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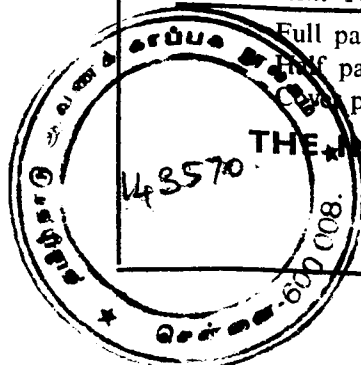
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*The Editor takes no responsibility for the views expressed in the Journal.
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THE INTERNATIONAL GEOPHYSICAL YEAR

By

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Geophysics is characteristically an observational science in all its phases, where nature performs the experiments and men observe as a preliminary to understanding. In this way it differs from fields of science which can be investigated under laboratory controls.

The International Geophysical Year, the greatest co-operative scientific undertaking of all time, is dedicated simply to the observation of man's environment—the land on which he lives, the oceans which he fishes and sails, and the atmosphere that he breathes and the influences from outside the earth, particularly the sunshine that supports all life. It is designed to help us understand our environment better so that we may be better able to withstand some of its majestic vicissitudes—earthquakes, ocean tidal waves, atmospheric storms and the vagaries imposed by solar flares and sunspots. It is the vastness of the geophysicist's laboratory—the earth—that lends to geophysics its fascination, that causes the study of geophysics to be a combination of the sciences conjured up in the word combinations science and art, invention and imagination, research and exploration, doubt and the probing of unknown reaches where as yet we cannot go. It is this same vastness of our environment which necessitates an international co-operative effort on its problems. The oceans belong to no one nation; solar activity and the ionosphere affect all on earth and are problems of such a scale that they transcend international boundaries; droughts, cold and great storms recognize no political lines and now aside curtains even of iron. This is why the excellent partnership between forty-eight participating nations, and ten or twenty more who will assist in the program, has been achieved. Indeed, the International Geophysical Year of 1957-58 is the third such co-operative attack on geophysical problems, the first in 1883, was a joint international effort to collect as simultaneously as

possible geophysical data on the then little-known north polar region. This first International Polar Year contributed mightily to our knowledge of geomagnetism and aurora. So successful was it that a Second International Polar Year was held almost exactly fifty years later. With the advances of engineering during those fifty years, the poles had become reasonably accessible and the observations led to many advances in understanding. Now, almost exactly twenty-five years since the second international effort, further advances in engineering and in instrumentation permit us to probe hitherto unknown regions of our environment which should leave no part of our planet geophysically unknown. Instruments which extend, add to, and complement man's own senses and powers of observation play one of their most dramatic roles in the field of geophysics. The deep recesses of the ocean, the impenetrable interior of the lithosphere, and the rarefied reaches of the upper atmosphere are challenging regions for modern imaginative instrumentation.

Because many features of our environment on earth, particularly in the lower and upper atmosphere, are caused or influenced by the sun, one of the unifying features of all the programs in the Geophysical Year is the observation of solar activity. Indeed, it is because this period will be one of near maximum sunspots that it was chosen. One might say that nature picked the date.

The enthusiasm for the International Geophysical Year and the magnificent co-operation of all, not only in our country but in the many others, has far exceeded that most optimistic expectations of those who took part in the early planning. Over five thousand scientists and engineers have been, and are still, preparing throughout the world for the eighteen months of observation, and the total research effort is estimated at about 250 million dollars with the direct United States appropriation by Congress of nearly 40 million dollars. Just as important as the direct participation of these research workers is the interest and support of lay people. Without this interest the necessary governmental support of the plan conceived by private scientists could hardly come about.

The United States program is but one, though a great one, of the total world effort. It contains thirteen groupings of disciplines and areas of activity. These thirteen may, in turn, be grouped under three main categories: *physics of the upper atmosphere* (rocket studies, the satellite studies, ionospheric physics, cosmic rays, geomagnetism, aurora and airglow, and solar activity); *lower atmosphere and surface and interface geophysics—the earth's heat and water budget* (meteorology, oceanography, and glaciology); and thirdly, *the earth's crust, interior and figure* (seismology, gravity, and longitude and latitude program). In bearing its share of the coverage of the earth, our program will cover not only the continental limits of the United States and Alaska but will co-operate directly in observations with nations of North and South America and will extend into the waters of the Atlantic, Pacific, and equatorial Pacific Oceans. In addition, the United States will make a tremendous contribution through its program in the Antarctic.

It is interesting to indicate the coherence and essential entity of the United States International Geophysical Year Program. All the elements are global in character and all the fields of geophysics in the program interact with one another and mostly bear ultimately on a relationship to solar energy fluctuations and disturbances to a greater or lesser degree. Furthermore, fields selected are those in which the solution of major problems will be aided by simultaneous and synoptic observation during the eighteen-month IGY period.

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that the inter-relationships of the fields, one with another, and with solar activity may be studied. Emphasis is also given to little known regions. The interactions between the fields can best be indicated in terms of major categories.

INTERACTION OF HYDROSPHERE, LITHOSPHERE AND ATMOSPHERE AT THE INTERFACES BETWEEN LAND AND AIR AND LAND AND SEA

The interaction is shown by the continual cycle of water from the oceans, carried to the continents by the atmospheric winds and back to the sea in the rivers, there to be re-evaporated. "All rivers run into the sea, yet the sea is not full." Also in this process it is the counteracting mountain-building forces in the restless interior and crust of the earth which battle with erosion processes to keep land's head above water.

Man's primary dependence on weather is for heat and water, both of which are distributed by the winds of the atmosphere driven by the sun's energy. The total water on earth is primarily in the oceans; on the land in lakes and rivers and in glaciers and ice deposits; and in the atmosphere as vapor and as condensate in clouds. To understand the over-all interaction in the budget of water and heat it is clearly necessary that a simultaneous closely-knit program in meteorology, oceanography and glaciology be carried out.

Meteorology in the International Geophysical Year will emphasize making up deficiencies of data in the Southern Hemisphere where the relatively unknown ocean regions together with Antarctica comprise over ninety per cent of the total area of that hemisphere. It is in this meteorological incognito that we will establish about sixty stations during the IGY. These, in conjunction with the already established networks on the inhabited land areas, will give us a suitable network of data for the first time. A second unknown region in meteorology upon a global scale is the high atmosphere up to about a hundred thousand feet. Balloon-borne instruments will fill this gap. The third major objective of the meteorological program is to provide new information on the large-scale global wind circulation. Because the global circulation is predominantly zonal, it will not be able to pass these fences unobserved. Three fences of stations along three meridians will be established from pole to pole to obtain data from the surface up to high altitudes. One of these lines of stations is primarily continental and another almost entirely oceanic.

Just as every heat engine has a warm and a cold side to its working-fluid, so does the atmosphere and the Antarctic program will provide us with daily weather maps of that huge continent which constitutes the major cold pole in the atmospheric heat engine. These, together with the supplemental data for the rest of the Southern Hemisphere, should go far toward a better understanding of the general circulation of the atmosphere.

The oceans which cover four-fifths of the surface of the globe form a huge thermo-accumulator or bank where heat is deposited and stored and withdrawn in times of cold, thus exerting a tempering effect on world climate. The reason that the ocean is able to store great quantities of heat is due to the stirring by the winds. It is the winds too that primarily drive the great oceanic surface circulations which distribute this heat in a manner profoundly affecting climate. The oceanographic program centers on two main objectives—first, to study the very deep ocean currents about which practically

nothing is known. This may provide clues for long-range weather and climatic trends and for an understanding of how the fertility of the ocean with its sink of nutrients at the bottom is maintained by the exchange of water between its surface and the depths. While studying the deeps a part of the effort will be devoted to delineating the shape of the sometimes craggy ocean floor and the constitution of the earth beneath that floor. Another major effort will be to measure sea level at about a hundred new stations located to fill out the existing tide gauge stations. Sea level is a misnomer perpetrated to confuse. Sea surface height varies from place to place, changes with the season, with the amount transported by the great ocean currents, and due to other factors. This study will, among other things, provide valuable information on the transport of water near the surface of the sea.

The meteorological and oceanographic programs will join in attempts to establish how fast the ocean can absorb the great quantities of carbon dioxide which industrialization is pouring into the atmosphere at ever-increasing rates. If this adjustment is not quick enough, man, by changing the infrared radiation balance, may accelerate the warming up of climate with consequent opening up of waterways, rise in sea level, and he may unwittingly be embarked on a colossal geophysical control experiment.

Whenever at the surface of the earth the interface with the atmosphere is an ice sheet, the ice by reflecting incident radiation where other surfaces absorb exerts a profound influence on climate. Glaciology is an essential part, therefore, of these interface problems. The amount of glaciation in the past has given us indications of major fluctuations of climate in geological time and an understanding of the retreat or advance of glaciers at present should aid in assessment of climatic trends. In IGY the United States program will attempt to observe not only the condition of that greatest of all the ice sheets in Antarctica but will also study many glaciers and ice deposits in the Northern Hemisphere.

THE UPPER REACHES AND INFLUENCES FROM BEYOND

The denser atmosphere in the troposphere and lower stratosphere is the protective shield against radiations from extra-terrestrial sources, some of which would otherwise be lethal and, as we have seen, it too is the vehicle in the regulation of our heat and water. But many phenomena fundamental in our environment occur primarily in the high atmosphere over fifty miles above the earth, where the atmosphere is so rare that an ordinary vacuum tube would burst outwards. It is in this region, of course, that the sun's activity in the form of flares and eruptions has the most profound effect on the ionosphere, on aurora and on geomagnetism, and it is at these heights that certain of the cosmic rays which are absorbed by the denser atmosphere below can be studied best. The basic study, therefore, in the upper reaches is that of the solar activity in the period near maximum of sunspot activity. The surface of the sun will be scanned in the visible frequencies and its noise will be listened to at radio frequencies on a world-wide twenty-four hour watch basis to count the number and size of the sunspots and of the flares which shoot out hundreds of thousands of miles and to observe the activity of the corona. The systematic recording of solar events will provide the basis of correlations with ionospheric, geomagnetic, auroral and cosmic ray perturbations. A warning service and special world intervals are planned for those periods of unusual solar activity and solar eclipses when other high atmosphere observations of the associated unusual consequences should be accelerated.

When Marconi sent the first radio signal from Europe to our continent, it was not understood how the radio waves bent around the spherical earth. The existence of the radiowave mirror, the ionosphere, which made this first and, indeed, makes all long-distance radio transmission possible, was only demonstrated experimentally in 1925. Since then the importance of the ionosphere and its study has been intensified.

The objective of the ionospheric program will be to develop a network of both vertically-scanning and oblique-scanning stations which can provide ultimately a global picture of the ionospheric layers much like a world weather map. From such a global picture prediction of ionospheric conditions with its ultimate application to frequency selection and "routing" of long-range communications is possible. The number of vertical incidence ionospheric stations now operating around the world will be doubled in IGY. The United States likewise will bear its share by doubling the stations which it now operates. The additional stations are carefully located to fill out a world-wide network. Particular emphasis will be placed on the 70° to 80°W. longitude fence (in the same position as one of the meteorological fences); a program in the region of the geomagnetic equator; and a program in Antarctica of particular interest in the long Antarctic night when all radiation from the sun and its influence on the ionosphere is absent.

Both northern lights and southern lights will be watched in the two polar regions. Data on the aurora can tell us a great deal about the streams of ionized particles from the sun which give rise to these magnificent visible displays. Spectroscopic and visual photographic observations of the distribution of aurora made simultaneously with the observations of the face of the sun and of the earth's magnetism will provide the three elements needed for further understanding. At the same time the ionization associated with the aurora, and which also affects radio communications, can be studied by radar. Aurora borealis and aurora australis, if observed simultaneously at the opposite poles, can establish time correlations and show whether occurrences are simultaneous. Time correlation studies such as these will aid in understanding the effects of the earth's magnetic field upon aurora.

The airglow, or weak light, which shines palely from the night sky, which is believed to be caused (in contra-distinction to aurora) from chemical reaction in the high atmosphere, varies in time, place and in intensity. Airglow will be measured in IGY with highly sensitive instruments distributed along some what the same longitudinal chain as the ionospheric stations; that is, from the Arctic through North, Central, and South America to the Antarctic. A few other stations will also be located at different longitudes. While not as dramatic in its manifestation as some other atmospheric phenomena, the processes causing airglow may be stimulated by the introduction of catalysts foreshadowing another conceivable geophysical control.

THE EARTH'S MAGNETIC FIELD

The eighty magnetic observatories now spread over the world record continuously the earth's behavior as a great magnet. Its magnetic field, while fairly stable and unchanging, not only shows slow variations which, like the permanent field, are connected with dynamo-like interactions of the crust and the interior of the earth, but also rapid fluctuations which are believed to be caused by external influences. What causes this geomagnetic storminess and how it relates to other variations in the upper atmosphere—solar, ionospheric, and auroral—is the main objective in IGY in this field of science. Twelve

stations outside of the United States (in Alaska, Antarctic and the equatorial Pacific), together with eight stations in the United States, arranged in an east-west north-south cross, will be the networks of the program in geomagnetism.

In cosmic rays emphasis will be placed on measurements at high altitudes where the masking effect of our layer of protective atmosphere is at a minimum. Here, too, inter-relations of the various high atmospheric phenomena are intimate but not entirely understood so the disturbances and great variations of cosmic ray showers and variations of the magnetic field of the earth each throw light on the understanding of the other. The magnetic field is a way of analyzing energy of cosmic rays and cosmic rays, in turn, give clues to the distribution of the magnetic field and in particular the location of the geomagnetic equator, and the relationship of both of these to solar flares and periods of sunspot maximum. The origin and nature of cosmic rays is still uncertain and reflects its uncertainty both on the geometrically immense field of astrophysics and the geometrically minute field of the structure of the atomic nucleus.

CRUST, CORE AND SHAPE

Seismology, gravity measurements, and the determination of latitude and longitude are three inter-related programs to tell more about the interior of the earth, the disturbances which occur in the interior, and the precise shape and size of our planet. Internal stresses and strains give rise dramatically to earthquakes, ranging from those of small intensity to those which rupture the crust and devastate human communities by their shattering forces and by the resultant floods and tidal waves. Seismology joins with meteorology in the field of microseisms where atmospheric disturbances through oceanic waves cause small tremors to jar the earth. Small man-made earthquakes by the use of explosives enable seismological techniques to aid glaciology in the determination of the thickness of ice in Antarctica and the as yet unknown profile of the underlying continent, and seismology joins in the same with oceanography to provide knowledge of what is beneath the ocean bottom. The size, of the earth, more precise distances between continental and island points separated by oceans (now uncertain by anywhere from 200 feet to a mile) and problems of uniform time and irregular earth turning rate will be some of the objectives of the latitude and longitude program which will use both astronomical techniques, a new technique involving the moon, and possibly the artificial satellite as well.

The shape of the earth is quite complex, departing from a true sphere, and measuring the pull of the earth (which varies from place to place) can tell us much about the shape and the density of materials in the earth's crust. IGY will concentrate on the use of pendulums which are the absolute way to determine gravity in order to provide a gravity standard throughout the world. To tie together the various international networks measurements on ships, on the bottom of oceans, on submarines, and in the Antarctic will all contribute to a greatly enlarged and more comparable world picture of the pull of the earth.

ROCKETS, ROCOONS, AND ROCKAIRS

It is only within the last ten years that the engineering tools have been provided to make direct measurements at altitudes above the ceiling of balloons and up to heights of 200 miles and more. The United States has planned an

impressive program using some 600 rockets during the period to measure directly a number of the events in the various inter-locking fields of interest in the high atmosphere. Surface launched rockets to reach 200 miles and up, rocoons (which are smaller rockets launched from balloons and which may be launched from shipboard), and rockairs (which are small rockets released from high-flying airplanes) will all be used—the rocoons for those parts of the program which can be satisfied with a sixty-mile altitude and the rockairs to be ready for periods when the sun breaks out in flares and increased activity. In all cases provision will be made for special firings when the sun decides to perform some particularly interesting experiment. While we still make good use of balloons for the lower altitudes, the need to go higher and higher has made the use of rockets common enough to be referred to as a conventional rocket program; but the trouble about conventional rockets is that they only spend a very short time at high altitudes at one small part of the upper atmosphere before they fall back to earth. And for many of the proposed investigations a longer time and greater coverage is needed. It is for this reason that the ambitious and difficult satellite program was added. The need for satellites for high altitude geophysical research has been urged by several international bodies. In contradistinction to the conventional rocket, the satellite will circle the earth in its orbit and make geophysical measurements with world-girding scope and at greater leisure as it hurtles along at 18,000 miles an hour. Even taking into account the expense and effort needed to make these initial satellites successful, if one were to assess the cost of the measurements per unit time at high altitude, the satellite would emerge as the cheapest way of obtaining this data.

So much has been written about the satellite that it will suffice here to summarize the main features of this ambitious experiment. Vanguard, the vehicle to carry the satellite up, over 70 feet long and weighing about 11 tons, will be launched from Cape Canaveral in Florida approximately at the end of next year. The first stage of the three-stage rocket carrying the twenty-pound, twenty-to-thirty-inch spherical satellite, is a reworked and improved finless Viking. Liquid oxygen and alcohol and gasoline will thrust the assembly off the earth with a force of 27,000 pounds. Starting up vertically a movable thrust chamber in gimbals will control the direction and gradually tilt the system so that two minutes (140 seconds) and 35 miles up from take-off, when this first stage separates from the system, it will be travelling roughly 45° to the vertical at from 3000-4000 miles an hour. The second stage will then ignite immediately and burn nitric acid and dimethyl-hydrazine for an additional two minutes in another gimbal mounted thrust motor. At about 140 miles high, when the system has reached 11,000 miles per hour, the second stage will burn out but will continue with the assembly to control the direction by means of a set of jet reactors while it coasts onward and upward to about 300 miles altitude, 700 miles from the launching point. During this coasting time the jet reactors will place the last stage in its correct position, and the final stage rocket will be spun to provide directional stability in the manner in which the spin of a rifle bullet provides stability.

The second stage has then done its work and separates. The third stage, an unguided solid propellant rocket, will then fire to speed up the satellite into its orbit at 18,000 miles per hour, which is required so that the centrifugal force offsets the earth's gravitational pull. When the third stage burns out, the bottle will be separated from the little satellite sphere at a relative velocity of only a few feet per second compared to the absolute velocity of 26,000 feet per second. The satellite and this separated bottle will really then form two satellites circling the earth. If the satellite could be launched

precisely horizontally, then the launching point could be the point nearest to the earth. But because of inevitable errors it must be launched from a height of 300 miles if the nearest point to the earth is to be not less than 200 miles; and if the satellite dips lower than 200 miles at its nearest point, its life time will be seriously shortened. The furthest point of the elliptic orbit away from the earth will be less than 1,500 miles. The orbit and speed is such that the satellite will circle the earth in a plane chosen to be inclined 40° to the equatorial plane. Every part of the earth between latitudes 40° N. and 40° S. will pass under the satellite once every 24 hours, or every 15 revolutions of the satellite. The lifetime of the "little moon" depends on how thin the very rare atmosphere at these heights really is, and so wide are the limits of our ignorance in this respect that estimates of the lifetime range from a minimum of a few days to a maximum of a few years. The most important and immediate result from the first satellite will be the closing of these limits and a real knowledge of the density of the atmosphere at these great heights. The end of the satellite's life comes as the drag of the atmosphere slows down its circumferential speed and as gravity accelerates its motion inwards toward the earth. When it spirals inwards and reaches the denser atmosphere, it will burn up like a shooting star and perhaps leave a trail which itself may give us valuable new data on the winds. Even in a short lifetime the satellite can provide information which it will relay by radio, not only on the atmospheric density but on the earth's shape and size, on the sun's shine in the ultraviolet, on cosmic rays, on the distribution of mass in the earth and numerous other matters.

There is one facet of the program which appeals to me as being of particular and unique significance. This is the effort to excite the interest of amateurs, both here and abroad, to watch the satellite either visually or with radio receivers. The involvement of large groups of amateurs actually performing most important work in the International Geophysical Year will give a further impetus to the general understanding and support of geophysics.

Throughout the program I have stressed the importance that is attached to extending observations in all the geophysical fields to the little-known region of Antarctica. Eleven nations will co-operate directly in the Antarctic program with the United States portion being no less than six stations, including the important one at the South Pole which will serve as a central point not only for its own important scientific work but to aid all other participants. To be ready for the period of intensive observation our expeditions have already established aircraft facilities and carried instruments, supplies, and other materials to Antarctica in anticipation of the Geophysical Year period.

From the scope of these programs and their inter-relationships, it is clear that a great deal of attention must be given to the best ways in which the millions of observations which will result can be recorded and processed to give maximum availability and usefulness. A center to do this will be put in the United States to supplement centers elsewhere in the world.

USES AND OUTCOME

When we are asked what uses will result from this tremendous effort it is a difficult question to answer, not because the uses are few but because they are so many. The direct and obvious contributions of the increased knowledge toward questions such as climatic trends, melting of glaciers with the consequent rise in sea level, improved long-range radio transmission

improved understanding and possibly prediction of violent events (such as storms, earthquakes, tidal waves and the like) which affect the daily life and activity of everyone including world commerce and industry and transport by land, sea and air. But in addition to these and many others that you may add, suggestions for the answers of thousands of other questions will emerge and results of the International Geophysical Year will lay a new groundwork of understanding that will be practically exploited in world-scale engineering applications in the future. There are many instances of man exerting, through lack of understanding, inadvertent and sometimes harmful control of his environment. It is not out of the question to suggest that with the far greater understanding that will result from this tremendous international effort he should be able to better predict, and therefore exert some planned beneficial control on some of the environmental factors which determine his living.

I have emphasized that the International Geophysical Year achieved its successful co-operation through the efforts of non-governmental international organizations. This is not surprising because co-operation is essentially voluntary. But it is well also to stress that it gains strength by the tremendous support in our country, as in others, of the unique government laboratories in the various fields, without which support it is quite clear that many of these programs would not be possible. It is interesting, too, to note in the International Geophysical Year the interaction between basic science and its application to new engineering and instrumentation. In the various programs of the International Geophysical Year it is the most modern engineering tools and vehicles and instruments which made them possible—the rockets, the satellites, the calm occupation of the Antarctic using every boon of modern engineering to overcome the rigors of nature in that inhospitable part of the world. The new understanding of fundamental geophysical processes which should result will in turn lead to applications which we cannot foresee.

Finally, I believe that the International Geophysical Year may set a pattern in world science which might well be emulated in other areas. The medical people are beginning to talk of an International Geopathological Year. If this and others can have a measure of the success which we anticipate in the IGY, the sum total cannot fail to make its impact felt towards the improvement of international co-operation in general.

ANNUAL AND SEASONAL RUN-OFF FROM INDIA AND VICINITY

By

G. Y. SHANBHAG,

(M. J. College, Jalgaon (E.Kh.).)

There are two most important factors in the man's exploitation of land for agricultural, pastoral and industrial purposes. They are on the one hand the structure and configuration of the earth's crust which is comparatively stable if measured in terms of human life and on the other hand the much less stable atmosphere with its daily, seasonal and longer period fluctuations. The interaction between these two, the structure and the climatic elements, creates that fascinating pattern of soil, water, life and market which changes not only from place to place, usually gradually but in certain localities with almost awe-inspiring abruptness, but also though less conspicuously with time. This is due to the fact that the earth's surface slowly readjusts itself to the great heavings of the crust and also to the periodic or non-periodic changes in the quantity and quality of the forces that pour on to our tiny globe from the vast expanses of our own solar system and also from the cosmos beyond. Super-imposed upon these great changes are the small changes of the climate which creep to and fro over land as well as on the sea. It is therefore, necessary for man, who uses this pattern of land to feed himself and to improve his mind and soul to think every now and then of the nature's activities, though not with the intention of solving them, but at least to grasp their tremendous complexities and to adopt himself to the very unstable environment.

It is well known that in this changing environment, man ever since he came to occupy the earth's surface had seldom found a place where the most essential requirement of life, viz. water, occurs continuously in that desirable moderation most useful to his needs. He had to fight for his very existence with drought and with flood, with deserts that bloom when watered and with inundated lands which are useless until drained, with streams that serve as barriers until bridged but are useless for navigation, irrigation, fishing in times of low flow. Thus the most important and one of the major variables that affects the economic activities and agriculture of any place in the tropics is water and this is particularly true for a mainly agricultural country like India and vicinity with its outstanding feature, the marked seasonality of the rainfall. Because of this strong seasonal concentration of rainfall it is impossible to take full advantage of our soil throughout the year except by irrigation. Hence it is proposed to discuss in this paper the run-off (annual as well as the seasonal) i.e. the amount of water left over from the precipitation after being evaporated from the soil, transpired by the plants and replenishing the soil moisture deficit. It is this amount that could be used for irrigation, to turn the arid and semi-arid regions into granaries and for hydro-electric productions to supply power to the major as well as small-scale industries in the urban and rural areas provided proper means are used to harness it. If uncontrolled and allowed to flow into the sea as is the case at present in most parts of the country, it will accelerate the already existing heavy erosion and starve the already starving millions. For the success of any measure to be adopted to control

and utilize the run-off it is necessary to know the total amount that is likely to flow in any catchment area and its march through the various seasons. This is what has been not only worked out but also mapped for the convenience of ready reference in this paper.

It is a well established fact that water, after being precipitated and before it finally reaches well defined stream channels, is subjected to the action of numerous agencies, including ground and surface evaporation, transpiration by plants and tree growths, infiltration and absorption by the ground, passage through shallow storage upon ill-drained lands, surface run-off through shallow system of tricklets and streams. The importance of subtraction from the precipitation before it becomes stream flow may be illustrated by the statement that to produce one pound of dry vegetable substance of a growing plant several hundred pounds of water is taken up from the soil by the roots of the plants, passes through the growing plant tissues, and then evaporates into the air from the leaf surfaces. Thus to obtain satisfactory crop yields many inches of water over crop-producing area must be used in this way. It is evident, therefore that in the arid and semi-arid regions, and indeed in the humid regions too, in times of drought, the flow of surface streams constitutes a surprisingly small part of the water initially falling as rain.

Rainfall which varies from place to place and time to time is known reasonably well over the inhabited parts of the earth because of the simplicity in the technique of its measurements. Evapo-transpiration which represents the amount of water lost by evaporation from the soil and transpired by the plants and which is one of the losses to be subtracted from the precipitation to get the run-off is practically unknown for every part of the world. This is because of its dependence on several complicated factors as is pointed out by the present author (1956). This question of determining the evapo-transpiration under natural conditions had plagued agriculturists, ecologists, foresters, hydrologists and soil-scientists for a long time but none had yet succeeded either in perfecting the theory or the instruments. However, at present there are two formula in the Anglo-American literature for the computation of what is called the potential evapo-transpiration. One of them is by Penman (1948) and the other is by Thornthwaite (1948). Penman's formula is rather complicated and its application depends upon the availability of large number of climatic elements of a station. Thornthwaite's formulae on the other hand enables one to compute the potential evapo-transpiration from the mere knowledge of the mean monthly temperature and the latitude of a station. This formula though has its own limitation (1956) is used widely the world over for estimating the water needs of the irrigated crops. His system of water budgeting (1948), especially the amount of water held in the soil and made available to the plants and its rate of depletion were all modified in the year 1955 when the writer of this paper had been to the Laboratory of Climatology as a Senior Research Scholar. This modified system was used to get the water detention during the wettest and the driest months of the year in India and vicinity (1956). The same method is employed in the present investigation to get the annual run-off and its seasonal march. Calculations that are needed to be made to get the run-off of a station are illustrated in Table I for a few selected stations. Similar computations were made for nearly 300 stations which had records of monthly mean temperatures and precipitations of duration 20 to 30 years or more. In spite of such a large body of data used in the present investigation data from the higher elevations of the Himalayas, the Western Ghats, the Patkai hills and the Arakan Yoma were only a few. This necessitated the extra-polation of the iso-lines in the

mountainous parts of the country in the process of mapping. This extra-polation was affected on the basis that the run-off usually increases with the increase in the elevation due to :—(I) decrease in evapo-transpiration, (II) shallow soil cover and (III) steep gradients. To affect the extra-polation properly a good base map with reliable contours were needed. The Aeronautical Planning Charts from U.S.A. of the scale 1:5,000,000 were used to prepare the present maps. Since maps of such a large scale could not be used for publications, the size was reduced to 1:10,000,000 but sufficient care was taken to preserve as much as possible the details from the larger ones.

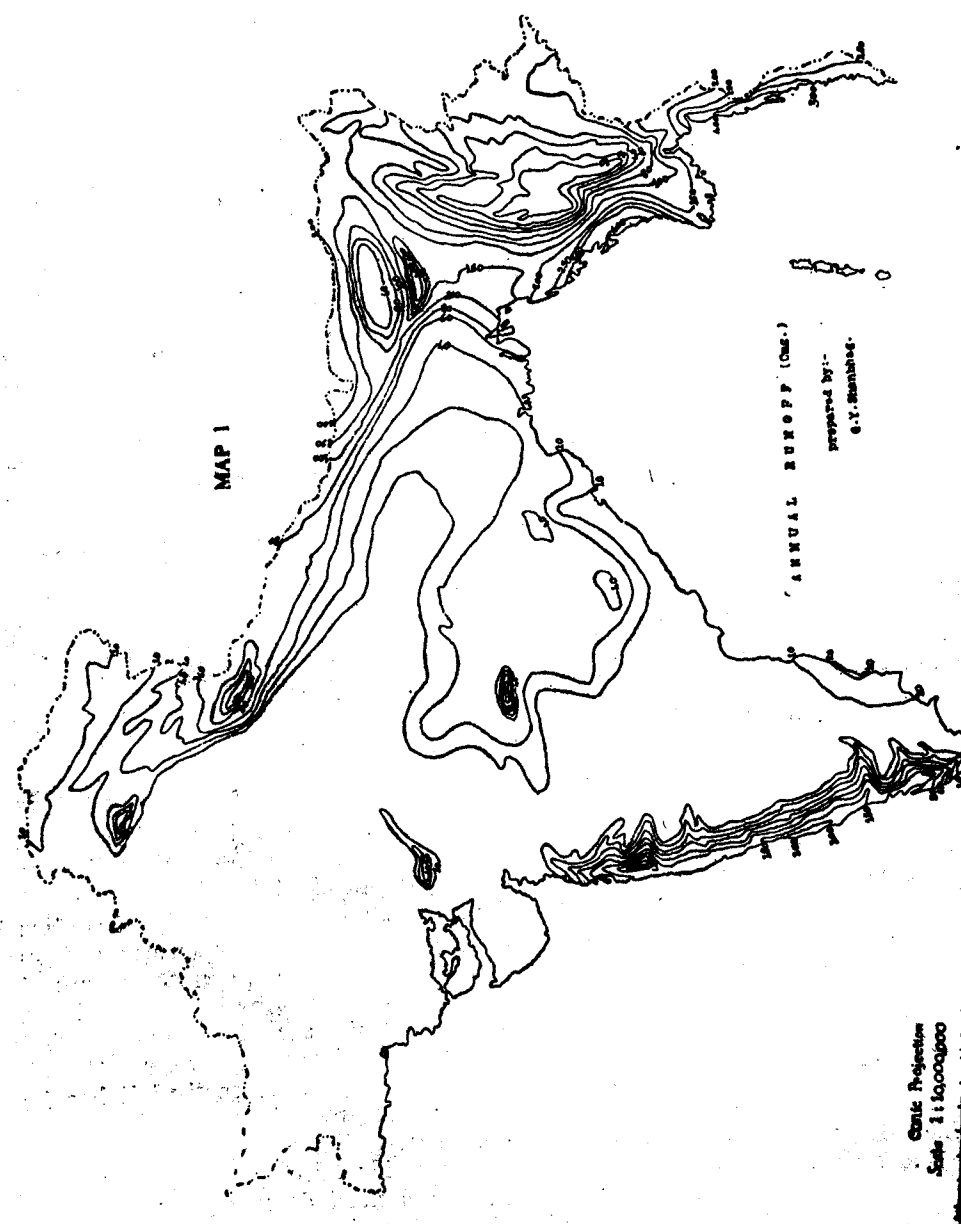
The run-off that is obtained and mapped in the present study is based on certain assumptions that were made by Thornthwaite in the derivation of the formulae for computing the potential evapo-transpiration as well as in the water budgeting procedure. His formulae is fitted to the data of consumptive use of irrigated crops grown in a number of valleys in one part of the world viz. the Western United States in latitudes ranging from 29°N to 43°N. These valleys are practically flat with gentle slope (if any) and are completely covered with soil and crops that absorb all the rain or irrigated water and allow nothing to flow by way of run-off. Both these conditions are hardly found in our mountain regions where we have the greatest rainfall. In these regions the top fertile soil is washed away and we have the bare rocks whose permeability is practically zero. This causes great flash-run-off not at all accounted in the Thornthwaite's system. Even in the case of the low lands the surface run-off during each storm is tremendous because of our peculiar rainfall intensities which almost always exceed the infiltration rates. The evapo-transpiration obtained from Thornthwaite's formulae are for a land fully covered with vegetation and supplied with abundant water at all times. Such conditions occur here only during a limited period of the year viz. the monsoon season. Even in this season the evaporation from the arid and semi-arid regions is less than at the potential rate and for the humid regions it depends upon the frequency and intensity of the rainfall. Lastly the 30 cms. of water which the new system assumes as the field capacity is too much for the majority of our catchments. All these factors separately and jointly cause the actual run-off from the rivers greater than what is obtained in this investigation. Besides these shortcomings in his system of water budgeting there are other defects in his formulae. They are :—(i) the data used in the derivation of his formulae are only general and not scientifically obtained since irrigators do not always know the correct amount of water and the proper time to apply it. The irrigation engineers or the scientists have not yet solved the problem of the time and the amount of water to be supplied by way of irrigation for a successful and abundant crop production. Opinions are divided regarding this point. Some are of the opinion that irrigation water should be applied when the soil moisture falls 50% below the field capacity while others are of the opinion that it should be done when the soil moisture reaches the wilting point. If the first view is correct more water is needed to grow a certain crop on a given soil under given climatic conditions than what would be the case if the latter view holds good. Nothing is known regarding the watering procedure adopted by the irrigators of the valleys in U.S.A. Under such circumstances Thornthwaite's formulae which is fitted to the water-needs of the crops in these valleys is to be used with great caution. His formulae for obtaining the potential evapo-transpiration is based on the correlation with the mean monthly temperature of a station but as has been pointed out by Wijk and De Vries (1954) such a formulae has not sufficient general validity under varying climatic conditions. The formulae, therefore, needs verification but unfortunately data regarding run-off from streams, soil moisture, field capacity, evaporation from free water or from land areas of evapo-transpiration from land areas covered with vegetation are

ANNUAL AND SEASONAL RUN-OFF FROM INDIA AND VICINITY 81

very meagre in India. Available observations of these elements are scattered and are available only for a few occasions or areas. These few observations even are not standardized and processed. Hence we have to content ourselves with figures that are obtained from a formulae deduced from the data of a region whose climatic conditions are quite different from those of ours.

ANNUAL RUN-OFF (MAP I).

In the whole of the country the maximum run-off which works out to be 1008.6 cm. occurs in the Khasi hills. It is rather difficult to represent such a heavy run-off by several lines in close proximity on such a small scale map

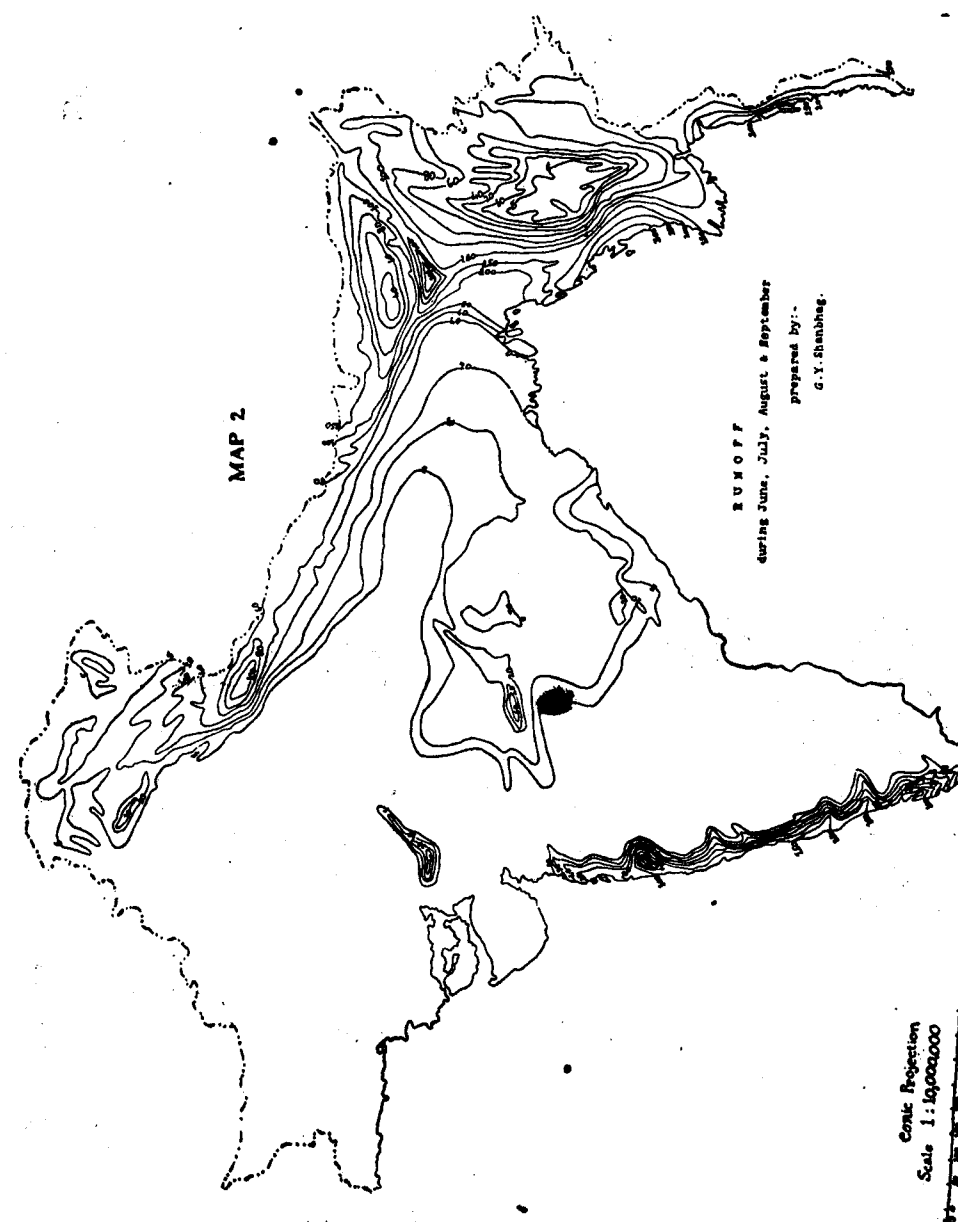


hence only lines upto 300 cms. were drawn in this region. The next region which has run-off of more than 400 cms. occurs in two patches along the South-West coast of Burma. Mahabaleshwar which is the highest peak in the northern tip of the Western Ghats has a run-off of 593.6 cms. Thus the areas of greatest run-off and hence of flood danger lie along the west coast of India as well as of Burma. In the Siwalik hills run-off of more than 150 cms. is found. Another region of appreciable run-off more than 100 cms. is in the Mahadev hills in Central Province. Mount Abu with its elevation of 3930 feet contributes its share of more than 40 cms. for the annual run-off. In the rest of the country, except those mentioned above, there is so little of precipitation that the soil moisture hardly reaches its field capacity not to speak of any run-off. Thus we in India are faced with two severe problems one of fighting the flood and erosion and another of tackling the droughts which are of permanent or semi-permanent types.

SEASONAL MARCH OF RUN-OFF (MAPS 2, 3, 4 AND 5).

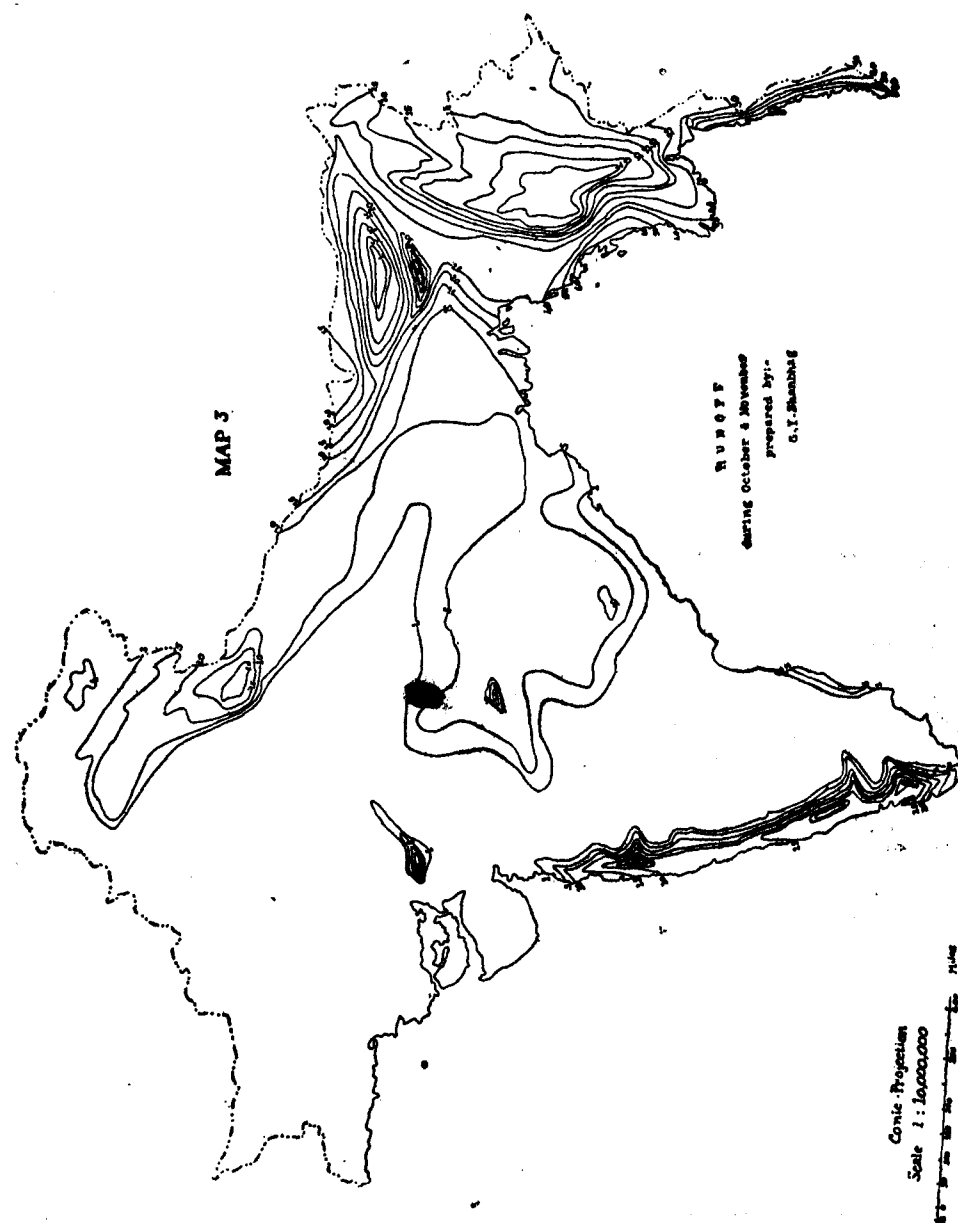
Reference to Maps 2, 3, 4 and 5 reveals to us that the period of maximum rainfall corresponds with the maximum run-off. Nearly 2/3 of the annual run-off of a given place occurs only during the monsoon period except in the South-East of the country where the rainfall during this season is insufficient even to meet the water requirements of the crops. In this area the run-off commences from the post monsoon period and reaches its peak value during the winter season. Barring this part of the country the run-off throughout the rest of the sub-continent decreases as the life giving monsoon season retreats and during the summer months no other parts except the Khasi hills, Barail range, the Arakan Yoma, the Cardamom and Nilgiri hills could provide some water for the rivers to maintain their flow. Thus the tremendous amount of excess water which Nature so generously gives to certain parts of India and vicinity all flows to the ocean within a period of less than five months carrying with it the fertile top soil which contains the subsistence of more than 80% of our population. This leaves behind that little amount of water at some places during the hottest summer month, May, that it is insufficient even for drinking purposes not to speak of any irrigation at all. Thus the pressing task before the Government and the people alike is the conservation of water and soil. Top soil which cannot be stock piled or mined from the depth of the earth or dredged from the floor of the oceans must be preserved at all cost to feed the existing and ever increasing population.

The soil as well as the water could be conserved and its full use could be made only by stabilization of the stream flow. Stabilization of the stream flow means maintaining a more nearly constant and uniform flow than is provided by nature without changing the average or total flow or run-off. This involves on the one hand a reduction of volume and intensity of surface run-off during stream rises and floods especially during the monsoon and an increase of the low water flow during the winter and summer. There are at present three schools which approach this problem on three different lines. The first school belongs mainly to engineers. They are of the opinion that stabilization could best be accomplished by surface storage reservoirs. Though this has been considered as the only practicable, effective method it has its own economic limitations. They are:—(i) there may be many streams on which nature has not provided suitable reservoir sites at desirable locations; (ii) to be economically beneficial it must provide adequate benefits through one or more of the following:—(a) decreased flood damages, (b) increased amount and betterment of grade of hydroelectric energy production, (c) pro-



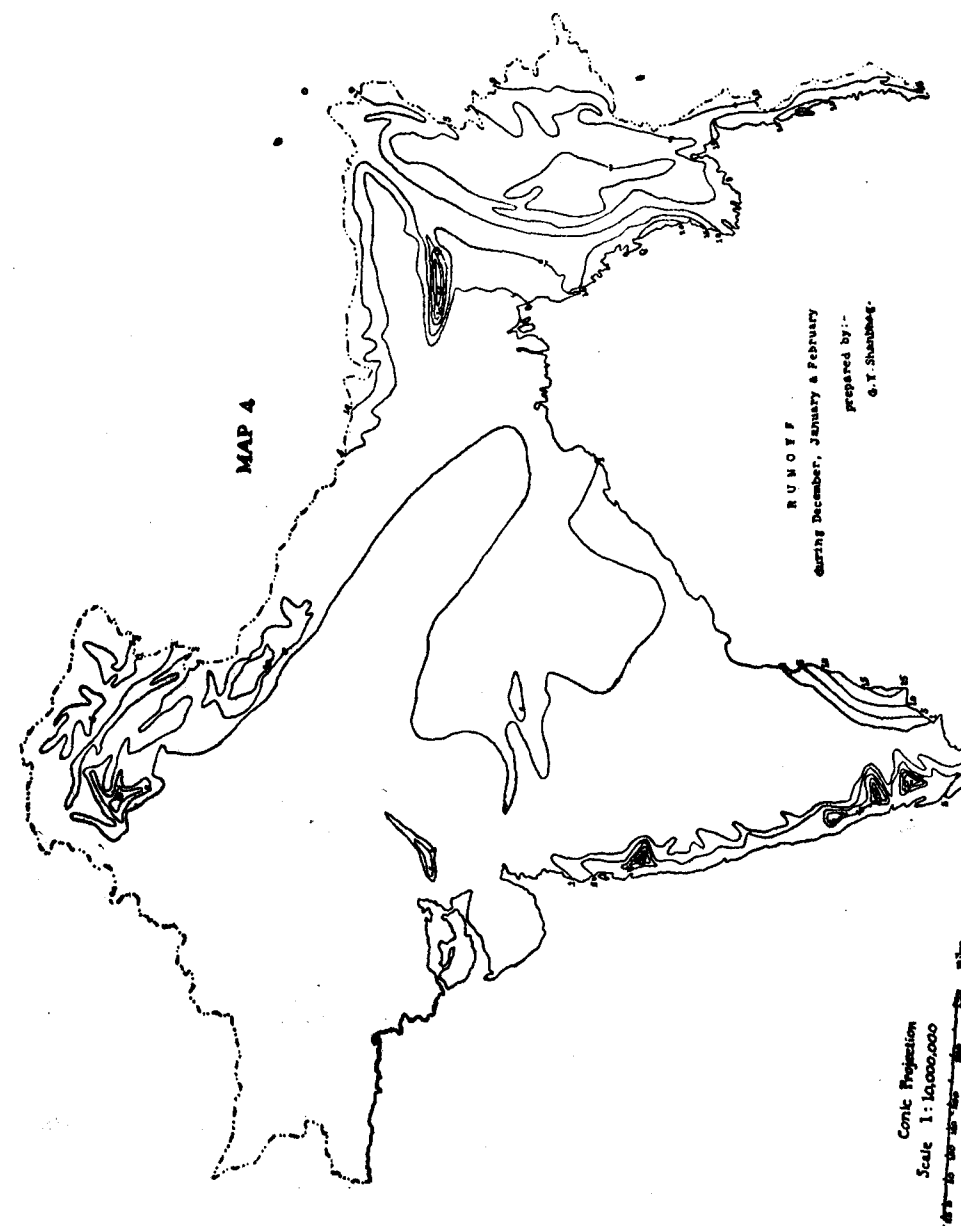
vision of irrigation water, (d) provision of domestic and public water supplies, (e) improvement of streams for navigation, (f) improvement of streams for recreation uses, fisheries, etc.

Among engineers who believe in stream regulation by storage there are two different classes one who hold that reservoirs should be constructed for one purpose only, such as flood control, while others are of the opinion that the same reservoir can be used advantageously to secure different benefits, including flood control and increased water supply for economic purposes. If a reservoir is operated, for example, for flood control only, it may be highly effective in this respect but will provide no other benefits. Multiple purpose



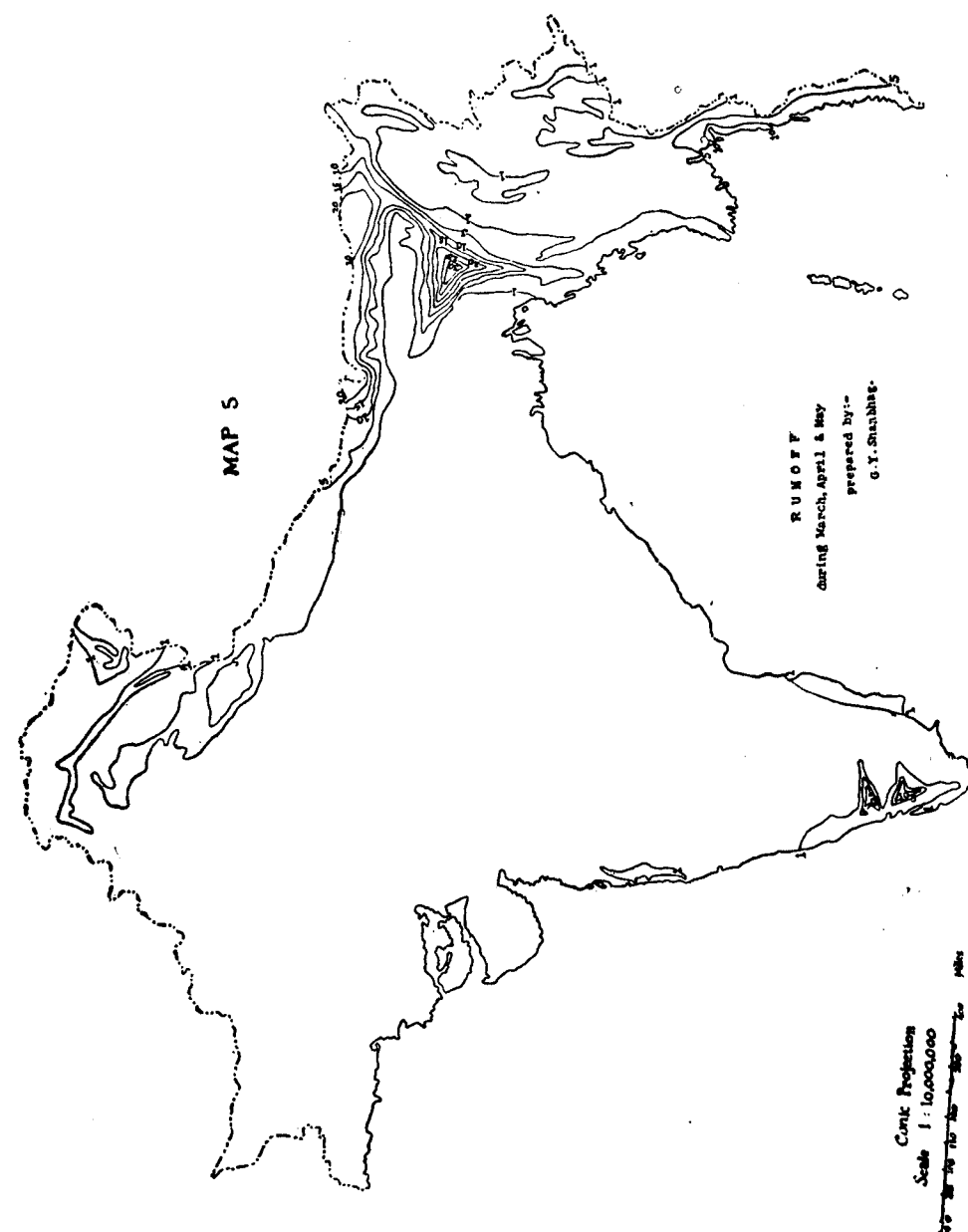
reservoirs, on the other hand, may provide economic benefits through increased low water flow adequate in value to carry all or most of the overhead charges involved, and at the same time produce a reasonable measure of flood control in instances where large expenditures for the latter alone would not be justified. If conservation of water has any meaning at all it does not mean allowing the water to run unvexed to the sea as soon as the flood has passed. On the other hand, it means use of water in its course to the sea for all purposes which it can economically serve.

The second school belongs to the so called conservation enthusiasts, the foresters. They claim that forests are natural stream flow regulators because



of the sponge like action of the forest litter in holding the rain water. They therefore, firmly believe that if forests are maintained in a drainage basin, particularly in the mountainous head water regions, much that is desirable in the way of stream flow regulation can be accomplished, including elimination of floods, and maintenance of adequate, regular, low water flow. Though there is little support for the stream regulation by forests the following facts are, however, well established :—

- (1) Leaf litter is generally so coarse-textured as to have little capillary power to hold water.



(2) If the rain continues for a long time the litter becomes saturated to its capillary capacity and thereafter exerts little or no effect.

(3) Leaf litter, especially that from broad leaved trees get packed when wet and thereafter greatly obstruct the entry of water into the soil.

(4) Experiments conducted by Beall (1934), Burger (1933) and Horton (1919) show conclusively that even after allowing for water that runs down the trunks and so reaching the ground, tree crowns intercept on an average 15 to 25% of the rain-fall (it may be nearly 100% in light showers and smaller in heavy rains). This has virtually the same effect as the reduction of rainfall of the forested region by an amount equal to the loss

by interception, since it is directly evaporated and does not reach the ground. There is also some interception by growing grass, crops and other vegetation besides from trees. Thus any beneficial effect of forests in stabilizing stream flow is accompanied by a serious loss or reduction of total run-off.

(5) Under normal conditions the forest is there because it can get water to maintain its growth, and forest trees are great consumers of water.

In recent years it is recognized that the leaf litter theory of stream stabilization by forests is unsound and the alleged beneficial effects of forests in stream regulation have been credited more generally to:—

(i) That the infiltration capacity of forest soils is greater than that of adjacent cultivated land of similar type. It may be true to some extent for the soil in the forest is undisturbed by cultivation, root, earthworm, insect and other perforation are much more permanent than on cultivated land, the experimental data on this point is not at all existing. There is no question that such perforations are an important factor in relation to infiltration, probably not so much with reference to admitting water as to permitting ready escape of air, since air must escape from the soil as fast as the water enters it.

(ii) The natural irregularities of the soil surface, particularly depressions, which hold water temporarily until it enters the soil by infiltration, are destroyed in the cultivated lands but remain undisturbed in forests. The amount of water held in the depression depends both on the size and number of depressions but when the depressions are few this additional water which enters the soil in the case of forested land may be compensated by the temporarily increase in the capacity of the cultivated land to absorb rain.

(iii) The presence of leaf litter which reduces the velocity of over-land flow, prevents soil erosion and inwash of fine soil particles in the interstices of the soil and so maintains a higher infiltration capacity. This is as a matter of fact compensated by trees and their branches which break the force of rain drops and prevent the packing of the soil surface, with consequent reduction of its infiltration capacity as compared with a cultivated soil directly exposed to the impact of rain.

(iv) The evaporating power of the air under forest cover is less than in the open. This is again a disputed point and experiments conducted by Hide (1954), Kolasew (1941) and Zingg (1952) show that the trees which act as wind breaks increase the rate of evaporation due to higher temperature near the ground caused by poor wind circulation behind the wind breaks. Secondly the plant residue which is added to the soil from time to time conserves heat rather than water and this brings about a higher rate of evaporation (Lemon 1954). In case of the cultivated soils the rate of evaporation from the soil depends upon the amount of water held in the soil. If it is saturated the evaporation rate will be the maximum but as soon as the surface becomes dry evaporation does not take place from the inter-face of soil and air, but a few millimeters below. Hence the water molecules have to diffuse through the dry soil which acts as a "barrier" before being caught and blown away by the prevailing wind. This barrier which increases the path of molecular diffusion, reduces the rate of evaporation (Staple & Lehané 1931; Dept. of Agri. U.S.A. 1949). Thus on the whole the evaporation from a cultivated area will be smaller than a forested area other things being equal.

Thus the differences between the hydrology of a forest-covered and non-forested area, especially if the latter is under cultivation, are too numerous and complicated to be capable of broad generalizations as to the effect on stream regimen. Each locality, every individual plot almost, demands its own individual analysis of the hydrologic cycle. This is what should be borne in mind by those who are responsible in directing a nation's movement and land occupation. A nation like ours which is still quite at the beginning in every field should not overlook the dangers of too early generalization from a few experimental data obtained from a specific set of conditions, to their regional, leave aside the whole country, application where the complex inter-relations between country rock, soil, topography, water and vegetation, not to forget interference with all or any of these factors by man, are never repeated in their entirety from place to place. On the contrary at the same place they change with time through geological happenings, maturing or deterioration of soil, plant succession and evolution, and changes in land occupation. Hence it is of no use to follow the present nation-wide Government Policy of "tree planting" without definitely knowing what we are trying to achieve thereby. If the aim is of water conservation then definitely no benefit is derived from such a policy. If it is for flood and soil erosion then there are other more effective methods which are made clear in the following paragraphs.

The third school in the stabilization of stream flow, reducing the soil erosion and decreasing floods belongs to those who seek some practical methods to increase the infiltration capacity of the soil. It is well known that surface run-off occurs only during rains of intensity exceeding infiltration-capacity. Floods and major variations of stream flow are due mainly to surface run-off. Streams become perennial if, and only if, they are sustained during rainless periods by surface or ground water storage or both. Erosion which is now carrying away the soil at a constantly accelerated rate is, with the exception of certain losses due to wind erosion, directly the result of surface run-off. Hence increasing the infiltration capacity, if it can be accomplished, is therefore a highly effective method in controlling all the havoc of water. Besides these it benefits agriculturists by increasing the volume of available soil moisture and thus reducing the amount of water to be supplied to the fields by way of irrigation.

There are several possible methods of increasing the rate and amount of infiltration. Every soil has a fairly definite minimum infiltration capacity. This minimum occurs due to the swelling of the colloidal material when the soil gets wet for a long time and also due to the closing of large openings such as insect, earth-worm and root perforations by inwashing of fine materials. This minimum infiltration capacity cannot be increased permanently unless the texture or structure is changed. A considerable increase of infiltration capacity of the surface soil can, however, be attained on cultivated lands by keeping the soil in good tilth and cultivating promptly when the soil surface has become rain packed or sun-baked. A loose mealy cultivated soil usually has an infiltration capacity equal to or greater than the highest rainfall intensities, ordinarily occurring but this benefit lasts only a short time during heavy rain owing to rain-packing and inwashing of fine materials into the soil pores. There are other limitations in the method of increasing the infiltration capacity by cultivation. They are :—(a) the infiltration capacity of such a soil cannot reach to a depth greater than the depth of cultivation. If this does not supply sufficient storage capacity to absorb all the water from a given storm, the excess will be absorbed only at a rate corresponding to the lower infiltration

capacity below the depth of cultivation ; (b) it breaks the large openings—earth-worm, insect and root perforations which are highly effective in permitting the escape of air during infiltration ; (c) this method is not applicable to forest or grass covered lands.

Other methods whereby the infiltration capacity could be increased are as follows :—

(1) Ploughing the land and thus providing large depression storage between furrows and increasing the surface area exposed to rain.

(2) Increasing the depression storage by constructing small or big dikes. Strip cropping is a simple and effective means of not only increasing the depression storage but also cuts down the overland flow in such a manner as to reduce or eliminate soil erosion.

(3) Decreasing the rate of overland flow by reducing the slope or increasing the length of the flow. This could be effectively accomplished by suitable level terracing.

(4) Allowing grass and close-growing grain crops to flourish on the water-shed. Experiments have shown that the surface run-off is less from a grass-covered area than from a similar area under cultivation. Several reasons are assigned for this, one being a higher and better-sustained infiltration capacity on the grass-covered area due to long sustained existence of root, earth-worm and insect perforations and the prevention of inwashing by the grass mat. These factors no doubt reduce the surface run-off but the most important reason appears to be the increased resistance and decreased velocity of flow due to subdivision of the flow by the stems and leaves.

Thus all those methods which increase the non-capillary porosity of the soil and make the water remain on land for a longer time do bring about greater rate and amount of infiltration provided there are no hard pans underneath the top soil.

The impression gained from these pages that increasing the infiltration capacity of the soil is a guarantee against floods, low water stages or irregular water supplies, cannot be true under all conditions. After all, the water in the streams is derived from rain and snow and these are bestowed with great irregularity as to time, place and amount and often in excess of the capacity of the soil to control the run-off. All man can do is to take advantage of the opportunities to turn them to the best possible use with means best suited to the locality.

At present it is believed that the flood control is in the field of engineering. Certain unavoidable short comings of flood control engineering works should not be overlooked. They fall short in affording protection to the people living on the myriads of smaller streams and tributaries. They accomplish nothing towards soil preservation.

Smaller floods, even those in small streams and brooks, do their proportionate share of damage, and make up in numbers throughout the nation what they lack in size or spectacle. They contribute to the destruction of crops or valley bottom land, the washing out of rural roads and bridges, the damage to towns and homesteads and numerous other consequences. They thus are a source of tremendous loss to the communities affected, and such losses in the aggregate, over the years, may equal or exceed the

TABLE I—contd.

AKYAB													
Temp. °C	21.0	22.5	25.7	28.4	28.8	27.5	27.0	26.9	27.6	27.5	25.3	22.1	
Monthly heat index	8.8	9.8	11.9	13.9	14.2	13.2	12.8	12.8	13.3	13.2	11.6	9.0	
Unadj. Pot. Evapo.	6.0	7.7	12.3	15.1	15.4	14.4	13.9	13.9	14.5	14.4	11.9	7.2	
Adj. Pot. Evapo.	5.7	6.9	12.7	15.9	17.4	16.0	15.8	15.4	14.8	14.4	11.1	6.8	152.9
Precipitation	0.2	0.4	1.0	5.0	39.1	115.1	139.9	113.4	57.7	28.6	13.0	1.9	515.3
Difference	-5.5	-6.5	-11.7	-10.9	21.7	99.1	124.1	98.0	42.9	14.2	1.9	-4.9	
Storage change	-4.3	-4.2	-5.5	-3.5	21.7	0.4	—	—	—	—	—	-4.6	
Soil Moist. Storage	21.1	16.9	11.4	7.9	29.6	30.0	30.0	30.0	30.0	30.0	30.0	25.4	
Actual Evapo.	4.5	4.6	6.5	8.5	17.4	16.0	15.8	15.4	14.8	14.4	11.1	6.5	135.5
Water Deficiency	1.2	2.3	6.2	7.4	—	—	—	—	—	—	—	0.3	17.4
Water Surplus	—	—	—	—	—	98.7	124.1	98.0	42.9	14.2	1.9	—	379.8
Run-off	5.4	2.6	1.4	0.6	0.4	49.6	86.8	92.4	67.6	40.9	21.4	10.7	379.8

TABLE I—contd.

NEGAPATAM													
Temp. °C	24.7	26.1	27.5	30.0	31.7	31.4	30.6	29.7	29.4	27.8	26.1	25.0	
Monthly heat index	11.2	12.2	13.2	15.1	16.4	16.2	15.5	14.8	14.6	13.4	12.2	11.4	
Unadj. Pot. Evapo.	10.0	12.7	14.4	16.2	17.1	17.0	16.5	16.0	15.8	14.7	12.7	10.6	
Adj. Pot. Evapo.	9.9	15.6	14.8	16.7	18.6	18.0	18.0	17.1	16.1	15.0	12.3	10.5	182.6
Precipitation	4.1	2.0	0.8	1.8	4.8	3.8	4.8	8.9	9.4	25.9	31.2	27.7	125.2
Difference	-5.8	-13.6	-14.0	-14.9	-13.8	-14.2	-13.2	-8.2	-6.7	10.9	18.9	17.2	
Storage change	-5.3	-9.1	-5.8	-3.9	-2.2	-1.4	-0.8	-0.4	-0.2	10.9	18.2	17.2	
Soil Moist. Storage	24.7	15.6	9.8	5.9	3.7	2.3	1.5	1.1	0.9	11.8	30.0	30.0	
Actual Evapo.	9.4	11.1	6.6	5.7	7.0	5.2	5.6	9.3	9.6	15.0	12.3	10.5	107.3
Water Deficiency	0.5	4.5	8.2	11.0	11.6	12.8	12.4	7.8	6.5	—	—	—	75.3
Water Surplus	—	—	—	—	—	—	—	—	—	—	0.7	17.2	17.9
Run-off	4.4	2.2	1.1	0.5	0.3	0.2	0.1	—	—	—	0.3	8.8	17.9

EFFECT OF TRIBAL AND CASTE FACTOR ON RURAL SETTLEMENTS IN UTTAR PRADESH

EVOLUTION AND IMPORTANCE OF CASTE SYSTEM

By

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Caste is the very basis of India's life and culture. No other social institution is as powerful as the institution of caste towards the development of material, moral and intellectual ideas of the Indian people. The Indian Society is split up into innumerable self contained divisions in which each caste leads its own life with its distinct profession, idealogies, code of ethics and behaviour. Indian society is an intricate fabric of varied texture formed by the different types of castes. In the villages and the cities, among the educated and the illiterate, among the rich and the poor alike, caste is all powerful and no one dares to break away from the caste regulations. Men of the same caste are closely bound together by common traditions and beliefs. Their communion is exhibited in the form of their common living quarters whether in the cities or in the villages. In all matters men of the same caste come closer and work in harmony. The Aryan infiltration into the Sindhu-Ganga Plain from the north western passes and their contact with the indigenous population, resulted in diffusion, absorption and assimilation between these two groups of humanity—the new comers and the old indigenous inhabitants. The Vedic Aryans were a casteless people and the system of caste evolved only after sufficient physical and cultural inter-course between the two had taken place. In fact the caste system was a result of the synthesis of two dissimilar physical and cultural groups. The tribes and the clans into which the Aryan society was divided, came gradually to be replaced by caste groups. Besides the hill and forest aboriginals of central, southern, and eastern India, tribal organisation among others is hardly discernible and even in the case of certain tribal castes like the Jats, Gujars, and Ahirs, who have Indo-Aryan physical features; Tharus and Bhoksas who have Mongoloid features; and Dom, Bhars, Pasis and Kanjars, who have Dravidian features, the tribal character has been eliminated by the more powerful caste features like endogamy and non-admittance of aliens into the caste fold. Caste organisation is distinct from tribal organisation. "A tribe is not a close corporation like a caste; it admits aliens who are willing to throw in their lot with it, specially women obtained by purchase or capture. It is not necessarily endogamous. A caste is a endogamous group or collection of groups bearing a common name, membership of which is hereditary, arising from birth alone, imposing on its members certain restrictions in the matter of social inter-course, either following a common traditional occupation or claiming such origin and generally regarded as forming a single homogenous community".¹ These words of Blunt draw a clear line of distinction between the caste and the tribe. Distinct from the above mentioned tribal castes, having some bloodkinship, there are the occupational castes like the Chamars, or the leather workers, the Kurmis, or the intensive farmers, who form aggregations of people of different origin bound today by common

traditions and functions. Same is true of other castes who do not have blood affiliations except in the case of tribal castes. Everywhere in India for thousands of years tribes and clans were gradually and insensibly turned into castes, and although the way in which this transformation took place is difficult to trace, yet one thing remains certain and that is function or occupation must have been the basis of this transformation. With the increasing complexity in the material culture and the economic structure of the Indian people, the whole population came to be split into innumerable functional groups. The Aryans who were originally a pastoral people, and were grouped into tribes, must have been later on grouped into pastoral castes, like the Gujars and Ahirs, priestly castes like Brahman, agricultural castes like Jat, Lodh, Ahir, Kurmi, Murao; artisan castes like Teli, Kumbhar, Lohar, Barhai, Kori, Luniya and others; serving castes like Bhangi, Dhobi, Nai, Kahar and Chamar and the fishing castes like Bhind, Mallah, Kewat and Dhimar. It was at the same time not necessary that the Aryans alone had the privilege of being grouped into superior castes; even the non-Aryans and the hybrid-Aryans also by certain actions acquired the privilege of being included into higher caste folds. Long before the formation of the complicated and varied caste groups, there formed new groups, as a result of Aryan and Dravidian contact. Out of these new groups evolved both the higher and the lower castes. It will be untrue to say that the Dravidians alone became the low castes, for the Chamars who are today in the lowest rung of Hindu society, do not necessarily exhibit Dravidian features. Some of the Chamars, particularly their women-folk show remarkable Aryan physical features. In India therefore, the physical types do not conform with the social types and the socially debased is not necessarily the physically primitive. Except in the case of certain tribal castes like Jats, Gujars, Ahirs etc. who show Aryan features, and the Bhar, Pasi, Dom, Kanjar, Musahar and Habura who show non-Aryan features, the bulk of the castes exhibit a wide variety of physical features.

CASTE COMPOSITION OF RURAL POPULATION

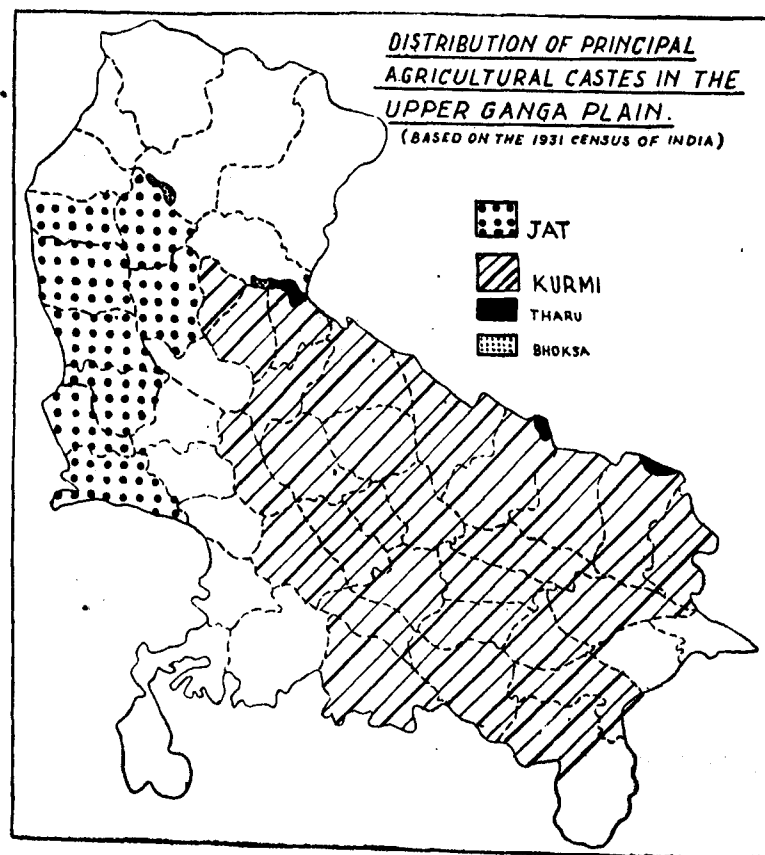
Rural habitations in the Upper Ganga Plain, (Uttar Pradesh) nay everywhere in India, are inhabited by agricultural castes. Rural habitations perform certain functions of which the agricultural function is the predominant. Besides the agricultural function, other rural functions are fishing in the case of the villages that are located near water surfaces, trading and rural crafts, all being subservient to the needs of the peasantry. So that besides the agricultural castes who form the bulk of the rural population, there are agricultural labour castes, who also form a large section of the rural population, village artisan castes, the trading caste and other miscellaneous castes whose number and variety largely depend upon the location, type and size of the village. Generally, larger is the village, more varied are the castes, living in the village, catering to the varied needs of the village community. It is at the same time not uncommon to come across villages and hamlets inhabited exclusively by the members of only one caste.

CASTE AND TYPES OF RURAL SETTLEMENT

The pervasive influence of the caste is evident in the rural habitation in the Upper Ganga Plain. Caste factor has affected the village communities in various ways. Dispersal and agglomeration of habitations, besides being controlled by physical factors is also to a very great extent, due to caste factors. It can generally be said that the agglomerated habitations are associated with extensive farming and the dispersed habitations are associated

¹ E. A. H. Blunt, *Caste System or Northern India*, p. 5.

with intensive farming. Jats, Rajputs, Ahars, and Lodhs who are extensive farmers, prefer to live close together in large agglomerated habitations and not necessarily close to their farms. These extensive farming castes are distributed in the western part of the Upper Ganga Plain in Muzaffarnagar, Meerut, Bulandshahr, Aligarh, Agra, Etah, Mainpuri and such other districts,



where the habitations are comparatively of larger size and are also agglomerated. The Jat or the Rajput villages are invariably agglomerated and for the sake of security they prefer to live together. Such is not the case in the central and eastern parts where due to the preponderance of intensive farmers like the Kurmi, Koeri, Kachhi, Murao and others, the habitations are diffused rather than compact. Because of their close devotion to their fields and crops and their intensive and careful methods of farming, they choose to live nearer their fields rather than nearer each other. For example, in the Bhadohi area of Banaras district, dispersed type of rural settlements can be ascribed to the predominance of expert intensive cultivating castes like Kurmis and Koeris who prefer to live in isolated single house or a group of houses nearer their fields. Not far from this area, farther east in the Jalhupur pargana of the same district, villages are agglomerated and compact because of the presence of higher castes, like Brahmans and Thakurs who besides being careless cultivators, prefer to live nearer each other for the sake of security.

LOW CASTE SUBURBS OF VILLAGES

In the Avadh, the Eastern and the Trans-Ghagra Tracts, habitations give a complete impression of scattering because of another form of caste control. Here the idea of dispersal is all the more heightened by the fact, that, the higher castes, who are owners of land but are not necessarily its cultivators, live in a central site, with its satellite habitations, occupied by the lower castes like Chamars, Pasis and Binds who supply the very necessary agricultural labour. These appendage habitations known as 'tolas' located within a furlong or two of the principal habitation, make the general pattern of rural habitation dispersed. The eastern orthodoxy and conservatism cannot tolerate the untouchables living near them. A sort of apartheid or social segregation has, therefore, been resorted to, and these unfortunate untouchables are made to live at a respectable distance from their more fortunate brethren, who because of their higher social status, enjoy certain special privileges. From a central habitation, therefore as one looks round, his eyes move over the surrounding, miserably looking small clusters of houses called the 'Bindtol', 'Chamtol' and 'Pastol' as the case may be. Such residential arrangement is necessitated by the dependence of higher, non-agricultural castes on the lower castes whose labour is needed not only for agricultural operations but also for many other odd errands. These untouchables and the depressed, in spite of their numerical superiority and their indispensibility as well, in the form of agrarian labour, have been made to live a sub-human life of poverty, misery and squalor destined by religious and age old tyranny of social customs and traditions. Examples of such suburbs of villages are numerous in the Banaras, Jaunpur, Ballia, Ghazipur, and Gorkhpur districts. In the Chandauli tehsil of Banaras district, Kharan is a large village of Thakurs with its satellite low caste habitations of Chamars and Binds. The central village, with its two tols, has a population of about 1,500 persons. The tols hardly contain more than fifty families and therefore consist of not more than fifty to sixty houses. Senapur is a similar rural habitation of Raghubansi Thakurs, in the Dobhi area of Jaunpur district, with some 2,000 persons including those of the three attached chamtols and a small hamlet of 160 Luniyas or the salt workers.

CASTE HAMLETS

Besides these hamlets of the depressed castes, every large village generally has its attached hamlets of specialized castes, who because of greater convenience as well as of scarcity of living space in the main village, because of increase of population, left it and established separate hamlets not far from the parent village. So much so, with increased population through the ages, such hamlets have multiplied, ultimately making the rural habitations, dispersed. They bear either caste names or the names of individuals who might have taken the initiative of founding the new habitation. Such hamlets are more numerous in the Avadh and the eastern part of the Upper Ganga Plain than in the western part. These attached hamlets are generally known as 'purwas' and consist either of a single caste or more than one caste. In the Maharajganj tehsil of Gorakhpur district, the main village of Amurtia, consisting of Ahirs, Kurmis and Brahmans, has several attached caste hamlets. These are Amurtia Bazar of Banias and hamlets of Pasis, Kewats and Chamars. With the exception of Amurtia Bazar, which is a large village of some six hundred persons, others have an average population of one hundred and fifty persons. They are hardly a furlong or so from each other. Similarly in the Rae-Bareilly district, the main village of Bathua on the southern side of river

Sai, with a population of seventeen hundred, has three caste hamlets, of Purwa—Parimal of 125 Ahirs, Purwa Khala of 200 Kurmis and Purwa Ganga of some 60 Kurmis. Gulupur, situated on the Lucknow-Rae-Bareilly line of northern railway, is a village of moderate size of Ahirs, Chamars and Pasis and a few houses of Chauhans. It has a population of some 500 persons excluding its seven purwas or hamlets of (1) Hajinpur of 100 Ahirs, Pasis and Gadhadias, (2) Purwa Parshad Ahir of 100 persons, (3) Purwa Narayan Sukul of 100 Brahmans, (4) Baida Purwa of 100 Ahirs, (5) Chattu Ahir Purwa of 100 Ahirs, (6) Purwa Baldi of again some 50 Ahirs and (7) Purwa Luniya of 200 persons.

Such caste villages are named either on the basis of the predominant caste or names of individuals. Caste names of villages naturally indicate, the presence of the members of that particular caste in the particular village or in the neighbouring areas. Thus in a district like Rae-Bareilly where Ahirs are in overwhelming numbers, most of the village names, particularly of the smaller villages, bear the caste names or names of individual with caste surnames. Thus a village is named Purwa Ahir or Purwa Chattu Ahir as mentioned above.

FUNCTIONAL CONTROL OF DISTRIBUTION OF CASTE VILLAGES AND HAMLETS

Certain castes prefer to live in certain areas, useful from the point of view of their vocation. Thus Ahirs, Gadadias and Gujars who greatly depend upon their animals, choose to live in those areas where pasturage for their animals is available. This is amply evident from the following rural proverb, "Ahir, Gadadia, Gujar; Yen Tinon Chahen Ujar," meaning thereby Ahir, Gadadia, and Gujar castes have a liking for woodland. Thus the rural habitations, located along the rivers or in scrub and partly wooded areas or the hilly tracts are generally inhabited by either of these castes.

There are numerous Gujar villages in the forested areas of Bijnor and Garhwal districts as well as in the Yamuna Khadar of Saharanpur, Muzaffarnagar, Meerut and Bulandshahr districts. In the Banaras district, the riverine villages along the Ganga are mostly occupied by the Ahirs. Ahirs, villages are also very common on large islands of the river Ghagra, located above the flood level. The wide bed of the above river near Faizabad, is dotted with innumerable collections of temporary as well as permanent huts mostly inhabited by Ahirs. Some of the Ahir habitations here are, Ghaman Ahir Pura, Balwant Ahir Pura, Mithu Ahir Pura, Pura Hathu Ahir¹ and there are many others lying between Golaghat of Ayodhya and Miranghat of Faizabad. Again in the Bara Banki and Gonda districts on large islands in between the twisted arms of the Ghagra, about ninety percent of the hamlets belong to the Ahirs. Such examples can be multiplied. Like the Ahirs, Gadadias, who generally keep smaller animals, also prefer to live in the riverine and such other tracts where pasturage for their animals is available. Gadadia villages are common on the Yamuna riverine tract.

Fishing castes like the Mallahas, Kewats, Bindis and Dhimars prefer to live near water surfaces; rivers, lakes or big tanks which generally form the sources of fish. Thus the riverine and lake villages are mostly occupied by

1. Topographical sheet No. 68-J
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the above castes. During the days of river transportation, Mallahas were very active along all the navigable rivers like the Ganga, Yamuna and Ghagra and although their trade has now declined with the development of railways and roads and fall in the water level of rivers because of canalisation, there has been very little change in the distribution and location of such caste villages. Loosing their original occupation, they took to cultivation of riverine land. These castes are more numerous in the Eastern and Trans-Ghagra tracts where there are large jhils and lakes. Thus all along the Ramgarh and Nadortol of Gorakhpur district, there are numerous Kewat and Mallah villages and hamlets. Bhagta, Siktaur, Baghagara and Narahi with an average population of 200 persons, are excellent examples of Kewat and Mallah villages along the Ramgarhtal of Gorakhpur district. Sarai Mohana, on the confluence of Varuna and Ganga, Sinahia, Gobardhanpur and Kurhwa nearest to the river front in the large island formed by the arms of the Ganga in the Banaras district, and Patna at the junction of Ganga and Gomti in Ghazipur district, are other examples of Mallah villages along rivers. Sarai Mohana is a geographical name, it means the village on the confluence. It is a small village situated on the high kankar bank of Ganga within the sight of Banaras city. The bank is some 20' above the normal water level of the river. The external features of the village tell the story of its inhabitants. Below on the water front several small boats lie anchoring. Above, in front of the houses, nets and other appliances of fishermen are kept in readiness. Fishing is the popular occupation in the village, the active season being the rainy season. Winter is a dull season and during this period, they busy themselves in making nets, preparing grass mattresses and doing such other odd jobs. Some mallah families have readily taken to the making of Banarasi sarees. At first it appears to be an anachronism that the mallah has picked up the Kori's trade; but this is because of the proximity of Banaras, the great centre of silk weaving, where this profession is successfully pursued even by non-weaving castes. Very little cultivation is done by the inhabitants of Sarai Mohana and they either catch and sell fish in the great urban market of Banaras, prepare sundry goods sold at Banaras or weave fine Banarasi Sarees which are in great demand all over the country. Strictly speaking Sarai Mohana is not a rural habitation, yet it is a typical example of a habitation other than urban, performing certain specialised functions under the influence of caste and its location in relation to a large urban agglomeration.

THE BHOKSA HABITATION

Another manifestation of Tribal and caste control of rural habitation is that of the Bhoksa village on the border of Bijnor and Garhwal districts. Laldhang, Dhakia and Bawansarai, visited and studied on the spot by the author are some of the typical Bhoksa villages, distinct from the villages of other castes living in the same area. The Bhoksa tribe is akin to the Tharu, inhabiting the Terai and Bhabar tracts between the Ganga and Ramganga and Ramganga and Sarada rivers. Everywhere the Bhoksa house type and the village type are the same. Villages are generally very small, the total population not exceeding two or three hundred persons. Houses are built on both the sides of a straight street, running always in a north-south direction. The villages are long and are oriented north-south. The street is of considerable width some 40' to 50' and is kept clean. Huts are placed end to end with intervals after every group of three or four houses. The walls are either made of fine local clay or wattle and the roofs are thatched with the local bhabar grass. The thatched roof with two sides, comes down very low in order to keep away the heavy showers entering the rooms. Houses are windowless, but there are two doors facing each other in the east and west,

opening on long verandahs on both the sides of the house. Verandahs facing the common street have bamboo or wooden fencing for keeping away the domestic animals. The rows of houses are placed considerably high above the general level of the ground. The whole village gives an impression of a tribal camp. Distinction of the Bhoksa village therefore, is due to the tribal factor, its traditions and modes of adaptation to the environmental conditions, and not so much due to direct environmental control.

THE CASTE QUARTERS WITHIN THE VILLAGE

There are not only caste villages, but within a large village itself there are separate caste quarters. This is true both of the conservative and orthodox rural habitations, as well as of the progressive and tolerant urban agglomerations, where the whole city or the town is generally divided into a large number of caste quarters. Caste affiliation and homogeneity are so strong that in all large and old villages in the whole of the Upper Ganga Plain, a particular caste lives in a particular part of the village. In the Ghatampur tehsil of Kanpur district, the large village of Bhadras or Bhadrapur with a total population of 1,300, majority of whom are Brahmans, is generally divided into three distinct caste quarters, viz., (1) Kaithana or the Kyasth quarter towards north-east with shops, schools and a library. (2) Pariana or the Pandey quarter in the west with a girl's school, post office and panchayat ghar and (3) Dubiana or the Dubey quarters towards the south. Similarly the village of Jagner in the Agra district, with a total population of 3,901 (1951 census) is divided into at least three caste quarters. Along the main market, towards north, there is the Vaish quarter with finely built stone houses, towards north-east is the Brahman and Thakur quarter with poor and dilapidated houses and towards south-west is the quarter of the mixed low castes of Gadadia, Kori, Muslims and Chamars. In the western part of the Upper Ganga Plain where the untouchables are not subjected to as much harsh treatment as in the east, they are allowed to live within the village premises but in a separate corner. In the village of Mondari Sidarpur in the Sahaswan tehsil of Badaun district, the Ahars who are in majority, occupy the central portion of the village, the Chamars are confined to the north and Gadadias towards south and the Kanjars who are considered to be very unclean, are made to live farther towards south, slightly detached from the main habitation and adjacent to the bank of river Mahawa. The large tehsil town of Chhata with a population of 7,514 (1951 Census) in the Mathura district, is also divided into a number of caste quarters. Nearest to the main market adjacent to the tehsil office, lives the Vaish community, and towards east and south-east is the Thakur quarter. Jats live towards north-east and Brahmans occupy the central part of the township. Chamars, Bhangis, Khatiks and Koris are scattered on the outskirts; whereas the Muslims occupy the north-western portion at the back of tehsil office and boundary. Such examples can be multiplied.

CASTE BELIEFS AND RURAL ARCHITECTURE

Caste customs and beliefs also to a great extent, control the rural architecture and the direction and orientation of doors etc. In the case of the Muslim village, there is provision for purdah and the houses are so placed in relation to each other as to ensure maximum seclusion of women. Contrary to the general practice, houses face the wrong way and the main entrance of the house instead of opening on the thoroughfare of the village, is placed on some blind lane, through which no one other than the inmates of the house or a group of houses move about. In Baibalpur, a village of some

300 Sheikh Muslims in the Badaun district, the village streets are lined with the back portion of the houses. The main entrance of the house is placed at such a position as to keep away the women folk from the eyes of the stranger. The door does not directly lead into the house, but through a gallery or a sitting room meant for the male members. Somewhat similar is the arrangement in the case of the houses of some of the Hindu castes, who also observe strict purdah. The Thakur house generally has similar arrangement of doors and gallery as in the Muslims' houses. Such is not the arrangement in the houses of Hindu castes, like, the Kurmis, Murao and Kachhi and others who are not particular about the seclusion of their women-folk.

As regards the orientation of the Muslim houses, there is no particular direction in which the house may be placed, but as far as possible, the back of the house is generally towards the west—the sacred direction of KABA. As is the orientation of the place of worship, the mosque or the Idgah; so is the orientation of the place for living, the house.

In the case of Hindu houses, all directions are auspicious except the southern side, which belong to YAMA, the lord of death. The entrance of the house is seldom placed towards the south, whereas the east,—the direction from which the first effulgent light comes, is always preferred. Orientation of the Bhoksa house and village as previously referred, is also controlled by caste beliefs. The Bhoksa village has invariably a north-south direction and each house has east-west opening with one door on each side. As I enquired into this unusual social phenomenon, I was told by an elderly Bhoksa himself, that they have evolved this arrangement because of their veneration for the Sun god. While the Sun is on the eastern horizon, all dirty waters etc. are thrown towards the west by the western door and *vice versa*. The Bhoksa house and the village differ from those of the other castes in more than one respect but two features in them are most conspicuous viz., first the north-south orientation of the village and secondly the east-west openings in each house in conformation with their religious ideas and beliefs.

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JAT SETTLEMENTS AND HABITATIONS

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INTRODUCTION

The study of settlements is also the study of human reactions to the environmental factors for settlement as the most important element in the regional landscape is the product of an adjustment between social forces and the physical conditions of the habitat. In social forces are to be included such inter-related factors as the history of the area, the customs, the tribes that inhabit the area and their social organisations, each of which has a direct or indirect influence on the settlement of the area. The physical conditions of the habitat include such geographical elements as topography, soil, water-supply and other conditions which are beyond the control of human beings whether acting individually or in social groups. In this paper the author has attempted to describe the settlements and habitations of the Jats and analyse the social and physical factors influencing these.

DISTRIBUTION OF JATS

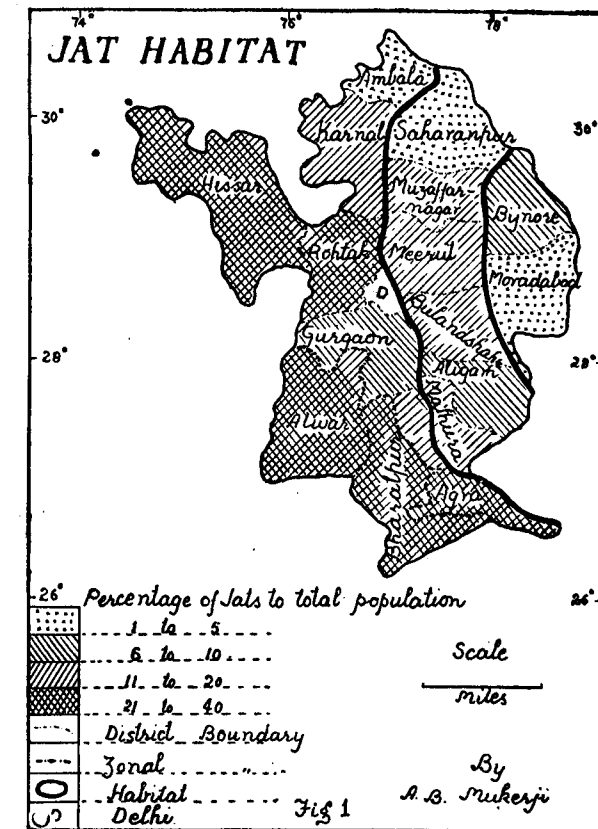
The historical geography of the Jats proves it conclusively that the habitat of the Jats have undergone spatial changes through different periods in their history. Jats are chiefly found in Punjab, Sind, Western Rajputana, Malwa and Upper Doab in Uttar Pradesh. In Bikaner, Jaisalmer and Marwar where they, probably equal in numbers all the Rajput races put together, the Jats remain as the remnants of an once prosperous and powerful tribe. The Upper Doab valley between Ganges and Jumna rivers contain as many as 6 lakhs Jats spread over in Dehra Dun, Saharanpur, Muzaffernagar, Meerut, Bulandshahr, Aligarh, Mathura, Agra, Manipuri and Etah districts. In Moradabad and Bijnor also their number is quite significant being nearly 80 thousand. The two distinct strongholds of the Jats in Upper Doab and south-western Uttar Pradesh are Meerut and Muttra, the former having a Jat population of nearly 1 lakh 70 thousand and the latter, of nearly 1 lakh 24 thousand. Outside the Jat habitat hugs the Gangetic Valley itself as Bijnor and Moradabad districts both are contiguous with the main river. In south-eastern Punjab the two most important Jat districts are Hissar and Rohtak with Jat populations of 1 lakh 85 thousand and 2 lakh 62 thousand respectively. The total Jat population of Punjab is nearly 8 lakhs.

HABITAT

The present Jat habitat includes Malwa plateau, Upper Doab Valley and the districts of eastern and southern and south-eastern Punjab which are contiguous with the river Jumna and stretching in a belt trending north-south. (Fig. 1)

DIVISIONS

The habitat has three zones or belts, the eastern inhabited mostly by Hindu Jats, the central by Sikh Jats and the western by Muslim Jats. Th



influence of religion operating through social culture has thus effected different patterns in the three different zones of the habitat. The Eastern zone again has two parts, the sugar-cane belt of Upper Doab in Uttar Pradesh and trans-Jumna Valley of south-eastern Punjab and the second part comprises the cereal and coarse-grain producing districts of Agra, Muttra, northern Madhya Bharat and north-western Rajasthan.

DIFFERENCES

The habitat and economy of the Jats are different in these two areas. Since Jats in both these areas have had the same origin, it seems quite logical to conclude that any changes that the group underwent resulting in differences must have been effected by the difference in the habitats themselves. The ethnography remains the same but the basis of economy resulting from the habitat-reaction is different. Not only the habitats but the patterns of historical circumstances and the contexts of the cultural mileus were different effecting a difference between the two types of economies and cultural patterns. It is clear that the northern habitat existing in close proximity to the master society of Delhi school of culture and Upper Doab way of economy was influenced and affected to a greater degree than the one which was far removed from it.

In the northern habitat the outstanding factor is the control of the cultural landscape and other items of material environment which are the creation of Man, but in the southern habitat the natural landscape is the

controlling factor for here Man has not been able to contribute anything substantive by the cultural environment. Consequently in the south the site, location, size and building materials of the villages are directly controlled by the factors of physical environment such as geomorphology, depth of water-table, extent of arable land, the rivers and the rocks. In the first stage of their history, the Jats were directly influenced by the natural landscape when their cultural development was at such a low stage that there was no question of a possibilistic selection; the occupation of dacoity was the natural outcome of such a relationship. Later on in the periods of stable political institutions and strong administrative control, the Jats began to look toward the Mother-earth, the bonds of deterministic control was loosened but even now the poor Mother-earth very often brings in the old historical spirit of banditry, dacoity and lawlessness. In the northern habitat the dominant control is that of cultural landscapes in which the most prominent position is occupied by the canals on which depends the cultivation of sugar-cane resulting in cash-income and material prosperity. Local wholesale markets (gur mandees) and sugar factories are the other important elements in the material environment and the cultural landscape.

Centuries before they settled permanently, their habitat of the plains had been continuously cultivated, so that the sudden change in the nature of the habitat worked like a miracle in transforming the semi-nomadic Jats into sedentary agriculturists binding them permanently to the habitat of the plains. Once tied to the soil in the plains habitat the early bohemianism became a heritage of the legend, the villages began to grow fast in population and material prosperity.

TERRAIN

The dynamic fluidity of the Jats has always stood in sharp contrast to the unchanging static nature of their terrain. In the north in the plains monotony reigns supreme except the broken high banks of the main rivers. The conventional relief differences consist of low-lying riverain tracts (khadar) and the central upland (bangar). The southern habitat consist of the historic Malwa plateau formed of Deccan lava and other old crystalline rocks. Chambal ravines form the most conspicuous element in this physical landscape. Isolated remnant hills are also found scattered over a large area. The plateau is a vast level plain consisting of granite terrain and broken only by low hummocks.

CLIMATE

The habitat of the Jats displays a continental regime both as regards temperature and rainfall. Climatic regime is extreme with a minimum of 55°F and a maximum of 98°F. In the northern part the rainfall is about 28 inches while in the southern part rainfall is 20 inches. From April to June there is an uninterrupted register of hot westerly winds while from November to March the weather is cool and the prevailing winds are northerly and westerly.

NATURAL VEGETATION

The natural vegetation of this area is conspicuous by its absence. Since centuries of agriculture has depleted the original cover of vegetation only the uncultivable areas have some sort of natural vegetation. The riverain tracts are full of coarse grass while at other places open woods with meagre resources of timber and various types of thatching grasses are found.

NOMENCLATURE

The nomenclature of the Jat villages itself makes a very interesting and highly instructive study since there are many factors involved in it.

GEOGRAPHICAL

The geographical conditions of the site and situation of the village is often indicated in its name. Loni (28°45' N, 77°18' E) derives its name from the word 'lon' or in Sanskrit 'lavana' on account of its being situated in the centre of a salt tract which is extensively infested with reh (saline efflorescence). 'Again it is very interesting to note such pairs of villages as Ahar Bangar (Pop 2,131) and Ahar Khadar (Population at present is nil); Bari Bangar (Pop 1,173) and Bari Khadar (unpopulated) and Faridi Bangar (Pop 3,142) and Faridi Khadar (unpopulated). Such a nomenclature explains two geographical facts: (a) the addition of Bangar means the site of the villages on the central upland removed away from the river and the addition of khadar means the site of the villages in the low sandy or marshy land near the rivers; (b) the bangar villages are much more prosperous and have a larger population than the khadar villages since in the former tracts agriculture is permanent and productivity is very high. Again in the pairs of villages such as Buwara Kalan (Pop 742) and Buwara Khurd (Pop 328) and Fahimpur Kalan (Pop 782) and Fahimpur Khurd (Pop 585), the suffix Kalan (an Urdu word meaning big) means a larger population and a bigger village than the one with a suffix Khurd (an Urdu word meaning small).¹ Two different villages having the same name but with suffixes like bangar, khadar, kalan and khurd are no doubt different in population, structure, sites and occupation but these still have some genetical relationship with each other and are like two members of the same family.

ECONOMIC

The economic factor often enters into nomenclature because some villages become famous for a particular industry or similar economic activity. Khallaur (28°12' N, 77°50' E) was founded nearly 300 years ago by Raja Jai Singh and derives its present name from the skins (khals) that were dyed here, though formerly at the time of its founding it was named as Jaisinghpur after its founder Raja Jai Singh. The fact that the change in name was effected later clearly indicates that the economic activity weighed far more heavily than the historical precedent.

HISTORICAL

The historical factor often indicates the name of the founder or a certain historical incident. Most of the Jat villages in the northern zone of the Jat habitat have been named after Muslim personages, but these villages were originally inhabited, settled and owned by Muslims and Jats came later on to settle them. Thus the Muslim names of the Jat villages were not given by the Jats themselves, at the same time after conquering and settling them, they did not feel any necessity of changing their names. Moreover the names of the villages have their own inertia and seldom undergo any change. The possibility of Jats naming their villages after Muslim personages having higher stature out of respect is ruled out because the bitterest enemies of the Jats were Muslims. There is enough historical evidence to prove this incontrovertible truth. Names such as Abupur, Asifpur, Latifpur, Faizpur, and Yaqutpur suggest their Muslim origin. In pargana Jalalabad (Meerut dist.) a stronghold of the Jats out of 160 villages as many as 126 are named

after Muslims. This is of course because of the fact that this area was formerly a stronghold of Muslims due to its proximity to Delhi. The presence of deserted and ruined mosques even in the Jat villages explains it further. Jats have however occupied the villages originally founded and named after men of other castes. Kirthali ($29^{\circ}15'N$, $77^{\circ}15'E$) was founded by Kirat, a Mali (gardener) and was given the name of Kiratsthal (Sthal in Hindi means place) but was later on changed into Kirthali. It, too was founded 1100 years ago, before the immigration of the Jats. The most prevalent practice was therefore to name the villages after their founders themselves. Gesupur a large Jat village in Bulandshahr was named after its founder Gesu Khan, a Bilauch. The Jats have also however established their villages and named these after some historic figure, a famous Raja or a warrior. Churaman Nagri (Muttra distt) was named after the first, most powerful Jat leader, Churaman. The historical incident also plays a part in the nomenclature of the villages. Budhana (Meerut distt.) has derived its name from the phrase burh-ana which means coming forward (Burh—forward and ana—coming). When the Jats were ousted from the nearby village Begamabad, the Jats went forward and settled a village Budhana and then from the latter village attacked the former and got its possession.

ETHNICAL

There are many Jat villages which are named after the communities or castes or tribes which occupied the villages prior to their capture and possession by the Jats. Bhatauna (Bulandshahr distt.) derives its name from Bhats (bards) to whom it was given by the former Rajput owners. As is usual with the Jat villages the original inhabitants were ejected out by force by the Jats themselves and is now owned by them. Again, Keshopur Sathla (Bulandshahr distt.) was founded by Kesho Bhatt, a Gujrati Brahmin but due to the weak intellect of the inhabitants its name was changed into Shathalaya (residence of the fools) from which the diminutive word sathla has been derived.

RELIGIOUS

Very often the village derives its name from some deity whose temple may be situated nearby. Belon, (Bulandshahr distt.) a village now inhabited by the Jats derives its name from the temple of Bela Devi which is situated in a grove of bel trees.

MYTHICAL

Some very old villages derive their name from some mythical incidents being associated with these. Ahar (Bulandshahr distt.) derives its name from 'Ahi' (serpent) and 'har' (killing) which thus means the killing of the serpent, and the present village is said to be the place where Janamejaya performed the great snake sacrifice and rewarded the Nagar Brahmins who assisted him with grants of land in the vicinity. Certain villages in Hissar derive their names from a tradition that a giant was killed and each of his limbs gave a name to the place where it fell.

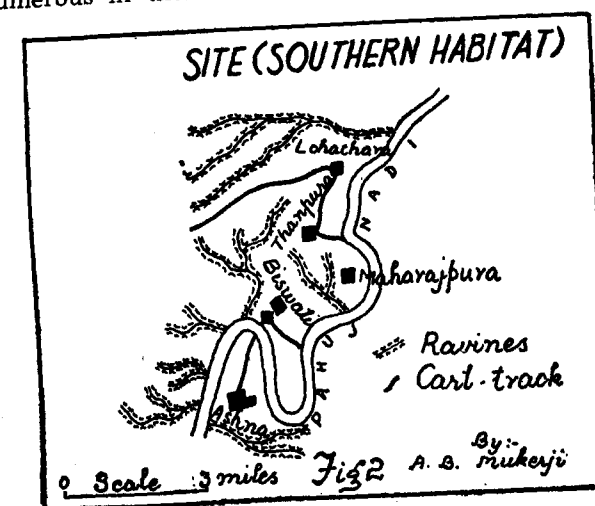
1. Sarsud—where the giant's sar (head) fell.
2. Balak—where the giant's bal (hair) fell.
3. Pabra—where the giant's pab (foot) fell.
4. Bichpari—where the giant's bich (middle part) fell.
5. Kanwa—where the giant's kan (ears) fell.
6. Hathwa—where the giant's hath (hands) fell.
7. Jeura—where the giant's jewar (ornaments) fell.

SITE

According to the sites of the villages also, we can divide the entire Jat habitat into northern and southern belts.

GEOLOGICAL CONTROL

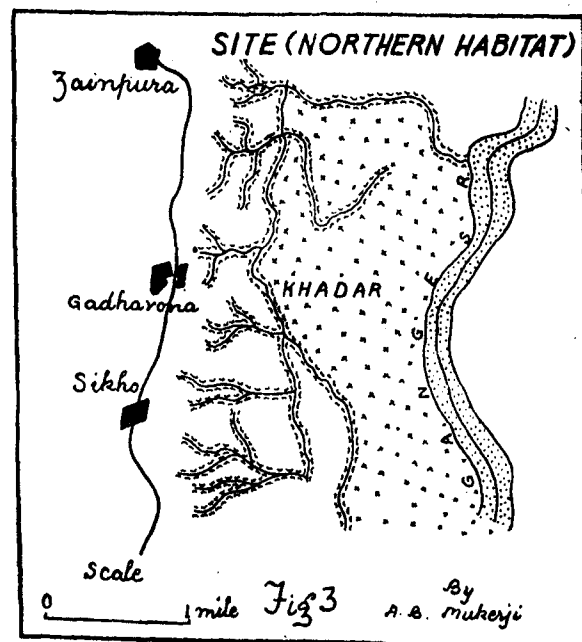
The geological control on the siting of the Jat villages in the northern habitat is non-existent but in the southern habitat, the influence of the geological structure and relief are clearly discernible for in the southern habitat the agricultural land is not extensive and continuous but found in limited and dispersed local patches which has necessitated the villages to be built on dispersed sites according as the geological structures have carved out plains for agriculture. The settlement is very often located near a stream from where water can be easily had. The importance of the river as a source of water is easily realised when we consider that this part of the habitat is specially very dry. Where there are no rivers, one or several tanks or wells are surely to be found on an open space near the village site. Malwa being the area of black soil, its tracks become almost impassable as soon as the rains have fallen, therefore high grounds become the sites of settlements, so as to keep the roads dry. 'Rising grounds were also necessary for drainage, which was still more needed in the days when there were no cuts and channels to take off the water.'² The one speciality of Jat villages as regards their sites is their particular suitability for defence. It is for this reason first of all that the villages stand on a slight eminence, on a knoll which is found widely scattered on the rocky plain or plateau. The village is laid out compactly on the highest and best drained part of the site. Availability of water is dependant wholly on the geological structure determining the height of the permanent water-table. In the southern habitat which is built mainly of Jumna alluvium the great depth of the water-table hampers the development of well irrigation. Hence the Jat villages in the southern habitat are numerous in those areas where the depth of the water-table is



very little. Geological control on the sites is thus manifested through three aspects, in the defence value of the site, in the availability of agricultural land and in the availability of water-resources. The villages are sited removed away from the rivers because these are liable to serious inundation during the flood season and even if these are situated near the rivers their sites are generally on the high strong river bluffs of the concave banks. The

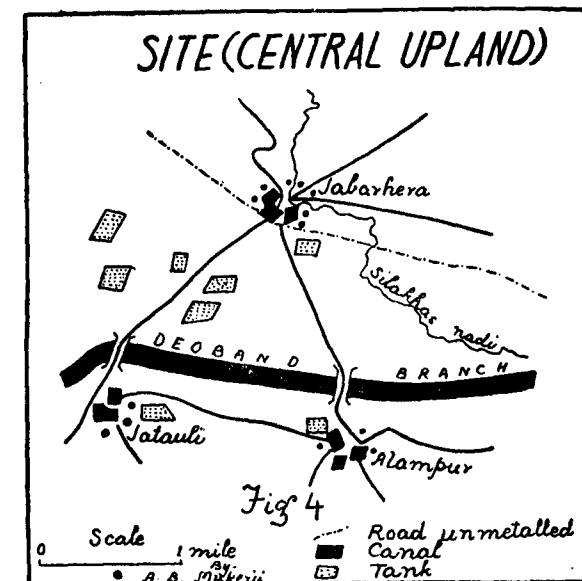
villages situated at the banks of the rivers are surrounded by wide belts of ravines, so that the defence value of the site is enhanced and the village remains inaccessible from the surrounding land area. (Ref. Fig. 2) Such villages have of course small population with a meagre income from limited agriculture. The protective value of the site in the southern habitat is thus very remarkable. Away from the rivers and the ravines the villages are situated on the hillocks and knolls.

In the northern habitat the sites of the villages do not bear a relationship with geological influences as everywhere the surface relief is uniform with minor and rather insignificant surface undulations. However, there is to be found a string of villages along the meeting line of bangar and khadar lands, the sites offering good advantages for the first line of defence. These villages both along Jumna and Ganges could protect the rich sugar-cane fields stretching on the central and inner uplands of bangar. (Ref. Fig. 3) But the sites



of the largest and the most prosperous villages are on the central bangar upland. 'Since the Jats specialise in the cultivation of sugar-cane, which is a heavy crop, the Jumna khadar tract cannot attract them, hence the largest number of Jat villages are now found in the central bangar upland.'³ In order to protect the villages from being inundated by rivers, these have been built mostly in the central bangar upland region which is really a broad river—divide between Ganges and Jumna rivers. Moreover it is only on this upland that the large extent of the continuous area of good arable land is found making possible the extensive cultivation of sugar-cane in which the Jat tribes specialise. Here also is found the most elaborate system of canal irrigation for the obvious reasons of the facilities of construction. Most of the villages are found situated near the canals, their distributaries or minor irrigation channels, (gool). But it should be noted that the villages are much older than the canals and actually the latter cultural features were added to the already existing cultural landscape. The canals and the distributaries were constructed so as to pass near the villages already in existence. Villages near the canals and situated on the same level as that of the latter

benefit from the irrigational facilities and thus are very productive and rich. In the low-lying villages the fields are often inundated by canal water beyond the necessary amount thus causing widespread deposits of reh which in its own turn causes a decrease in productivity and consequently the wealth of the villages. (Ref. Fig. 4) The sites of the worst villages very often stand too high for the ordinary canal levels and are destitute of facilities for the sink-



ing of wells. Here also the surface is frequently broken by ravines. The nodality inherent in the sites of the villages in the northern habitat is particularly noteworthy. Every village is a focus of communication lines which range in category from the ordinary cart-tracks to fine macadam motor-roads. The newer villages have of course been built near the canals. The older villages were built wherever wells could be easily dug and as the water-table was everywhere high, the digging of wells was widespread and along with that the sites of the villages were also distributed over a wide area. In the khadar area, though the water-table is quite high and the digging of the wells comparatively an easy and cheap job, yet the maintenance of the wells is very difficult and the instability of the walls of the wells shorten their longevity, hence the sites of the prosperous and old villages are almost always found on the bangar upland. Lawar ($29^{\circ}7'N$, $77^{\circ}47'E$), Sardhana ($29^{\circ}9'N$, $77^{\circ}38'E$), Hastinapur ($29^{\circ}10'N$, $78^{\circ}1'E$) and Loni ($28^{\circ}45'N$, $77^{\circ}18'E$) are such villages in Meerut district. All these villages are of course of Muslim origin and their central sites were really the basis of the local pargana administration of that region.

SITE SHIFTING

A major percentage of the villages have changed their sites several times during their life-cycle. The village Daulatpur urf Farrukhabad Kayasthgaori ($28^{\circ}52'N$, $77^{\circ}32'E$) was first established by the Baluch people on a site which was far removed from the road, then the Banjaras (a gypsy tribe) settled the village near the canal. Both the tribes after some years left the village empty when Kayastha people came and settled the village on its presene site. Subsequently the Jats ousted the Kayastha and settled the

present village. The former sites of the village remain as little hillocks or earthen mounds (khera). Khera is thus the raised site of a deserted village and since most of the villages have had changes in sites, khera is a feature, common to all of them. It is generally found that whenever a village undergoes a sudden and violent change of hands, the new caste or tribe shifts the village on to a new site, of course with the consideration of some new advantages. Some villages contain several kheras indicating the several changes in the ownership which it had undergone. Bamnauli (29°9' N, 77°22' E), a big village in Meerut district contains as many as four kheras named as Budhi (old woman) Bamnauli, Karal, Kandhaura and Hariyati. Most of the villages were already in existence when Jats came into this area and appropriated these by force. Naturally these have changed hands many times. For example Karnawal (29°6' N, 77°32' E) was first owned and inhabited by Rajputs but later on it was seized from them by the invading Muslims and then destroyed by fire. The remains of the earlier village form a khera near the present site of the village. Then Jats came and shifted the village to a new site. Shifting of the village from one site to another was necessitated primarily by the needs of security and defence in the period of general disorder when the Jats were beginning to settle in these villages. That the defence requirements were specially significant is amply borne by the fact that the feature of khera is not so widely found in the southern zone of the habitat where the villages were almost always sited in inaccessible places and therefore needed no shifting of the sites. The most frequent changes have however occurred in the northern part of the habitat where due to the proximity of the empire-capital the impact of the disintegration of the Moghul empire was felt most deeply. Each change in site thus gave new opportunities for defence to these villages. Shifting of the villages from one site to another was also induced by the newer irrigational channels and distributaries. Since the main occupation of the inhabitants has been farming which they carried on in a zone of dry-farming having a very low rainfall, it was but natural for the villages to shift toward the canals and distributaries for the irrigation of their fields. Hence we find that the presence of innumerable kheras are the facts which substantiate the thesis of necessary and rational shifting. Once destroyed by fire, arson or violence the village was left empty and the site was forsaken, then an entirely new village was created by the new settler-group and of course always on a new site.

TYPE OF SETTLEMENT

A Jat settlement is invariably of a clustered type, the basis of the pattern being a set of common activities and objectives which necessitates a 'living together'. Moreover 'the law of mutual adjustments is specially rigid in the irrigated districts'.⁴ What Richtofen said about the Chinese villages is true of the Jat villages as well. 'They are groups of families, united by a common descent or at least having rites in common, who cleave to one another because of the necessity for co-operating in the cultivation of the same crops'.⁵ In the case of the Jat villages the common crop is that of sugar-cane in the north and cereals in the south. The arable land has had its influence on the clustering of the settlements. Since the land is continuously arable belonging to one family and its branches, it is natural that clustered settlements have been built up. 'The clustered village is indigenous in the districts where the arable land is continuous, admitting of uniform and extensive exploitation'.⁶ Mr Drake Brockman writes in the *Muttra Gazetteer*, 'the Jat villages almost always consist of one single compact site.' The isolated farmstead is such a

rarity so as to become an exception to the general rule of agglomerate settlement. Since the main crop of Jat habitat is sugar-cane which does not require so much of constant neighbourly care, the necessity of having a farmstead within the farm has been eliminated. Though there has been no necessity for the dispersed settlement, there have been many necessities that have created the agglomerate, compact and nucleated settlement. The type of society of the Jats in their nomadic condition was definitely very low and hence the need for permanent settlement was non-existent but in the eastern habitat both in its northern and southern parts, the Jats changed into good sedentary agriculturists and hence evolved a higher type of society with improved type of social and community organisation which necessitated permanent settlement in larger villages. The relation between type of society and settlement thus becomes quite clearly established. 'With transition to the sedentary life of agriculture, society makes a further gain over nomadism in the closer integration of its social units, due to permanent residence in larger and more complex groups.'⁷ The troublous times and the period of general disorder also necessitated compact, clustered settlement for the purpose of common defence. In Aligarh in the parts south and west to Jumna, large villages of a semi-fortified type were built for the purposes of defence against the marauding Sikhs and Marathas. In such periods of insecurity, naturally the creation of hamlets was never to be thought of. The compact settlement is also the direct result of the necessity to protect the village from Muslim raids which used to come both from the Delhi side by the Moghuls and from Rohilkhand side by the Rohillas. Moreover the Jats' habitat being always on the frontier of two different states, it was under the sufferance of the inter-provincial insecurity conditions that characterise the border areas. The agglomeration also reflects the nature of colonization of the Upper Doab by the Jats which was by organized communities and not by individuals. The colonising group had previously existed in Rajputana and Malwa as a tribal and marauding congregation, so that the colonists arrived in Upper Doab motivated by certain common aims and a relatively homogeneous political and social character. It was their policy to appropriate villages by force and hold it as the property of a particular clan under the bhaiyachara tenure. The type of agglomeration is not different in the southern zone of the habitat of the Malwa plains, there too the clustered and nucleated settlement is the general rule. In the open field system of agriculture the holdings are not only very minutely fragmented but also very widely non-contiguous thus making separate homesteads for different fragments almost impossible and impracticable. Hence the peasants prefer to live in agglomerate settlements though in this type they lose much energy and time in going to and fro from widely separated holdings. In the agglomerate settlement however they save the difficulty of building several farmstead for each individual holding. Moreover the centralising of all the agricultural activities also necessitates a close and compact 'living-together'. The digging of wells and well-irrigation had also a lasting influence on the coming together of the population and thus creating the agglomerate and clustered settlement. The well was always dug first and then the habitations were constructed around it. The seed of the clustering was thus the well within the village. In general, in all of the villages, the central and the most used well is as old as the first habitation itself.

POPULATION

The most striking peculiarity of the Jat villages is their big size both in population and its area. The large population of the Jat villages in their northern habitat is clearly due to the agricultural security and larger agricultural yield provided by the wide and elaborate system of canals. The biggest

agglomerations are found in the Meerut district of which the north-western tracts are accepted as the original home (desh) of the Jats. The large population of the villages is best exemplified by the four villages which comprise what is popularly known as Chaugaon in Sardhana sub-division of Meerut district. These are Daha (Pop 5126), Tikri (Pop 7773), Nirpura (Pop 6205), and Doghat (Pop 6119). By any standard these are enormous villages and highly prosperous too. All these villages are owned on a bhaiyachara system of tenure in which members of the same clan of the Jat tribe hold all the four villages. As is natural, all these are agricultural villages and are noticeable and conspicuous on account of their enormous sizes. The large population of the village and the growth of population are directly related to the cultivated land area, irrigated land area, the fertility rate, historical and geographical factors, all acting together sometimes or other.

CULTIVATED AREA AND POPULATION

In general the population of any village largely agricultural depends primarily on the cultivated area of its land. This is specially applicable because Jat villages are inhabited mainly by peasants. The area of double-cropping increases from south to north and along with that increases the population per hamlet, since double-cropping increases the productivity and the maintenance capacity of the land.

IRRIGATED AREA AND POPULATION

The Jat habitat is a dry area where all agriculture depends upon irrigation. The growth of rural population is therefore directly proportional to the growth of irrigation facilities and hence to the areal extent of irrigation. This correlation is operative however in broad patterns since it is indicative of persistent influences and one that has been achieved in a long period of time say in a decade or two.

POPULATION AND FERTILITY-RATE

The growth in the population of the village is also related to the Rural Growth Rate, the increase in the latter obviously effects an increase in the former. The population of the village is directly dependant on the growth rate of the rural area of the district in which the village is situated. Such a data bears a straight relationship to the population per hamlet.

POPULATION AND RAINFALL

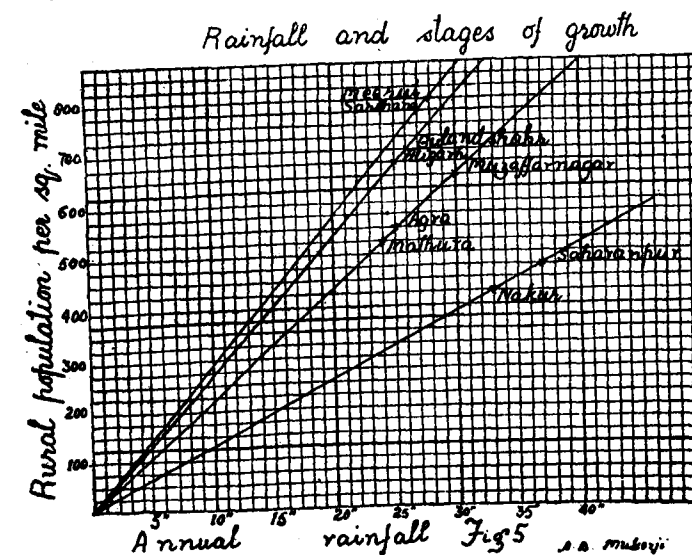
In a habitat whose economic structure is based wholly on agriculture in an area of dry-farming, the importance of rainfall is overwhelming, but climatic factors have to be combined with other factors of health, productivity of the soil and the availability of land for farming. The graph (Fig. 5) clearly indicates that even in the same habitat the stages of development are different though the material and social environments are the same. In the northern habitat Saharanpur lies on a different line than Meerut and Muzaffernagar. This difference cannot be explained simply on the basis of the difference in the rainfall but must take into consideration the productivity of the soil, the availability of land for farming and the general climatic conditions which affect the health and consequently the working capacity of the farmers and people in general that Saharanpur has such a low rural population density. Moreover the large area covered by Terai lowlands limits the extent of the agricultural land. The dryness of

Agra and Muttra affects the water-supply and hence the agricultural production while the dampness and unhealthy elements in the climate of Saharanpur affects the health of the peasants and thus their agricultural efficiency. It is only in Meerut that the utilisation of land for farming seems to have reached a saturation point and thus in this district the rural population density is at its maximum. It seems more than probable that with an increase in irrigational facilities, there will be a corresponding increase in the rural population as well as in the density of rural population. But even ignoring the factors of rainfall the analysis can never become complete. The fact of decreasing rainfall from north to south is thus of paramount significance. With this decrease in rainfall here is a corresponding decrease in population per hamlet as it evident from the table given below.

TABLE I^a

Districts	Rainfall	Population per hamlet
Saharanpur	37"	721
Muzaffernagar	29"	1094
Meerut	28"	1420
Bulandshahr	26"	787
Aligarh	25"	501
Muttra	24"	495
Agra	25"	476

The meaning and influence of economic opportunities become clearer when we consider the fact that toward the south the arable land being discontinuously spread out, the number of villages tends to increase and the tendency to dispersal becomes evident. The area per hamlet therefore decreases in the same proportion. (Reference: Table 5)



^a Based on data given in p. 29 of Vol. II Census of India (1951) and pp. 145, 146, 147 of Memoirs of the India Meteorological Dept., Vol. XXVII, Part II.

TABLE 2^b

Districts	Number of hamlets	Area per hamlet
Muzaffernagar	1117	1.507 sq miles
Meerut	1607	1.446 "
Bulandshahr	1906	.991 "
Aligarh	1842	.630 "
Muttra	3078	.796 "
Agra	3152	.590 "

^b Based on data given in p. 29 of Vol. II Census of India (1951).

FAMINES AND POPULATION

In the famine of 1837, Bulandshahr district was thronged with emigrants from Hariyana and Marwar where the agriculture was mainly single-cropped and limited to kharif season in which in the particular year rainfall had failed. Even in Gurgaon, the people had to feed their cattle on the leaves of the trees. In the south the matters were always worse. The worst affected tracts were the parganas along the Jumna where the means of irrigation were scanty. Again in the famine of 1860 the principal sufferers were the parganas along the Jumna which suffered not only because of the failure of rainfall but also due to large-scale migration from Punjab. Subsequent famines in 1868, 1877, 1896 and 1899 did not affect this district adversely, so that in all the cases its attraction for emigration remained constantly strong. Similarly during the famine in 1877-78, Aligarh was invaded by numerous immigrants from Rajputana and Agra, on their way northwards. In 1899 again there was a considerable influx of famine stricken people from Rajputana and particularly from Bikanir. Meerut with its ample means of irrigation is practically secured against famines. Though failure of rains had caused in many years a period of scarcity, the district did not suffer as other parts of Duab. The famine of 1291 A.D. engulfed the whole of the Duab but Meerut had escaped it. Other famines that occurred in this district were caused by belligerents in the Duab. Even in the famous famine of 1840, widely known as Chalisa, Meerut did not figure prominently.

SIZE

The areal size of the Jat villages is also unusually large and that is again a differentiating characteristic possessed by it. Mostly the Jat villages are enormous in size. The length for example of Lumle (29°16' N, 77°14' E) in Meerut district is 5 miles. The north west part of Meerut district is characterised by very big Jat villages. The maximum and minimum distances between two villages are on an average 4 and 2 miles respectively. The distribution of the villages is in general very uniform and equal, with every few areas dense concentration and empty space, hence the villages are in general of big areal sizes. A few examples will illustrate the point. Adha (1466 acres), Ahar (3285 acres), Malakpur (1318 acres) and Kuchesar (3686 acres). In continuously stretched arable lands of the villages having nearly the same population the percentage of the area of the built-up land to the total land area is nearly equal. This percentage naturally becomes less in the villages having larger areas but having lands whose productivity

is limited and therefore having low population. This percentage becomes very high in the villages where the total land area in proportion to population is less where a significant majority of the population is engaged in functions other than the rural.

FORM

The forms of the Jat villages do not possess any differentiating characteristic peculiar to them for the geographical conditions of the region acted similarly in the case of all the villages belonging to different castes.

EXTERNAL FORM

The overwhelming majority of the Jat villages is of polygonal type, obviously because of the fact that no village has been planned at the time of its creation and first settlement and any new piece of banjar, usar or permanent fallow land lying contiguous to the village would be occupied by a new group of huts. A Jat village has no formal geometrical design. There are no doubt very old villages but only a very few in number, which date back to the Mahabharata times, whose patterns follow the plan of an Aryan village which was the plan of a Swastika, a plan used in the military camps for defending the gateways. In Baghpat (Distt. Meerut) one wide street runs from north to south and the other from east to west with an open market at their point of junction. In those areas where political stability and general security were not to be found, the form of the village is a circular, walled and semi-fortified settlement. In Aligarh district in the north and also in the parts beyond the Jumna to the west and south, large villages of a semi-fortified type were built for the purposes of defence against the marauding Sikhs and Jats. Very often the houses are clustered round the mud-built castle of the zamindar, under whose protection the inhabitants could do well in prosperity.

INTERNAL FORM

Internally a Jat village consists of a three-tier plan, the two habitation groups divided by a road. There is firstly a central compact settlement of residences in the shape of a half-ellipse; a road running all around it on its outer side and the third part consists of another belt of residences round the road. The road however does not allow any looseness in the compactness of the village to creep in. The village remains compact and hard as granite; organised and united as a mediaeval fortress. The skyline of the Jat villages remains uniformly horizontal on the same level of about 15 ft. high above the ground because of the general absence of temples and other buildings of the same nature in the inner parts of the village as well as because of the fact that the houses are mainly one-storeyed. House upon house fall like heaps and the entire body looks like an irregular earthen mound. Along with the labyrinthine divisions and sub-divisions of the house blocks the internal form becomes a complex mosaic of elements patterned in an utter confusion. There is no arrangement visible in the pattern of the distribution of the houses since no village is built in accordance with a geometrical plan.

(To be continued)

A GEOGRAPHICAL STUDY OF THE POPULATION AND SETTLEMENTS ALONG THE BALUCHISTAN COAST

By

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INTRODUCTION

The study of population and human settlements along the Baluchistan coast, is a study of a handful of people existing and striving against nature for their existence in a desolate, barren and inhospitable environment. In that area, people live in grand isolation and have divided themselves into what may be called 'islands of human habitations'. As the sequel would show, the human settlements and their pattern as also the occupations of the people carry a close influence of the physical aspects of this dry, stony and sandy region.

For the purpose of this paper, the author is limiting himself to the coastal Plain Region, an area which starts from the mouth of the river Hab and extends to a little beyond the Dasht river, near the Iran border, covering a total length of about 350 miles. The northern limits of the coastal plain have been marked by the southern limits of the Makran Range in the Makran State, and the raised beaches in the State of Lasbela.

The coastal plain of Baluchistan¹ is bounded by the Pab Ranges, in the east; the Baluchistan Plateau, an area of very different physiography and economy, lies to the north; the Iranian border which politically separates it from its own extension in Iran, forms its western limit, and in the south the waters of the Arabian Sea wash its coast line. It is an arid region in the extreme south-west corner of West Pakistan.

HISTORICAL ASPECT

The earliest reference to Makran, of which it is a part, has been made in the age of King Kāūs, who is said to have toured along this coast by boat. Alexander the Great marched through this area in 325 B.C., and called the coastal region as the country of Ichthyophagoi; the rest of the area was, however, described as desert. It is reported that he sent Thoas down to the sea with a few horsemen in order to find some suitable harbour along the coast for the benefit of his fleet. They did not find much, but 'some fishermen upon the beach living in stifling huts, which had been constructed by heaping up mussel shells, while the roof were formed of the back-bones of fish'. They found that 'those fishermen had only scanty supplies of water, obtained with difficulty by their digging through the shingle, and that what they got was far from sweet'. Most of the historians admit that all the hardships which Alexander's army suffered in Asia were not comparable to the miseries which it experienced over here. The blazing heat, scanty water supplies and shortage of food destroyed a great part of the army.

¹ The coastal plain of Baluchistan, lies between the longitudes of 61°30' to 60° 20' E, while the latitude of 25° 20' N runs almost in the midst of the coastal plain.

The very name of Makran was horrifying to Arabs, as they used to think of it as a land of 'makar' or deceit. They have described the whole country as a vast land, mostly barren. They also found that along the coast, life was barely possible except for a few fishing folks. In spite of its horrid nature, Arab sailors and merchants were constantly in touch with this part of the sub-continent. They used to come in boats, and sailed along the coast. There were very few ports on which they landed, before they moved onward to any other part of this sub-continent. These people used to have trade in sugar, which was being manufactured in Makran in those days and was considered as an exportable commodity. The Port of Tez was well noted among the Arab traders, and it was the first port of landing on this coast, east of the Persian Gulf.

Towards the beginning of the 16th century, the Portuguese made their way towards India and captured several places along the Makran coast. In 1581 they burnt and captured the villages of Pasni and Gwadar, but the region failed to tempt them to make it any permanent Portuguese colony.

In 1862 the area came into the prominent notice of the British Government in connexion with the construction of the Telegraph line, and a British Officer was stationed at Gwadar from 1863-1871. Since the British rule, security has replaced anarchy, and peace prevailed there in tracts formerly given over to bloodshed.

From the above historical events, it is clear that from the days of the King Kaus down to our age, the region has remained inhospitable to human beings, and in each age there have been tales of miseries and discomforts, which people have faced either passing through or living within the area.

PHYSIOGRAPHIC ASPECT

Geologically,¹ the costal region is composed of very young rocks, which probably belong to such recent period. The flat tops of the hills in this area are composed of sub-recent shelly conglomerates. The few exposures of rocks seen near the Sonmeani Bay are older Tertiary, or perhaps cretaceous, and the greater part of the region consists of alluvium. The low cliffs near the coast are apparently composed of sub-recent deposits.

Physiographically, the entire coastal plain is one compact region, which is almost level, and the low flat-topped hills stand at uneven distances between Gadani and Jiwani. The coastal fringe of the region is low and behind the beach, sand-dunes are of common occurrence everywhere. The interior of this region consists of a flat plain bounded by the mountains in the north and dotted with low hills. Also it is traversed by numerous hills torrents. Large and small tracts of cultivable lands are, however, available in this plain. Generally, the northern portions are more cultivable and level than the southern ones.

There are hardly any perennial rivers in this area. Whenever there is any rainfall, the streams of the area become raging torrents. These streams

¹ Based on: Blanford, W.T. — 'Geology of Western Sind' Mem. Geol. Sur. Ind. Vol. VII, Pt. I, 1879, P. 6.
Asrarullah — 'Geology of S.W. Makran' Pakistan Journal of Science, Vol. 6, No. 1, Jan. 1954.

fill only after rains, while at other times are nothing but strings of small pools of water. After heavy downpours, the rush of water from the hilly region on either side causes them to rise and inundate the land considerably and for a long distance. The land thus flooded becomes cultivable. The banks of the streams are often higher than the plain and are composed of mud. At suitable intervals they have been ploughed down, and gradual slopes have been maintained towards the beds. Such patches of land are fertile enough to have some cultivation on them. The water is good and fresh wherever the streams maintain a surface flow.

Thus, the hydrography of the area plays two significant opposite roles within the region. On the one hand, the streams of the region play havoc by raising floods, inundating land, and washing away many of the villages, which are sited along their banks. On the other hand, these very streams are a great boon to the inhabitants of the region, as the floods enrich the soil, and thus facilitate cultivation. The rushing streams and the floods provide the inhabitants of the area with fuel, as each stream brings down plenty of dead trees and plants. The banks and the beds of the streams and 'nalas' afford excellent pastures for flocks. A few of these streams, when properly dammed, may provide irrigation and drinking water facilities to the people residing in this barren region. In this dry tract, most of the drinking water is procured from the beds of these streams and 'nalas'.

COAST

The entire coast-line from Jiwani to the mouth of the river Hab consists of a low lying strip of land. It is almost unbroken, having only a few bays with few back-waters. There are only two back-waters, which may only be utilized for fishing on a small-scale, but there are physical difficulties of developing any good fishing harbour in them. One of the back-waters is called Miani Hor, which is nearly 40 miles long and at some places 10 miles wide. The other one is Kalamat Creek, which has been practically divided into two parts by a sand bar. Further west, there lies Gwathar Bay, which is shallow and the river Dasht drains into it. The hinterland of all the ports lying on these bays viz. Sonmiani, Pasni, Ormara and Gwadar is almost a desert and contains very few patches of productive land. The entire region hardly carries any suitable means of communications.

Owing to the shallow nature of the coastal water, there are always navigational difficulties, which hinder the establishment of any good harbour on this coast. The chief characteristic feature of the coast is that of occurrence of peninsulas of white clay cliffs capped with lime-stone, which have been used as shelters for fishing and the fishing boats. The coastal water deepens outward almost everywhere gradually and regularly. A ship drawing 3 or 4 fathoms can seldom approach the land nearer than two miles. The amplitude of the tide varies in different parts from 6 to 10 feet and may generally be considered about 8 feet at the spring tide. When the tide is on, the river mouths, which are frequently dry at low-tide, become salt water creeks and are only navigable by small country crafts. The entire coast-line, having a shallow coast and an open and warm sea, possesses excellent conditions for an abundance of fish. There is great future for fishing on a large scale, because of its unique and advantageous geographical features of the coast-line.

CLIMATE

Climatically,¹ the Baluchistan coast is a part of the hot desert, which occupies the western part of the Indo-Pakistan sub-continent. The area is hot for the longer period of the year, and winters are very short and comparatively cool. The mean maximum temperature for January, which is the coldest month of the year, is 74°F. The temperature shows a steady rise everywhere from January to June. June is the hottest month of the year. The mean maximum for June is 93°F. The humidity is very high throughout the year, and ranges between 74 and 82 per cent. The predominant wind direction along the coast for about 8 months being north westerly, the winds are off-shore, and the effect of the Arabian Sea Monsoon current is insignificant. Whatever rainfall is received, it is due to the secondary lows which originate on the Persian Gulf and extend upto Sind. The rainfall, which averages about 6", is not only scanty but also variable. About 70 to 60 per cent of the total rainfall is received during the winter period.

In short, the climate of the entire coast may be called Tropical Arid Marine. The chief characteristics of this climate are as follows:

It is dominated by a steady flow of the sea breezes throughout summer; humidity is appreciably high; both annual and diurnal ranges of temperatures are low, and annual precipitation is very scanty.

As the entire coastal plain region falls under the arid zone, climate has a great bearing on its vegetation, domestic livestock and human beings of the area. The occupation of the local people, e.g. agriculture, cattle-rearing and fishing, are greatly influenced by the climatic conditions. The prevailing winds throughout the most part of the year being westerly, most of the fishing settlements have obviously been selected originally by the fishing communities along the bays on the eastern lee-ward side of the Peninsulas. Incidentally, most of these coastal settlements have had a natural setting, giving the inhabitants and the primitive fishing crafts a natural protection from the high cyclonic winds that sweep over entire coast of Baluchistan. On account of dry climatic conditions, migration serves as a safety-valve to a large section of the people, with the exception of those who have fishing as their occupation or possess patches of irrigable and culturable land.

VEGETATION

On account of the severe climatic conditions, the area is almost devoid of any vegetation. The little vegetation that exists is found widely scattered. There is a close association between patches of vegetation and human settlements within the area and often the groves of date-trees mark the site of villages. Along the sand-dunes, there are occasional patches of low tamarisk and acacia. Wherever there is little soil and a suggestion of fresh sub-soil water, green grass is found with a few trees growing in it. Such patches of greenery are at once the attraction and mainstay of local pastoralists.

WATER SUPPLY

In such a hot and arid region, adequate water supply is one of the taxing problems, and it not only hinders the development of agriculture within the area but also restricts many of the productive activities which are most suited from the point of view of its physical environment. That is why, it is

¹ Climate figures are based on the Indian weather Review and the Meteorological Office records, Government of Pakistan, Karachi.

poorly developed both agriculturally and pastorally. It is generally observed that vast tracts of land with rich agricultural soils are lying barren and waste, only due to the lack of water supply. The only sources of water along the coastal plain are (1) uncertain downpours, which are too insufficient to meet the needs of the people; (2) flood waters which are caught by earthen embankments; (3) the shallow pools of water, which the streams of the area leave behind while they are in flood, and (4) wells, which are generally dug either in the dry beds of the rivers or in the clayey beds. Often some supply of fresh water is had from the shallow wells which are dug along the foot hills or near the sand dunes. These sources of water are the mainstay of plant and human life within the area. Many of the wells, dug in the northern part of the area are deep and their water is unsuited for irrigation, as the greater part of such plains is composed of calcareous clay and loess. At several places, there is lack of fresh water for any use. In several cases, it has been noted that along the coast the water now used for drinking is very brackish and hardly potable. The scarcity of water has not only limited the agricultural and pastoral pursuits, both qualitatively and quantitatively, but has also affected the growth of population and the size and number of human habitations in the entire coastal plain region.

AGRICULTURE *

The region can hardly be claimed as an agricultural region, as the main occupation of the people is either fishing or flock-owning. As a means of livelihood, agriculture is both insignificant and precarious. The whole of the agricultural land is dry crop area and is dependent on either occasional showers or the floods caught by embankments. The cultivated patches of land occurring as scattered oases in the barren and waste tracts, are mostly situated along the villages of the dry streams. Many more tracts of cultivable land can, however, be available for cultivation if only water for irrigation is made available. The soils of the cultivable land are mostly whitish clay mixed with sand and are fertile. In many cases, the excess of the soluble salts due to the longer period of aridity makes the top layer of the soil 'kalarish' or alkaline. The principal crops raised within the area are *juari*, *bajra* and other millets. Melons and dates are also grown in favourable localities.

COMMUNICATION

The region is very badly connected with the developed parts of West Pakistan, and there is hardly any modern means of communication available. There are many 'kachha' tracks which are hardly traversed even by jeep. Lasbela, however, has a few miles of 'Pukka' road. There are very few fair-weather roads and even they are in an underdeveloped condition. There is one long fair-weather road, which sometime back was used as a bridle path. It crosses the entire coastal belt and has been recently improved. It is level and easy for

* In the absence of the statistical data, it is difficult to give any exact information regarding the agricultural production, acreage under various crops and the per capita acreage about the entire region. But, whatever information is available, it is about the eastern section of the region i.e. Lasbela State, where there are about 6,600 acres of cultivated land, mostly *Khushkala* (dry cropped), and the source of water supply is either rain within the area or the floods caught by embankments. The per capita acreage of the cropped land may be estimated at about 0.4 acre. The principal crops raised within this sector are *juari* (1,800 acres), *bajra* (300 acres), melons and millets. Fodder is also raised for cattle. (Figures have been taken from the Office of the Deputy Commissioner, Lasbela State).

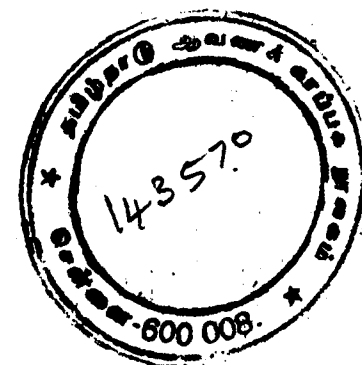
pack transport. Camels and donkeys are the chief means of transport; in a few places trucks and jeeps are also being used to transport passengers and the imported goods between the ports and the interior. The absence of the good quick and cheap means of transport is at present a serious hindrance in the development of the area.

POPULATION

In the absence of any systematic and detailed information regarding the population of the coastal region, it seems desirable that an overall study of the Makran and Lasbela States should be made. It should be clear, that, firstly, there is very little comparison between these two states as regards distribution of population and the economic conditions of the people. Secondly, a lot of adjustments have been made in the population figures for previous censuses pertaining to different geographical divisions of the province as a whole, in order to correspond to the subsequent inter-state transfers of territory and changes in area. Thus, any study made with the help of the existing data will be just an over-all picture in a broad sense, and that may not be very true in the case of coastal region, as it differs very much from that area lying to the north of it.

As regards the population of the Makran and Lasbela States nothing can be estimated for the period prior to 1911 as no records are available. According to the census of 1911, the population of these two states was estimated at 133,147 with an average density of population of 4 persons per square mile. The table given below gives an estimated figures of population for the year 1911.

	Population	Area sq. miles	Density per sq. mile
Lasbela	61,205	7,043	9
Makran	71,942	23,194	3
Total	133,147	30,237	4



From the figures, it is clear that the Lasbela state had the greater density i.e. 9 persons per square mile and 46% of the total population. It can safely be concluded that this density and percentage were due to the better pastoral and agricultural facilities available within the state, existing even in those days. On the other hand, the Makran State possesses the greater area i.e. 76% of the total area, but it is mostly barren, with very small agricultural and pastoral facilities, and possessed the lower density i.e. 3 persons per square mile and comparatively much lesser population in relation to its supporting area.

According to 1911 census, there are about 7 coastal settlements with 500 to 3,000 inhabitants and the collective population of these settlements was estimated at about 6,700 i.e. 5% of the total population of these two States. The main occupation of these coastal people has been fishing, in which 20% of the coastal population was engaged.

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TABLE I

Total population and variations in number and percentage since 1911.

STATE	1911	1921	1931	1941	1951
Lasbela	61,205	50,696	63,008	69,067	75,769
Variation in each decade		-10,509	+12,312	+6,059	+4,702
Percentage of variation in each decade		-17.2	+24.3	+9.6	+9.7
Total variation 1911-51					+14,564 24.5% increase
Makran	71,942	71,869	68,462	86,651	138,691
Variation in each decade		-82	-3,398	+18,189	+52,040
Percentage of variation in each decade		-0.1	-4.7	26.6	60.1
Total variation					+66,749 93% increase
Total Lasbela and Makran	133,147	122,556	131,470	155,718	214,460
Variation in each decade		-10,591	+8,914	+24,248	+58,742
Total Variation					+81,313 61% increase

TABLE II

TOTAL POPULATION OF THE COASTAL SETTLEMENTS BETWEEN 1911 and 1951

Coastal Settlement	1911	1951	Variation
1. Gadani			
2. Ormara	292	710	+418
3. Damb	2,712	2,720	+8
4. Sonmiani	187	630	+443
5. Ganz	1,245	460	-785
6. Jiwani	532	1,520	+988
7. Pasni	430	3,310	+2880
8. Kalimat	1,253	6,630	+5377
9. Kapparahunda	..	360	
Total	6,651	16,940	+10,289 i.e. 154%

Tables I, II and III give the estimated population and variations in population of these two States from 1911 to 1951.

¹ Figures are based on the census Reports of Baluchistan from 1911 to 1951.

From the above Table I, it is clear that the population of these two States has increased by 61% within the last fifty years. The decrease in the first decade in the Lasbela State and in the first two decades in the Makran State may be attributed, firstly, to the different methods employed for the enumeration of population, and, secondly, the unsettled political and economic conditions within the States. The increase in the population since 1931 is evidently connected with the comparatively effective system of enumeration, the revision of survey figures, new surveys, inclusion of certain disputed areas and some social and economic improvements in certain pockets of these states. The increase within these last 50 years is just 610 persons to every 1,000.

According to the recent census taken in the year 1951, the population of these two States has been estimated at 214,460 persons with an average density of 7 persons per square mile. The density per square mile in Lasbela has been estimated at 11, while in Makran it is only 6. Thus between 1911 and 1951, Makran has shown a far greater increase in population than Lasbela, which may be attributed partly to natural growth but partly to better coverage due to the more complete census organisation in the remote areas at this

TABLE III

STATEMENT SHOWING THE VARIATIONS OF POPULATION IN THE VILLAGES, LYING IN THE PLAIN AREA OF THE COASTAL REGION IN BETWEEN 1911 & 1951

Village	1911	1951
Bandi	20	750
Bisholi	87	650
Panwan	39	860
Ban	49	100
Chakuli	128	190
Kappar	62	600
Gano	50	49
Chichai	247	190
Kila	529	300
Kund	368	770
Musafri	233	450
Mawali	564	1280
Pathra	94	530
Sakran	904	1910
Batra	95	50
Had	282	410
Japi	57	80
Kawari	102	60
Rachh	84	80
Tusuk	52	70
Bala	259	380
Chhor	146	130
Windar	115	580
Siranda	460	190
Adam Pir	142	220
Total	5,168	9,879

census. The urban population in the two States is only 6% of the total population, while the rest of the population is either settled rural or semi-settled or even nomadic in character. It is interesting to note that these states have plenty of people who are of working age, ranging from 19 to 59 years and constituting 41% of the total population. The table given below gives an idea of the people of different age groups.

Age Group	0-9	10-19	20-29	30-39	40-49	50-59	60 and over
Percent	30	21	12	14	9	6	8

The above figures also reveal that these two states have high birth rate and low expectation of life so that the number of children and young people is high, the number of old people low.

According to the 1951 census the population of the coastal settlements is 17,000 which comes to about 8% of the total population. It is interesting to observe that the coastal population has increased by about two and a half times within the last fifty years. (see table). There is decline in number only in one case and that is of Sonmiani, where the population has gone down from 1,245 to 460. Before the rise of Karachi and Ormara which are better sited than Sonmiani as regards their physical setting, it was important as a port through which much of the trade was carried on, but with Karachi and Ormara enjoying more favourable conditions on either side of it, it has dwindled in importance. Hence the decrease in its population.

Besides, the population of the villages, lying along the coastal plain of the area under study, has nearly doubled within the last fifty years.

It is significant to note that the partition of the sub-continent into India and Pakistan which has considerably affected the population of the areas elsewhere has failed to affect the population of this coastal region at all.

TRIBES

The other important thing to note is that the entire population, though Muslim, is sharply divided into the layers of the tribal society, which live apart from and dependent of one another. There are three main division of the population, which are mainly based on the principle of division of labour, and are locally recognised; (1) the dominant class called *Hakim*; (2) the middle class known as *Baloch*; and (3) the lowest class the menials and servant members of which are called *Hizmatgar*. The traders are generally non-tribal group and have their homes elsewhere in Pakistan. The Baloch is the largest tribal group, constituting about 37% of the total population. They generally possess little land and are organized in small communities. The Brahais, which are 13.5% of the total population, are the second largest group. Lasis, an indigenous tribal group of the Lasbela State, come to 20% of the total population. There are very few Jats and Pathans in these two States and constitute about 2% and 1.5% of the total population respectively. Other indigenous group, which is about 25% of the total population, comprises the miscellaneous indigenous tribes such as Darzada, Cadra, Lori, Nakib and others whose home is the coastal country of Makran and Lasbela. Most of these tribes are nomads and are famous as camel breeders, flock-owners, and whenever they find a place which is fit for cultivation, they quickly form a permanent settlement and adopt the life of a cultivator. The last group represents the inferior classes and their inferiority is determined by the type of work they do. Some of them work as agricultural labourers within these States.

There is non-tribal group, which comes to about 3% of the total population, represents that section of population which does not belong to any of the indigenous tribes, and consists of either permanent settlers or temporary visitors from other parts of Pakistan and elsewhere.

Nomadism is a dominant feature in the area. Also there are many examples of semi-nomadism, in which cultivation and stock-raising have been intermingled. It will not be possible in this short paper to deal with nomadism or the condition under which it exists or the development it has undergone and may undergo in future; still it may safely be stated that it is in a stage of progress, and the nomads have already started showing better adaptation to the geographical environment of the area. In spite of this, a regular migration is still going on. The prosperity of the tribe depends on the number of flocks which it owns, and thus there is a great desire to extend the grazing grounds. It often leads to tribal feuds.

Under the climatic and other physical conditions of the area, nomadism would at first sight appear inevitable. But this is not quite true, as during the last few years some changes have already taken place, and even tend to become more marked. This transformation will be the influence of a gradual process of development through which the whole social structure of the tribal society is already passing.

OCCUPATION

It is difficult to give any estimate of the numbers engaged in various occupations within the area under study, and no attempt can be made to make a comparative study even on the basis of these two states, as the census figures of the previous decades are unreliable and inadequate. On the strength of the 1951 census, it can be estimated that in the Lasbela and Makran States about 31% of the total population engaged in agriculture and non-agricultural activities, about 69% of the total population has been shown as dependant on the working population. About 67% of the depending population is made up of womenfolk.

As regards the occupational distribution, about 75% of the total working population has been classified as the agricultural force;* about 25% of the total working population is Non-agricultural Labour Force. About 60% of the total working population works as cultivators; about 13.5% supports itself as the herdesmen and the animal breeders, and about 5% of the total working population lives on fishing as the main occupation. About 1.5% of the working population is employed as the manufacturing workers. The remaining 20% of the working strength may be called un-classified, non-agricultural labour force.

SETTLEMENTS AND THEIR DISTRIBUTION

Location

The area under study is sparsely populated and possesses very few villages, which are very small in their size. The forms of human settlements have a great bearing upon and a deep relation with their environment to

* This statement may not be taken true in the case of the area under study, as the occupational conditions are quite different. In the absence of figures, no attempt can be made to give any occupational distribution within the coastal region. Apparently, the main occupations of the people living within the area under study may safely be said the flock-owing and fishing, in which a large percentage of working population is engaged.

which they owe their own existence. In this barren and desolate tract of land, each settlement, whether it is a village, or hamlet or even a single hut happens to have a natural location. The distribution of human beings and their size of settlements are in direct proportion to the distribution of natural water sources, the quantity as well as the quality which these sources supply. The influence of such water bodies may easily be marked by the size and the density of a village, or any other form of human settlements, directly depending on them. The topographical conditions have also provided a natural advantage of the location of many a village within the area under study. The direction of winds, combined with other coastal landforms advantages have been great influencing factors for the selection of sites for various coastal settlements, which now have assumed a character and a form of an urban settlement, where small vessels and boats get a shelter from the prevailing winds. However, the part played by the coast in providing better facilities for fish and fishing may also not be over-looked, while enumerating the factors of location of various settlements along the coastal region. Many of the human settlements may be marked either on old caravan routes, running alongside the dry-streams or on camel tracks which connect the coastal settlements with the interior. At several places along these routes, the supply of fresh water is almost uncertain. Also there is a scarcity of forage. In fact, the physical conditions are mostly responsible for the unequal distribution of population and human settlements in the entire region. The population in such a barren region is mostly confined to oases, which are completely separated from each other. For miles together, in many parts of the area under study, there are hardly any permanent habitations, and even they are merely a few temporary palm-leaf huts occupied by cattle-breeders and flock-owners. On the other hand, if there are few patches of cultivable land, they are always accompanied by villages of permanent character. Since water is necessary to all life, it is to the wells that villages or hamlets have been attached.

Distribution of Settlements

The distribution of the human-settlements within the area under study is very uneven, and varies from the eastern sector to the western sector of the coastal region. The region possesses a number of villages, hamlets and single huts. The village is generally defined as a revenue 'mouza' with all its attached hamlets. In this case, as it is in the entire Baluchistan Union States, the term 'village' signifies not only the revenue 'mouza' with its attached hamlets, but also residential localities occupied at certain season of the year by the semi-nomadic people in the course of their migration. In such cases the encampments have also been treated as a separate village. There is hardly any information available to estimate the temporary and permanent villages already existing within the area under study. The size of the village varies from 0-50 people a village to over 900 people. Besides this, there are settlements along the coast, the population of which varies from 1,000 to over 6,000.

About 17.5% of the total number of villages fall under the category ranging from 51 to 100 people living each village; the villages with a population of 101-150 rank second and come to about 15% of the total number of villages; the settlements having 0-50 people per village come to about 13% of the total number and stand third in rank. The category of villages with a population of 151 to 200 ranks fourth and are about 12% of the total strength of villages of the area. The rest of the villages are in minority and form a little percentage. (See Table IV.)

TABLE IV
STATEMENT SHOWING THE DISTRIBUTION OF VILLAGES ALONG THE BALUCHISTAN COAST

Size of village (population)	0-50	51-100	101-150	151-200	201-250	251-300	301-350	351-400	401-450	451-500	501-550	551-600	601-650	651-700	701-750	751-800	801-850
	5	4	2	1	2	—	2	2	1	2	1	3	1	—	—	1	1
	10	16	15	13	8	5	3	3	3	1	1	2	1	—	2	3	—
	15	20	17	14	10	5	5	5	4	3	2	5	2	—	2	4	1
	13.1	17.5	15.0	12.3	8.7	4.4	4.4	4.4	3.5	2.6	1.8	4.4	1.8	0	1.8	3.5	0
																	8% = 100

Based on The Village List of the Baluchistan Union States, 1951

Having in view the Eastern and Western sectors of the coast, the Lasbela coastal region possesses about 76% of the total number of villages. On the other hand, the Makran coast possesses about 24% of the total strength of the villages. The villages in Lasbela are comparatively larger than those sited in Makran. As the size of the village is dependent upon the water and forage facilities throughout the coast, there are very few spots which can afford large concentrations of population at one single spot. Whatever their number or size, the spots available for human habitation within the area show a marked and significant difference from east to west. There are very few settlements which may be called permanent.

It is also significant to note, that with the enforcement of some kind of administration and security measures, however, a change has come over in the character of the villages, and now they consist of a collection of mat huts jumbled together without any order. They are divided roughly by narrow lanes, instead of protected forts, where the mat huts have been placed inside the walls. Besides, here and there is also to be seen a few permanent residence made of sun-dried bricks, but still surrounded by the usual courtyard of matting. Many of the huts within the region are made of mud or earth with a shelter of dwarf-palm mats. The common goat-hair blanket tents of the nomads are also seen in the area. The native material is employed in the building of the houses and huts, and almost all are very humble in their finish and architectural style.

Settlement Patterns

The area under study has a definite form of human settlements which may easily be distinguished. It is rather easy to classify them into three major groups:

- I. Dispersed Settlements
- II. Concentrated Settlements
- III. Semi-permanent Settlements.

I. In the first group fall those villages which are (a) occupied by the communities of small, isolated cultivators and fishermen, and (b) those which are inhabited by animal breeders and cattle owners and may be termed as the community of 'maximum dispersal'. In this group single hut settlements may also be included. The locale of all such settlements is always changing along the migration of people within the area.

II. This group comprises of those villages which have been concentrated at one spot and where people usually live permanently. Under this group the following types may be recognised: (a) The cross-road and way-side villages which are situated at the cross-road and along the roads within the area. Such villages are generally sited along the camel tracks, bridle paths, caravan routes and also at the crossings of the fair-weather roads; the communities of nuclear villages which are only found along the coast within the region. (b) There are the Mushroom-growth villages which have assumed no specific shape or form, yet which are permanent. Such villages are just a heap or cluster of huts and nothing more. They may be found both along the coast and the plain area.

III. To the last group fall those settlements which have fixed encampment grounds. In one season of the year the people migrate in search

of food and fodder, and in the other season of the year they come back to their respective localities and have their huts erected at the same spot. Such localities have been occupied by the semi-nomadic and semi-sedentary people.

URBANIZATION

In spite of the fact that the area carries quite a few concentrated settlements, none of them can ever be called truly urban. They are at best urban villages. They are towns with a collection of houses possessing very little urban characteristics. Their population ranges from 1,000 to over 6,000 people. Urbanization in true sense may hardly be observed due to the backwardness of the region, where hardly any industrial life exists. The main attraction in such urban villages is the opportunity for trade. In other words these villages could be called towns only by courtesy for they have been treated as such partly due to their being headquarters or military posts and partly owing to their positions as markets in this area. Under this class Ormara, Pasni and Jiwani and Gwadar may be treated.

Ormara is situated about 120 miles due west of Karachi, on the east of the hammer-shaped peninsula, at the base of hills and protected from the winds. Its population is mainly of fishermen, about 2,720. The dwellings are mostly huts and very few 'pukka' buildings exist. A telegraph office has been located there. It is the main post of the Lasbela State.

Pasni is situated 95 miles west of Ormara. It is the main port of the Makran State, and is connected by a road with Turbat. The population consists mostly of fishermen. It is surrounded on three sides by sand-dunes; and in the west lies a real hill locally called 'Jabal Zain'. Due to the shortage of building materials there are very few 'pukka' buildings in the town. The population of the town is estimated at about 6,630.

Jiwani lies on the eastern side of the Gwadar Bay. As a port its location can hardly be called satisfactory, as the prevailing winds for the greater part of the year make landing difficult for fishing craft. The town is very small with a population of about 3,310, but it is beautifully laid out with neat and clean houses. There is a Royal Pakistan Air Force centre which is adjacent to the village of Jiwani.

CONCLUSIONS

After having a cursory glance on the physical environment of the region, it is evident that it holds very little attraction to the people for any permanent settlement. Wherever any fresh water supply and suitable soils are available for raising any crop or fodder are available, it has become an attractive spot for people to make it their permanent abode. Internal migration exists on a large scale within the area under study. However, fishing and to a little extent agricultural population is fixed. Large number of nomadic tribes keep on continually moving from place to place in search of fresh water and pasture lands for themselves and for their flocks.

As the greater part of the area under study is occupied by barren land, there are scattered small size settlements of fishermen and sedentary population, supported here and there by little patches of precarious cultivation. Much of the land is not fit for human habitation. Such areas may

be termed as 'negative areas'. They are uninhabited and in many cases are likely to remain empty, as they are too rugged and barren to permit any settlement depending on cultivation. In the larger part of the region there are very little chances for permanent and semi-permanent settlements, except in the fertile valley of streams and nalas where, there are culturable land, supporting small villages, and where people may carry on agriculture and flock-owning wholly dependent on the rainfall received along the coast. There are some chances of developing the stream valleys. They may be developed and irrigation facilities may be extended upto coastal region. But it all depends upon the frequency and nature of floods in these valleys, which should be investigated. There is thus a chance of cultivating the little cultivable land which lies in this region. To create an attraction for any permanent settlement, it is necessary to organize a few caravan to carry the produce to market. Also many villages should be linked up with motorable roads. A coastal railway connecting Karachi with Jiwhani, though not an economic proposition for several years, is greatly desirable in this connection. Not only fishing and fish curing, but also animal breeding, crop raising and a few cottage industries may be stimulated, which may be helpful in raising the standard of the people. Commercial centres with great animal fairs may be organised along the cross-road villages in the area. To provide a better and settled life, water may be tapped with the best modern engineering skill, and thus the development of the water resources is also necessary in the region. Through these measures, the area is bound to have a better economy, nomadism will decrease and settled life would be greatly encouraged.

ACKNOWLEDGEMENT

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REVIEWS

POLITICAL GEOGRAPHY AND THE WORLD MAP:—By Y. M. Goblet.
292 Pp; Maps, half-tone plates. George Philip & Son, Ltd., London,
1955. 30s. net. $8\frac{1}{2} \times 5$.

The discipline of Geography is both centripetal and centrifugal. Regional Geography — the core of the subject — illustrates the centripetal nature of Geography while Geomorphology, Climatology, Economic Geography, Political Geography and other branches of Geography demand a working knowledge of their respective border disciplines. The character of Geography is thus unique, and this makes it very difficult to develop a rigid methodology in the subject. Now, more than ever before, there is a strong urge for theory and quantitative approach, and this is evidenced not only in the scholarly contributions in the different branches of Geography in the various Geographic Journals but also in some of the text-books, published recently. Twenty-five years back Political Geography was described as "the wayward child of the Geographic family", and that, dealing with the aspects like political organisations and political attitudes of the people. At that time there was also a threat to amputate political geography from Geography. Then, political Geography was also not included in many College curricula. But now the situation has taken a favourable turn, though this is interpreted by some as only "an outward sign of success".

It should be realised, more particularly in our country, that the future of Geography entirely depends upon scholarly work and better teaching, the latter, being possible only when there are really good text-books, which can be produced only from the digest of scholarly and field studies. Only then, there is scope for establishing a definite field for a discipline of study.

One finds that in some of the text-books on political Geography there is a tendency to theorise superficially, while in others, there is fanciful visualisation by the authors. Dr. Goblet's book does not fall in any of the above categories. It incorporates the findings of the Professor for a quarter of a century, and there is evidence of his proficiency both in style, method and interpretation.

The book is divided into eight parts—Part I—The development of political Geography — its role and sphere and method; Part II — Elements and forces; Part III — State and Nation; Part IV — World relations — Route — Interdependence and Frontiers; Part V — Types of States and Evolution and Dissolution; Part VI — Colonisation; Part VII — Political Geography in the making and Part VIII — Conclusion. The maps included in the text are informative and some of the photos and sketches are instructive.

However it should be said that the book is not without shortcomings. It is difficult to understand why the famous dictum of Mackinder is quoted as "who rules in Europe commands the Heart land" (P. 13). The treatment of the section — Political Geography in the 20th century (Ch. I) is very brief and one would expect a detailed treatment of Mackinder's theory and also Haushofer's geopolitics, though it is now branded as a negative school

of thought, receded into background. The section on the great political regions is also very brief. Some of the boundary problems in the type areas of the world could have been discussed in chapter 3. It is surprising why such an important aspect of Political Geography — the formation and functioning of political capitals is omitted altogether. Excepting for short notes at the end of each chapter, there is no bibliography, and in a treatise of this type one expects a comprehensive listing of titles. There is also no index.

In spite of these lapses, Dr. Goblet's treatise is a type by itself in the general literature on Political Geography dealing with systematics. We are confident that not only to the post-graduate students in Political Geography and Political Science but also to those who deal in political affairs, the book will prove to be a valuable reference text.

V.L.S.P.

- (1) THE INDIAN GEOGRAPHER: Vol. I, No. 1, August 1956. Pp. 100. Price Rs. 4; Foreign 10 sh. or \$2.00. Ordinary Membership Rs. 5. A 'semi annual Journal' published by the Association of Indian Geographers, Post Box 644, New Delhi.
- (2) GEOGRAPHICAL OUTLOOK: Vol. I, No. 1, January 1956. Pp. 64. Price Rs. 2. Foreign 3 sh. Ordinary Membership Rs. 4. Issued twice a year — Published by the Department of Geography, Ranchi College, Bihar University, Ranchi.

It is becoming more and more evident these years that the profession of Geography in India is showing signs of virility and vigour. This dynamism is partly symbolised in the two above mentioned additions to the short list of Indian Geographical periodicals. Both the new Journals are half yearly, and it is indeed a wise and a cautious step to start a new Journal as a half-yearly, if not an annual, in spite of the likely comment that contributors become a bit impatient.

From the contents of the *Indian Geographer* published by the Association of Indian Geographers, it becomes evident that the journal is broad based, having many of the sections of a full fledged journal. The bibliographical notes is really a very valuable feature while the photo-geography section is novel and instructive. It will further add to the value of the journal if the section includes the photos of local aspects of geographical interest. One wonders whether there is any need for a popular section as such in a scientific journal. A section on local or regional geography will be more valuable. This means of course more of local and regional studies. The get-up of the journal, format and type are pleasing.

Geographical Outlook is of a different tone. The scope of this journal seems to be more regional, and aims are modest. It appears from the contents that the journal is going to emphasise on the different aspects of Human Geography. It is, of course, true that the contents of a journal cannot always reflect its philosophy, since the final cast depends on the articles available. If this journal succeeds in primarily stimulating local and regional geographical research, it would have served its purpose quite well.

That India has a large reservoir of geographical information, yet untapped, needs no special mention. But the problem is how to get at this reservoir? Either facts should be collected in the field, which is impracticable because of the size of the country and the dearth of technical workers (more than 3,000 post graduates in Geography are needed even for sampling work) or the information already collected by the different agencies should be made available for what it is worth. To sermonise that each Geographical Society in India should endeavour to centralise all geographical data pertaining to the region in which it is located, and conduct local field-work with the help of local geographers and workers is very easy but most difficult to translate into action.

We look forward for the achievements of these two Societies. We must say that the Editors of these two journals are to be commended for what they have done.

There can be no difference of opinion on the point that India needs more Geographical Societies, primarily judged from the point of view of the country's geography potential. It should also be recognised that the mere existence of a Society cannot necessarily stimulate or maintain the tempo of work. There should be genuine workers and also facilities for work. But how to get workers of the right type and train them is a problem of first order, and this requires leadership of the type of Blache or Davis.

The new societies should draw up their programmes of work in such a way that the family tree of Indian Geography grows to its full stature. The *East Midland Geographer* published by the Department of Geography, University of Nottingham and *Geographical Studies* published from Birkbeck College, London, in our opinion, serve as good indicators.

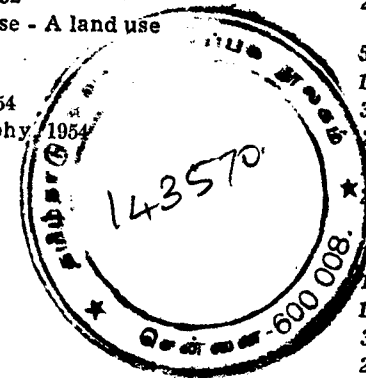
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