is why during 1941-51 the rate of increase of population stood relatively low. "In 1947, the Doab enjoyed freedom and her modern social and economic development started. The old feudalism had been slowly disintegrated for some decades."[7] In 1942 when 'Quit India' movement was launched the whole Doab faced serious political alterations." The trouble started on August 9 with dramatic swiftness and the administration was paralysed for weeks. The most effected area was the eastern part of the State particularly the districts of Ballia, Ghazipur, Azamgarh, Banaras, Jaunpur, Allahabad and Gorakhpur.[8] Therefore, the economy of the Doab was disturbed and it showed lower rate of the growth of population. But after 1951 population of the Doab enjoyed social and political liberty. The increase of agricultural production scheme to reduce the percentage of illiteracy and social reformation schemes were enforced consequently. Population of the Doab enjoyed prosperity and goes on increasing without any check. Therefore, at present it has become a serious problem before Government because our food resources are unable to feed the hunger of teeming millions of the Lower Ganga-Ghaghra Doab.

From the study of the trend of death rate in the Lower Ganga-Ghaghra Doab from 1891 to 1961, it is quite clear that death rate has declined.

Causes of Declining Death Rate

Elimination of war and banditory may be taken as the foremost cause of declining death rate. The last days of nineteenth century and the beginning of the 20th century have been a period of rivalry, robbery and crimes due to wicked and autocratic rule. So the life of the people was affected by the prevailing insecurity. The band of robbers made the roads unsafe and harried the villages at their pleasure.[9] Wide-spread robbery made it impossible to secure food-stuffs and to achieve security of life and prosperity.[10] People also became the victim of autocratic attitude of the landlords and the administrators. To possess visible or tangible wealth, they used to invite stronger men to take it by force.[11] Therefore after a month from the harvest of a crop, people started to die of hunger and consequently they adopted robbery for the sake of livelihood. But gradually, as people became wiser, they started to fight against the corruption and slowly such deaths declined.

Control over the famine is also responsible for decline in death rate.

The Lower Ganga-Ghaghra Doab is mainly an agricultural region where about 78% of the total population is directly dependent upon agriculture which is fully governed by monsoon. But our rainfall is absolutely variable, seasonal and scanty over a vast areas. Our monsoon some times starts earlier and sometimes later, hence it causes drought. Sometimes it brings an extra rainfall and causes a serious flood. Thus, the uncertainty of monsoon is characterised as the biggest single factor influencing life in India.[14] That is why the framing of the annual Budget of the Government has been described by several Finance Ministers as a gamble of monsoon.[18] Now our democratic Government is fully interested in the development of irrigational projects. Canals have also been constructed in Azamgarh and Ballia dist icts and financial assistance to purchase pumping sets and to establish electrified tube-wells in private sector is given to the cultivators. Small scale industries, cottage industries and handloom industries of the Doab are also being encouraged. During drought years, Government makes all efforts to save the lives of the people. At the times of floods Government distributes ready meal and provides them better facilities of life. On account of all three factors, the death rate is now declining.

Control over epidemics and infant mortality are other causes for the low death rate. In the Lower Ganga-Ghaghra Doab infant mortality and epidemics were common till the end of British rule. Attempts were made to control diseases especially in the beginning of the 20th century. After 1920 plague was controlled by anti rat campaign and anti plague inoculations also reduced the incidence of plague. To check the effect of cholera, inoculation of cholera has been made compulsory to the pilgrims. Small pox was also controlled by vaccination. Malaria played main part in high mortality rate. It not only killed but also saped the vitality of the people. Credit goes to the Government which took anti-malaria step to get victory over it. Intensive use of mepacrine, atabrine, paludrine and quinine resulted low death rate in the Doab. Under the auspices of W.H.O., UNICEF Malaria control demonstration team took strong steps in the State since 1949. High rate of mortality has been controlled by the construction and the extension of new rail-road routes. In fact prior to nineteenth century there were few roads in the whole of the Lower Ganga-Ghaghra Doab. Only rivers were the chief means of communication, hence at the time of monsoon failure, food supply was not possible properly. That is why, the famine commission of 1880 successfully advocated a programme of railway construction as a specific measure against the recurrence of famines.[11] The construction of new metalled roads and railway lines started a new era and have broken the isolation of the region from the other parts of the country. The railway communication did not really become common till the last decade of the nineteenth century. In 1891, there was still only one mile of railway to every 90 sq. miles if area but in 1940 there was one to every 25 sq. miles. Now at the time of severe famine, drought and flood, foodgrains are being supplied easily. From the attack of the diseases and other natural calamities Doab can be saved now. At present almost all the urban and rural centres are well connected with metalled roads, over which Government buses, taxis and even tangas are running in an interval of an hour The author has often observed during the course of his field study that in a small village

which is situated along the roads, taxis and tongas are always found ready for service. Therefore, at the time of emergency, doctors, food supply and other type of assistance are available. In a small hamlet if any one is ill, his family members immediately call the doctor and within a short time he is saved from the mouth of the death. Thus the death rate has declined in this area considerably.

In addition to the above causes, gradual increase in literacy has changed the political and social map of the area. Now per capita income has increased, money circulation has become faster and consequently the mode of life is changing. People are not so passimistic and orthodox as they were before independence. At the time of cholera dysentry, tuberculosis and small-pox, they provide best possible medicines to check their attack. Now every body knows the names of anacin and codopirine tablets and takes all possible measures to decrease death rate.

Natural Increase of Population:

Natural increase of population is the difference between crude birth rate and mean death rate which may be expressed as:

$$Y - X = R^*$$

Fig. 3 depicts that crude birth rate and decennial death rate have been shown by graphic curve line and the difference between both curves is the natural increase in the Lower Ganga-Ghaghra Doab since 1891-1961. Thus, it is also clear that natural increase of population has been continuously increasing.

TABLE SHOWING NATURAL INCREASE OF POPULATION FROM 1891 TO 1961†

Decade	Mean decennial death rate	Mean decennial birth rate	Decennial natural incrase
1891	30.51	27.31	− 3.20
1901	29.12	30.02	+ 2.80
1911	30.21	34.00	+ 3.8
1921	34.23	35.12	+ 4.32
1931	26.00	30.56	+ 4.8
1941	19.06	31.0	+11.9
1951	16.48	22.46	+ 7.5
1961	13.25	30.50	+16.25

Above table reveals that during 1891 crude birth was 27.31% when mean death rate was higher (30.51%).

*Y = Crude birth rate
X = Mean death rate
R = Natural increase of population
\+ mean increase
− mean decrease

†District Gazetteers and District Census Handbooks of the Districts concerned.

Therefore, natural increase showed a loss in population of birth rate quickly recovered its loss and became 32.02%° while mean death rate declined resulting natural increase of population 2.80%° From the inspection of the same table it is quite vivid that from 1911 crude birth rate constantly increased (34.0%°). Although mean death rate also increased (30.0%°) yet natural increase became higher (3.8%°). As a matter of fact that during 1921 natural increase became higher (3.32%°) because death rate was less (30.8%°) than that of crude birth rate (35.12%°). Decade 1921-31 was not favourable from the point of view of the human growth because crude birth rate (30.56%°) and mean death rate (26.0%°) both declined even then natural increase of population became higher (4.8%°) in comparison to the previous decade. During 1941 again crude birth rate regained its loss (31.0%°) whereas mean death rate remained 19.06%°. So natural increase recorded surprising increase of 11.9%°, because there had been no attack of any catastrophy. But the fact is that comparatively in this decade rural urban birth rate became almost parallel while trend of death rate became just reverse due to medicinal facilities and control over infant mortality; attack of cholera, small pox and some other tuberculosis diseases. Thereafter crude birth rate declined sharply during 1951, which also resulted reduction in natural increase (7.6%°) of population in the Lower Ganga-Ghaghra Doab. The main causes were the effect of second world war and heavy food shortage over a vast area. Above all, in decade 1951-61, the population of the Doab attained full economic prosperity and social freedom. Therefore, mean birth rate increased (30.50%°) by leaps and bounds while mean death rate decreased to a great extent and remained 13.25%°. Therefore, natural increase became absolutely higher (16.25%°). It has been a common practice in the whole Doab that girls are married at the age of 12 to 14 years, whereas this age is very much fertile from the view point of child productivity. In fact, it is the general tendency of the people in the villages of the Doab that girls are married below 12 to 15 years and should not be highly educated. That is why birth rate is increasing without any check.

Projected Population:

Population projection is a phenomenon which broadcasts the growth of population in ensuing future. The stupendous growth of population, shown in Fig. 2 manifests that the increase in the population of the Lower Ganga-Chaghra Doab from 1951-61, exceeded to our observation, scrutiny of the actual enumeration and post-enumeration survey of selected localities. However, it convinces us that the increase in population between 1951 and 1961 was significantly larger than the moderate estimates made earlier.[15] Office of

Projected Population 1966-2001*

Year	Total Population (in thousand)
1966	69780
1971	7826
1976	8702
1981	9581
1986	10539
1991	12753
2001	14028

*Directorate of Agriculture and Economics, Government of Uttar Pradesh, Lucknow, 1969.

the Deputy Director of Agriculture and Economics has projected the population of the Doab as it is depicted in Fig 2 that from 1961 to 1966, its total population has become about 7 million with a net addition of 0.8 million person and upto 1971, it will reach 7.8 million persons. After 1971, there will be considerable speculation about the population growth rate, not only in the whole Doab, but in the entire country. Consequently, reaching upto 1976, the total population of the Doab will be 8.7 million, and in 1981 census it will total an alarming figure of 9.6 million. It becomes quite clear that the rate of increase will be more accelerating and will bring a storming situation in the society. Inspite of Government's preventive attempts, the rate of natural increase of population will be faster due to low death rate and the rural population which contributes a larger proportion of the total population of the Doab, where means of recreation is scarce, Therefore, in 1986 the total population of the Doab will be 10.5 million and 11.6 million in 1991 enumeration. From the census, this rapid growth of population will take a serious and, unchallengeable turn which will throw the Doab into deemed future. Everywhere, in the society, there will be crisis and dissatisfaction. Even rich people will not be happy, robbery and dacoity will become an usual phenomenon in the society. For the sake of money and happiness, people will not feel hesitation by committing murder in the society as it even today has become common. But as a matter of fact that upto 1996, its total human strength will be 12.75 million and by the last days of twenties (2001), there will be a load of 14 million persons[16] in the whole Lower Ganga-Ghaghra Doab. This rapid increase in population will create a larger number of economic and social problems. Some people hold the 'opinion that each new mouth has also a pair of hands to produce; they, however, forget that considerable investment is needed to make a pair of hands productive; such as education in schools and colleges, public health services, housing, water supply and transport, etc. Moreover, the hands in order to feed the mouth need work and it has been found that even in rich countries like U. S. A., unemployment is one of the most serious problems.[17] Thus, the overwhelming growth of population will create numerous unsolvable problems in the country.

Variation in Population:

Fig. 4 depicts the net variation in population from 1881 to 1961 in the Lower Ganga-Ghaghra Doab. From the table 1 it is also clear that variation in population has three modes of increase. Firstly, the areas of maximum growth, secondly, the areas of medium (where population became double) growth and thirdly, the areas of minimum or low variation. Moreover, at a glimpse of the same it is fully realised that there are two patterns from the point of view of physical formation. The Ghosi tahsil which has recorded above 200% increase is near the river Ghaghra. Due to the change in the course of Ghaghra it deposits a fertile layer of alluvium every year. The tahsils of Varanasi and Saidpur which are located near the bank of Ganga river which have shown a net variation of 118% and 112% respectively due to high fertility of soil, transport and above stated facilities. Now there is no piece of land without cultivation. The problems like over-population and unemplovment are burning problems in aforesaid tahsils. Means of subsistance is totally unable to feed the extra burden of population. Sagri tahsil too attained an alarming (96%) growth of population within 80 years. It lies on Ghaghra Khadar land.

The tahsils of Kerakat (47%), Bansdih (39%, Rasra (39.5%), Mohammadabad (49%), Azamgarh district, Lalganj (49%), Phulpur (44%), and Mohammadabad (36%) of Ghazipur district showed a net variation below 50 percent during 1880-1961.

Variation in population is closely associated with the carrying capacity of the land, nature of soil, irrigation facilities, nature of crops, means of trade and commerce, low death rate and high birth rate and full control over diseases.

Moreover, the whole Doab is passing through a critical stage. If this rate of increase of population will not be checked, a day is not far when it will create a serious problem.

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"A COMPARATIVE ANALYSIS OF THE GROWTH AND FUNCTIONAL CHARACTERISTICS OF THE TOWNS OF GANGA YAMUNA DOAB"

by

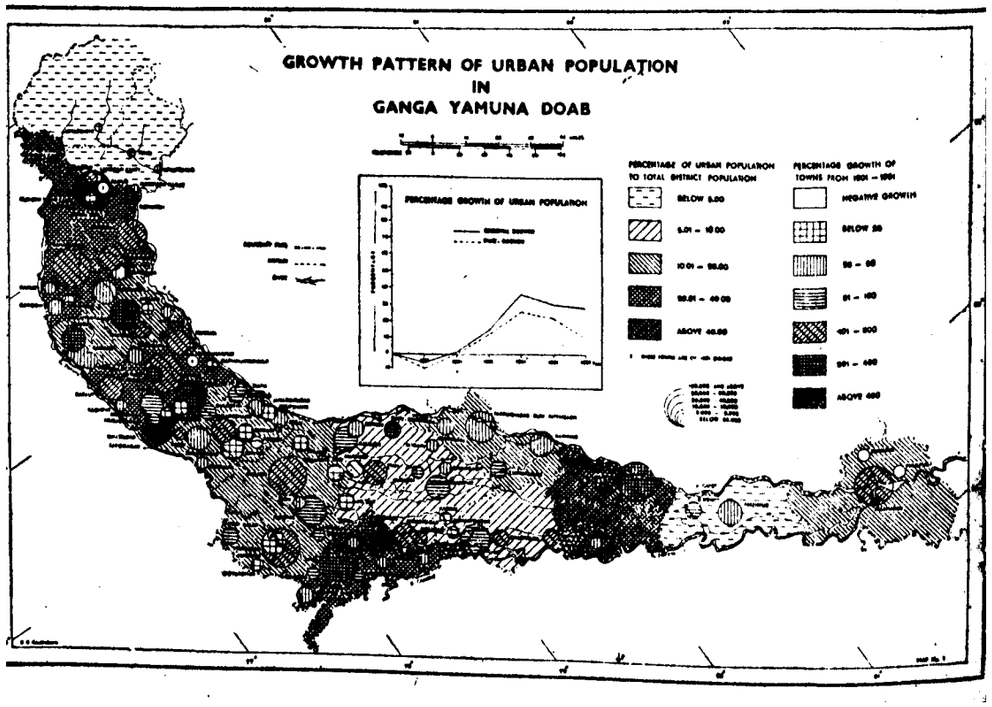
R. P. SINGH & M. P. DABRAL

Object

The paper presents some aspects of the functional characteristics of the towns of Ganga Yamuna *doab*. A further attempt has been made to bring out a comparative analysis of the growth pattern of the urban centres of the region.

Area Studied:

The region under study is located between 25°20′N to 31°20′N latitudes and 77°5′E to 81°55′E longitudes and comprises an area of about 93949 sq. kms. It extends from Uttar Kashi and Chamoli districts in the north to Allahabad district in south-east in a cresent shape. Most of the towns are concentrated in the middle of *doab* in the districts of Saharanpur, Muzaffarnagar, Meerut, Bulandshahr, Aligarh, Mathura, Agra, Etah and Mainpuri. The number of towns in eastern and north-western part of the area are few. The exceptions are the three large urban centres in east, *viz.*, Allahabad, Kanpur, Fatehpur and Dehra Dun in north-west. Total number of towns situated in the area under study are 100.



Classification of Towns

The Map I shows the towns according to their size of population. The definition and concept of the classification of the towns adopted in this study is based on that of Census of India (Mitra, A.—1961). In Census the empirical criteria used to declare an area as urban are (i) density of not less than 1,000 person per square mile; (ii) a population of 5,000 person; (iii) three-fourth of the occupations of the working population should be outside of agriculture. Besides, urban centres are further classified into six below mentioned categories.

Category	Size of Population	No. of Towns
Class I towns	100,000 and above	8
Class II towns	50,000 to 99,999	8
Class III towns	20,000 to 49,999	17
Class IV towns	10,000 to 19,999	28
Class V towns	5,000 to 9,999	33
Class VI towns	Below 5,000	6
	Total	100

All the Class VI towns are located in the north-western part of the *doab*.

Growth Pattern

The total urban population of the region in 1901 was 18·12 lakhs which was nearly one-third of the State's total urban population (53·90 lakhs). Since then population increased more than two folds (46·04 lakhs) upto the 1961 and comprised nearly the half of the total State's urban population (94·79 lakhs).

The concentration of this urban population is highest in the districts of Saharanpur, Muzaffarnagar, Meerut, Bulandshahr, Agra and Mathura (15·0 to 25·0%) while it is only 5·0 to 15.0 per cent of the total population in the districts of Etawah, Manipuri, Farrukhabad, Fatehpur and Dehra Dun. The lowest percentage is in Uttar Kashi and Tehri Garhwal. District Chamoli is entirely rural. Decadewise percentage increase of the population was maximum in the year 1941 (37·07%). This growth of population coincide with the growth of State's urban population (26·00). The lowest growth rate of population of the *doab* was in 1921(+ 1·70%). Urban population of the region show a decrease of 5·23% in the year 1911. Thus the population growth in 1941 was a peak point from where both side show a decreasing trends.

Decadewise growth of towns varies in a large number. A comparison has been made to find out the percentage growth of different towns from 1901 population to 1961. This growth has been calculated on the basis of 1901 population. The highest percentage of growth among all categories of towns can be seen in Ghaziabad (524·72%) followed by Firozabad (485·26%) and Dehra Dun (404·55%). Dehra Dun is a service town while the remaining two towns are industrial centre of the region.

There are only 9 towns which show the percentage growth in sixty years from 200 to 400%. Kanpur, the industrial core of the area, show a very high percentage growth (378·83%) in this category followed by Rishikesh (371·10%) and Kankar Khera (311·05%). The remaining towns are Tundla (287.34%), Muzaffarnagar 272·04 %), Shamli (252.99%) and Bharthana (243.38%) while the lowest growth in this category is marked by Hapur (210.45%), the well known grain *mandi* of Uttar Pradesh.

In the next high category, there are 20 towns having a growth rate of 100.01 to 200.00 percent from 1901 population to 1961 population. The highest growth in these towns are in Baraut (196.22%), Dadri (181.14%), Etah (181.03%), Saharanpur (179.54%) and Agra (170.49 %), while the lowest growth is in Sirsaganj (104.76%), Khatauli (105. 84% and Mussoorie 105· 89%).

Besides, these remaining towns do not have a high growth rate of population. In all there are only 32 towns which have above 100 per cent growth of population. The towns of Class I and II categories have a very high growth rate (above 100%) but this trend decreases in the lower categories of towns. Most of the towns of Class IV, V and VI have below 100 per cent growth in population. This fact reveals that the growth rate of population in big towns are relatively higher than the small towns.

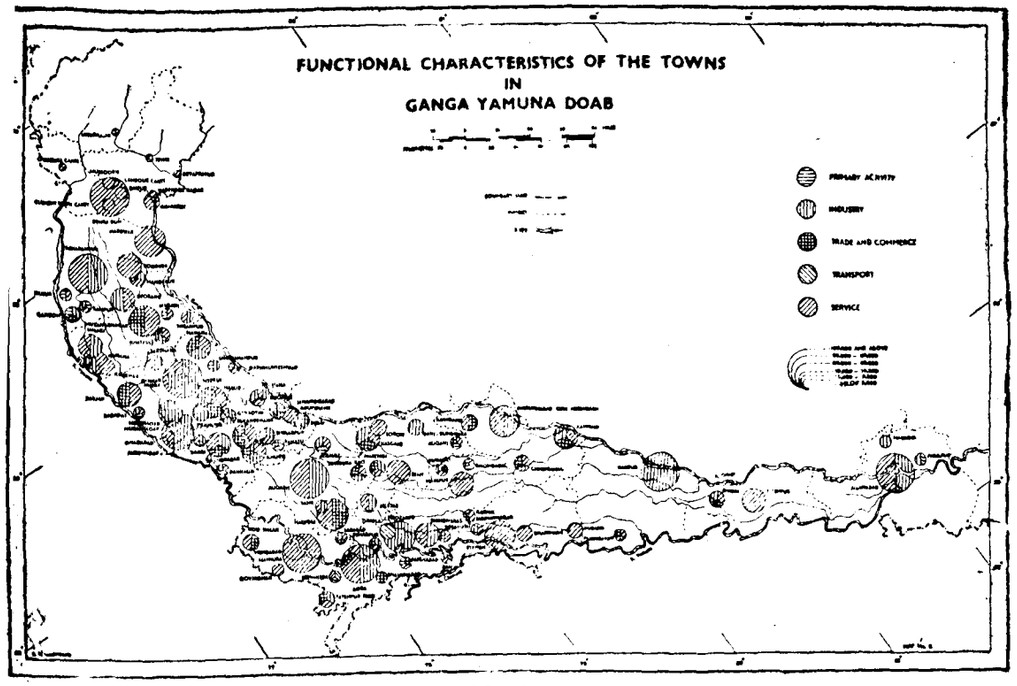
Decreasing growth can be observed only in 4 towns of the region. Two of which Phulpur and Mauaima are located in Allahabad district while Landaur Cantt. and Pahasu are in Dehra Dun and Bulandshahr districts respectively. Landaur Cantt., being a service town, has a very little scope of growth (−19.24%) followed by Phulpur (−10.01%), Mauaima (−5.67%) and Pahasu (−4.03%).

Functional Analysis

The activities which provide the earning of the people are a good indicators of the urban functions. This functional classification is based on the grouping of the workers in different industrial categories. The towns of Ganga, Yamuna *doab* are of diversified economic structure. The nine-fold industrial classification of the workers in 1961 Census are arranged into five broad industrial categories, *viz.*, Primary activity, Industry, Trade and Commerce, Transport and Service. The percentage of workers engaged in these activities are sum up from the total working population. If the percentage of any single category is 40 per cent or more, it is treated as a monofunctional town but if it is less, the next high category of workers are sum up but its total percentage has to be 60 per cent or more. These are called bi-functional towns. If the total sum of these two categories are also not upto 60 per cent then the percentage of the third category is added in it and the towns are called multifunctional. Any category employing less than 20 per cent of the working population is not considered as a predominant function. The functional types of the towns are shown clearly in Map No. 2.

Primary Activity

Primary activity includes people engaged in the activities like food, drink, agricultural labourer etc., or which provide essential raw materials required by other activity groups. This function is mostly dominant in Class VI and Class V towns of the region but it is not predominant in any town of the region. This activity shows that these towns are functioning as a rural market centre. The highest percentage of workers engaged in this function is Uttar Kashi (31.6%). Being situated in the hilly terrain people earn their livelihood either from agricultural activities or from services. The Jahangirabad (28.3%) followed by next town employing high percentage of workers in this category is Rampur (27.1%), Siana (26.5%), Shahiahanpur (26.1%), Pahasu (23.7%), Atrauli (23.2%), Shikarpur (23.1%) etc.



Map 2

Industry

This function is dominant in a large number of towns. A large proportion o population depend on this activity. Kanpur, a major textile centre of the Uttar Pradesh, employ 41.63% of the total working population of the town in Industry. Modinagar, a newly grown textile town, has the highest percentage (75.39%) of population in industrial sector although the town is of very recent origin (1941-51). Firozabad, a famous bangle manufacturing centre of India employ 63.50 per cent of population in Industry. Besides, the remaining important industrial towns are Kankar Khera (44.7%), Mauaima (45.6%), Pilkhua (43.9%) Ganj Dundwara (42.5%), Faridnagar (41.7%) etc. Ghaziabad, being situated in the umland of Delhi, has a large number of industry established in recent years but due to high population growth the percentage of workers in this activity is only 35.9 per cent. The other towns where industry has been shown as a bifunctional are Jalesar (39.4%), Fatehpur Sikri (38.7%), Bangarsi (38.4%), Agra (37.5%), Shamli (37.20%), Mangalur (36.7%), Miranpur (36.7%), Meerut (36.3%) etc. Mauaima, being a industrial town is the only exception where trend in population growth is negative.

Trade and Commerce:

It is limited with a few towns of the region. Shamshabad is the only town where 44 per cent of the population are earning their livelihood - from trade activities. Besides, Hathras (32.33%), Khurja

(25.24%) and Hapur (24.47%) are the other important business centres comprising a sizeable population in this activity. Kanauj, a famous perfume business centre of the northern India has only 27.76 per cent of population engaged in Trade and Commerce. Remaining bifunctional towns are Kosi Kalan (35.2%), Kaimganj (34.2%), Kuraoli (32.0%) Sirsaganj (31.9%), Fatehabad (31.6%), Gubothi (29.6%), Karhal (29.4) etc.

Transport :

This function is limited only in Tundla (54.9%) and Achhnera (24.5%) towns of Agra district. Tundla is very important railway junction and well connected by road links. There is one railway colony with a population of 7392 persons. In the other towns transport is very insignificant.

Services

Service is the very important function of towns located in the region. Most of the towns have sizeable proportion of population engaged in this activity. Out of 17 districts, 13 district headquarters have service as a predominant function. It is because, all administrative offices are located in these places. It is mono-function in 24 towns which is the largest number in all the functions. Chakrata Cantt. (90.0%) and Clement Cantt. (88.3%) towns where persons in services are highest in percentage. It is due to the overwhelming of defence personel. All the class VI towns (except Uttar Kashi) have services as a mono-function. In Class I towns Dehra Dun (49.13%) and Mathura (41.22%) are the only two towns where service is a mono-function. Besides, there are so many other towns such as Hardwar (45.08%), Etawah (45.50%), Vrindaban (64.81%), Etah (43.18%), Mainpuri (43.88%), Fatehpur (42.41%), Roorkee (71.46%), Rishikesh (45.0%), Kandhala (42.9%), Anupshahr (40.5%), Soron (43.3%), Barthara (40.8%), Auraiya (43.4%), Mussorie (54.7%), Raipur (57.3%) and Govardhan (41.3%) where service is a mono-function. There are other towns where service is a bi-function also.

In all we find that there are 34 mono-functional, 31 bi-functional and 35 multi-functional towns in this region. Most of the towns (24) have Service as a maior function, followed by Industry (8). Trade and Commerce and Transport is limited with two towns only, namely Shamshabad and Tundla. Remaining towns are either bifunctional or multifunctional.

Conclusion

After analysing the growth with the function of the towns it is noticed that the towns of very high growth rate are mostly of mono-functional character. Service and Industry are the two dominant function which provide a large proportion of population to earn their livelihood. The second characteristic is noticed that towns of Class I and II have a very high percentage of growth rate as compared to the other categories of towns.

Acknowlegement

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Abstract

Authors have done comparative study of the towns of the Ganga-Yamuna Daob keeping in view the tendencies of growth and functional characteristics of towns. They concluded after analysing these characteristics that the high growth of population of towns are mostly of considerable size and have less diversified functions and low growth of population of towns are mostly of poly-functional.

ROUGH PASTURES AND PASTORAL ACTIVITIES OF JAISALMER

(A. K. Tewari, Jodhpur)

The Setting:

Jaisalmer, the westernmost district of Rajasthan, (Lat. 26°4′—28°20′N; Long. 68°30′—72°42′E) constitutes the major portion of the Indian desert — the *Thar*. The ancient names of this region were *Mardhara* and *Valladesha* but later it was known as Jaisalmer state after the name of Maharaval Jaisaldeo who established a new desert capital of the same name in A.D. 1156. The area of this district is 14,847 sq. miles with a population of 140,338 in 1961. Low and sporadic precipitation inhibits intensive use of soils and enhances the role of grazing. The climatic fluctuations determine the increase and decrease of flocks and the dependency on pastoral products. The district is characterised by a typical desert landscape with vast stretches of sandy plains strewn with dunes of all sizes, rocky plateaus and dried up basins (ranns). Its extreme aridity and precarious rainfall has retarded its economic development and rendered it a most desolate and inaccessible district of Rajasthan. Its district headquarters is connected with Jodhpur via Pokharan by a metalled road and a recently built metre-guage railway line. Except for a few camel tracks that traverse through the shifting sand hills, there are practically no roads in its western interior.

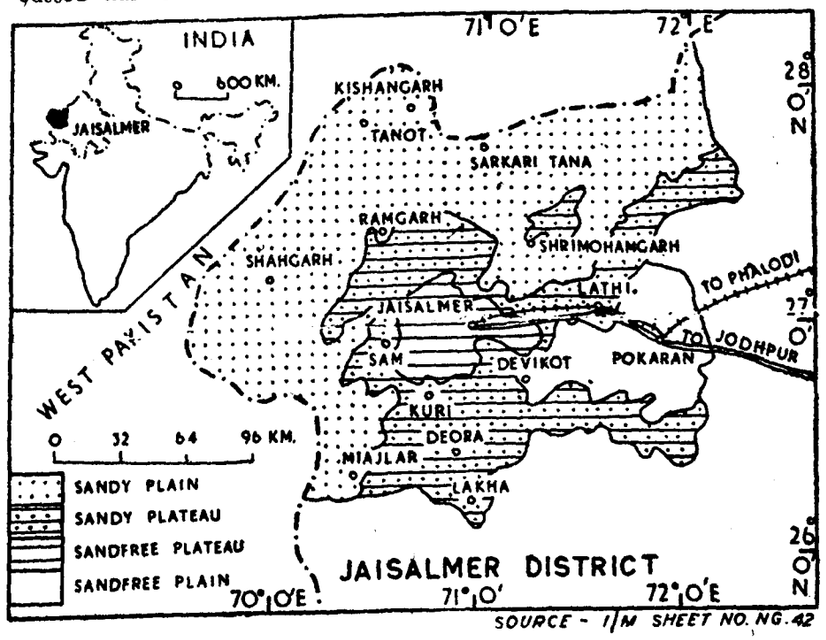
The settlements in this region are few and sparsely distributed. For the most part they are used as temporary habitation. The density of population is only 4 persons per square kilometre, and that too varies from 1 in sandy areas to 10 in sand free plains and plateaus. The villages have their foot-holds in the rocky out crops and pediplains where a number of centripetal drainage basins and ephemeral channels assure a surface and sub-surface supply of drinking water. Many of the settlements are mere wigwams collected round a well of brackish water or around a seasonal tank. Their fortune fluctuates with the level of ground water. All these environmental restrictions have compelled the people to be animal graziers leading a wandering life, migrating regularly from pastures to pastures in search of grass and feed. Prudence in the management of the size of flocks and the carrying capacity of these rough pastures is essential for the bare existence of these herdsmen. The imporance of pastoral activities may be assessed by the following table of livelihood pattern in Jaisalmer district.

LIVELIHOOD PATTERN IN JAISALMER DISTRICT 1961.

Total Pop.	Cultivators	Ag. Lab.	Pastoral nomads	Household activities	Trade & Com:	others
140338	34744	350	8461	18224	1349	4686

The Ecology of Pastures : —

The vegetal cover of a region is an expression of the integrated effect of landforms, climate, soils and the people inhabiting it. The relief as already discussed has three distinct components: the north-western sandy plain, the dry sand-free central plateau (Jaisalmer plateau), and the southeast plain (Pokkaran plain). These natural sub-divisions are marked in Fig. 1. The climate is com-



pletely dry with less than —40 moisture index on the basis of Thornthwaite's formula. Precipitation fluctuates between 2 -c.m. and 40 c.m. a year with an average of 15 c.m. The relative humdity, likewise, is also very low which remains 50% in rainy season and less than 5% in summer season. There are certain local variations too, such as in the plateau of Jaisalmer more than 50% of cloudy days materialise into rainy days whereas in the adjoining sandy plains hardly 30% of cloudy days bring any shower. The evaporation and percolation of meteoric water varies considerably from place to place depending upon the type of rocks and nature of terrain. There are, however, certain acquifers in the limestone and sandstone beds of Jaisalmer series (Jurassic) where promising ground water sources occur. These zones are reflected on the ground by rows of dense shrubs and trees which are otherwise found at great distance. The soils of Jaisalmer are wind-deposited brown loess with both coarse and fine sands. In plateau areas calcareous and mature soils may occur in suitable localities but in general they are light and sandy, and, for the most part infertile with

a very poor base-exchange status. The moisture retention capacity is so low that the water percolates deep down into the earth just after the rains and later, due to the dry atmosphere it comes out with salts and alkalies by capilary action. This vertical flow of soil moisture turns the soils more infertile. In areas of impeded drainage patches of saline lands with pH values between 7 and 10 are found in considerable stretches. The ecological conditions of this area, therefore, are not congenial for the biotic growth and it has been further deteriorated by over grazing.

The Nature of grasslands and Pastures.

The natural vegetation of Jaisalmer consists of the tropical thorny shrubs and xerophytes[2] scattered in clumps of small patches seperated by wide expances of sandy and rocky wastes. The vegetation grades from the little stunted trees on the eastern borders of the district, through the xerophytic bush and tufts of long grasses in the central plateau region to the complete desert in the extreme west near the Indo-Pakistan border. The general depressing effect of the landscape of Bikaner and Jaisalmer desert has been well depicted by Aldous Huxley in his book *Jesting Pilate*[3]. The density and size of such patches increase on the one hand from west to east (due to increasing rainfall) and on the other hand from the sandy parts to the plateau region and areas of fixed dunes. *Phog bush* (*calligonum polygonoides*) is a common vegetation over the fixed sand dunes and kikar trees (*acacia senegal*) over the rocky regions. On the basis of landforms, and local variations of soil and ground water resources the pastures of Jaisalmer may be put into the following three ecological sub-types. The biotic and edaphic forms of the ensemble of these vegetation groups may vary considerably but a uniform desert climate has manifested most of the characteristics alike.[4]

(i) *The Sandy Desert Pastures* : More than 60% of the area of Jaisalmer is composed of fine sandy waste with innumerable sand dunes. In these areas hardly any plant can obtain a footing except on the slopes and crests of fixed sand hills. The vegetation consists of small stunted trees and shrubs with dry grass cover at the leeward sides of the dunes. A characteristics association of *Crotalaria burhia, Leptadenia spartium, Aerva Pseudo-tomeritosa* and *Panicum turgidum* is found in the elevated dunes of Loharki in this district. The common sand grasses that grow over these dunes are *Phog, Prieurii* and *cenchus ciliaris*. With in the sandy zone there are several depressions and *Ranns* where high salinity has given origin to ephemeral halophytic grasses which spring up in rainy season. Many other drought resistant bushes and salt bushes also occur in the open desert areas.

(ii) *The Gravelly Desert Pastures* : About one fifth of the areas of this district is covered with coarse type of sand and gravels where vegetation is more sparse and patchy. The origin of the gravel and coarse sand formations is due to sorting action of winds. In Jaisalmer the typical gravel associations consist of the tufts of long grasses with stunted trees having strong woody top-roots penetrating to a considerable depth. The chief tree and shrub species are *leptadenia spartium, cleome*

papillosa, boerhaavia diffusa and several species of *eleusine, aristida* and *fagonia*. In the poorer sites of the Jaisalmer plateau occasional associatons of *Khejari* (*prosopis spicigera*) with *salvadora oleoides* and *gymnosporia montana* are also found.[5]

(iii) *The Rocky Desert Pastures* : The most interesting composition of the Flora of Jaisalmer is found over the uplands and rocky out-crops which are comparatively sand free areas of the Indian desert. Geomorphologically they stand as typical pediplains littered with a mosaic of coarse products of rock disintegration. In rocky formation the most important shrub is *euphorbia neriifolia* which is widely distributed over plateau region. Apart from this, several types of grasses such as *Jors* (grass *bir*) and *eleusine cympopogon jwarnacusa* and shrubby growths such as *zizyphus nummularia* display the richness of these pastures. The slopes of the plateau and hilly areas of Jaisalmer are the favourable habits for the rough pastures and grasslands. Most of grass species are highly nutritive, palatable and productive, with deep root systems. In areas of sown pastures, the Arjan grass (*cenchrus-setigerus*) and gramma grass (*panicum antidotale*) are readily grown and they increase the carrying capacity of these pastures to a considerable extent.[6]

Pastoral Landuse :

As it is evident from the preceding account of the nature of vegetation in this area, pastures are the main element of the landuse of Jaisalmer. The following table gives the main features of its landuse :[7]

Land Utilization in Jarsalmet 1966

Area	Forests	Area not available for Cult.	Permanent Pastures	Cultivable Waste-Rough Pastures	Old & Current Fallows	Net area sown
3861000 hectares	19000	1682000	77000	1691000	261000	153000

The grazing area of Jaisalmer consists of 80% of total area of the district including lands such as cultivable wastes, common grazing lands and old and new fallow lands. Since whole of the area comes under mono-culture of hardy cereals, the agricultural fields also serve as grazing lands during winter season. One disturbing feature of this region is this that out of this vast area of rough pastures the true pastures with good grass cover are hardly 4% of the area. Apart from this their quality is poor and they occur only in scattered patches. The estimate of the total fodder derived from these rough pastures is about 3,200,000 tons or 800,000 tons of dry matter. The carrying capacity of these pastures is only 80 acres an animal unit[8] in normal seasons and may go higher during rainy season but seldom exceeds acres to an animal unit. Although the pressure of human population is not much yet the animal pressure on land is great. At present about 3 hectares support one animal unit in Jaisalmer which is definitely alarming with regard to its carrying capacity. In other dry zones of the world an ideal balance is maintained between the total potential of pastures and livestock grazing over it.

The great pressure of livestock population in this district has much

disturbed the balance of fodder resources. The central Arid Zone research Institute, Jodhpur has made several experiments on the safe balance of livestock population and grazing lands and has suggested 6 hectares of grazing land per animal unit. It means that at present the livestock population of this district is just double the carrying capacity of pastures. The animal population in Jaisalmer in 1966-67 is shown in the following table.[9]

Livestock Population in Jaisalmer

cattle	Sheep	Goats	Camel	Donkey	Horses and ponny
216,640	529,261	174,381	40,214	13,124	1,144

Pastoral Activities

The environmental limitations in Jaisalmer have given origin to a pastoral-cum-agricultural economy of the people. The small amount of summer rainfall is just sufficient during average years for the caltivation of dry cereals such as Bajra (*peñniñsetum typhodes*) Guar (*cymopsis tetragonoloba*), Jwar, (*sorghum vulgave*), Moth (*phaseolus acontifolius*). Mung (phaseolus radiatus) and Til (sesamum indicum). The winter season is entirely a fallow season for cultivators and even in the Kharif season the farm out put is not sufficient for their bare existence. Thus livestock rearing becomes the mainstay of their economy. The herds of cattle, sheep, goat and camel become their actual wealth. Since time immemorial these animals have been domisticated in the arid land of India and Pakistan. The pastoral occupation of the desert inhabitants has two well defined groups; the one carried as a subsidiary to agriculture by permanent cultivators and the other carried on nomadic basis by those tribes who are by habit nomads and by those people who do not own any piece of land. Persistent search for pastures is a characteristic of the well defined transhumance of the latter.

The boundary between the agricultural and pastoral zones is not defined except that the former have permanent villages and the latter lead a wandering life migrating regularly from pastures to pastures with their large nerds. The cultivators mainly own cattle for milk where as the nomads and non-cultivators rear sheep and camel for export to the other regions of Rajasthan. The present importance of pastoral nomadism can be attributed to the fact that 70% of the animal stock is owned by the pastoral nomads. Their stock consists mainly of the sheep of Magra and Pugal breed. The average size of flocks varies from 300 to 500 sheep and goats. These nomads have a monopoly in camel breeding in the whole of India.

The animal products such as blankets and pile carpets, of sheep's wool and bags and druggests of goat's and camel's hair, hides and skins of cattle and livestock and bones are marketed in the fairs and bazars of Western Rajasthan. The distribution and duration of these local *hats* and fairs are in themselves testimony or to the people's economic dependence on pastoral activities. A great number of camels, cattle and sheep is regularly exported to different parts of India and in years of droughts it becomes a must for them. Apart from the local consumption, a handsome quantity of 'Ghee' finds its market in different parts of Rajasthan. The Tharparkar (Mallani) and Rathi breeds of cattle are the best known high yielding milch stocks of our country. To sum up, it can be said with justification that the district of Jaisalmer is best suited for pastoral activities. The constant scarcity and frequent famines following the failure of monsoons or damages done by locusts have not much worrying effect on the people. They are practically always prepared for famines. They are by nature and necessity, self-reliant, nomadic and hardy. But the problem which disturbs them most is the restrictions imposed on their nomadic movements which had to be altogether stopped towards western regions (Sindh) owing to the partition of India. The movements towards east and south (E. Rajasthan, Gujrat and Madhya Pradesh) are also not free from obstacles because most of the land is gradually being owned by cultivators and no space is left for landless nomads. The area of nomadic movement is constantly being reduced; but no *prudence is being exercised to equate the balancing* decrease in animal units. Consequently the rough pastures of Jaisalmer are being grazed beyond their carrying capacity.

The present scarcity of fodder following a complete failure of monsoon in western Rajasthan has created a danger of extinction of one of the best cattle and livestock breeds of our country. It is estimated that within two months (Sept. and Oct. 68) more than 200,000 of animals have either died or have been left loose at the mercy of wolves and wild animals in this district alone. This fodder famine is also responsible for many armed clashes between the pastoral nomads and the settled cultivators when the formers' cattle eat away the latter's crops. This proplem can be tackled by a long range planning and management of pastures with a view to increase their stock carrying capacity. At present there are nearly 400,000 adult animal units in Jaisalmer district requiring 1100,000 tons of dry matter (25% of the green fodder and 90% of dry fodder) whereas the available dry matter is only 900,000 tons. Out of this dry matter the rough pastures account for more than 800,000 tons. This gives an annual deficit of 200,000 tons of dry matter. This scarcity can be overcome by increasing one fifths of the present area of the cultivated grasslands. But it also requires a complete control on animal population.

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A GREAT LOSS

The Indian Geographical Society deeply regrets to record the passing away of one of its Vice-Presidents and a founder member, Shri A. Thirumalai Iyengar, at "Gotha Vilas", Chrompet, Madras-44. He was a great benefactor of the Society and took keen interest in all its activities since inception. In his death, the Association has lost a wise and able guide. It is a great loss to the Society in particular and the Geography subject in general.

We offer our heartfelt Condolences to the members of the bereaved family.

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