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CONTENTS

CLIMATE OF SIND

By

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Sind is primarily a desert, the individuality of which is made up of a subtle mixture of climate and relief, but the relief presents such a consistant and peculiar association of forms that it might almost be considered as an element of climate. In fact the sole criterion of the climate of Sind is aridity, and aridity in its turn produces a number of secondary characteristics such as sunshine, relative humidity and temperature range.

Now aridity while mainly a matter of rainfall, may be qualified by a number of other circumstances which may serve to mitigate or increase it. In Sind, the thirsty porous soil, desiccating winds and excessive evaporation go to emphasize the desert conditions intiated by a deficient and variable rainfall.

Sind is located on the flanks of the Kirthar Mountains near the Tropic of Cancer on the western margin of the Indian sub-continent. On account of its characteristic interior and leeward location temperatures tend to be severe for their latitudes. The annual mean maximum temperature is 91.6° F., while the annual mean minimum temperature is 68.1° F., for the whole area. The seasonal temperatures are relatively extreme and consquently the annual range is large, amounting to 23.5° F.

More marked, however, are the large daily ranges of temperature. In Jacobabad the diurnal range of temperature is 45°., F., though in the south near the coast the range is less. Clear, cloudless skies and a low humidity (63.6%) permit an bundance of solar energy to reach the earth by day, likewise allow a rapid loss of earth's energy at night. Large diurnal ranges of temperature in the area are associated with the meagre vegetation cover, which presents a barren surface to the penetrating rays of the sun by day.

In the north of Sind the trend of monthly temperature is irregular. After the fall of 72.3° F., of temperature, in January, there is a very steep ascent in February and March and a slight rise in April, then again sudden rise for May till

*Figures are based on India Weather Review ; 1935—1945.

themaximum of 107.4° F., is reached in June. The fall after Juue is also rapid with little fall in October, as in central and southern parts of Sind.

In central Sind conditions differ sligetly than the southern Sind. Maximum temperature of 107.0° F,, is reached in May with rapid fall upto August. In the months of September and October there is a gentle fall and then a sudden rise again in the winter months of November, December and January. In January the temperature is 75.8° F.

In southern Sind there is a steady rise of temperature from 73.6° F., in January to 103.9° F. in May, which is the hottest month of the year. It then begins to fall in August and remains more or less steady in September ; then after a slight rise in October, it falls rapidly in Noverber, December and January.

Both as regards the daily and monthly ranges of temperature, central Sind and northern Sind differ from southern Sind, where the range is small owing to the influence of the sea. But even at a little distance beyond the coast line at Drigh Road, it increases considerably. At Karachi the daily range of temperature is 35° F., at Hyderabad it is 40° F. and at Jacobabad it is 45° F.

Though the rainfall in Sind is meagre the average being 6.3 inches per annum, it shows a definite monsoonal character, but it is extremely variable from year to year so that the average is misleading. Sind therefore suffers from two serious drawbacks *viz.*, meagreness of precipitation and its extreme unreliability.

It is not intended here to describe in detail the two currents into which the Indian monsoon fall and their relation to rainfall incidence in Sind. Suffice it to say that the goal in each case is the low pressure of the Indo-Gangetic Plain, culminating in the intensely low pressure over Sind. But the heart of the system varies in position from day to day and so influences the trajectory of the winds and the course of cyclonic storms in northern and southern Indo-Pakistan.

The monsoon rainfall due to the Arabian Sea Branch decreases considerably northward from the Gulf of Cambay. The rainfall is 29 inches at Ahmadabad, 15 inches at Bhuj, over 14 inches at Nagar-Parkar, 7 inches at Karachi and 3 inches at Sukkur. The explanation of this is to be found in two factors : (1) the trajectory of the air currents and (2) the dryness of the air of Sind. The eastward deflection of the air current in the Arabian Sea, seeking the focus of Sind, has become greater and greater from north, until it has practically lost its north-ward component and the air is moving east or even south-east. The rain bearing winds thus reach only to the south-west tip of Arabia and fail to reach Persia and Baluchistan where aridity at this season is complete. An east to west line drawn near Karachi divides those winds to the south which have travelled over the Arabian Sea, from those to the north which have travelled are the arid lands of Arabia and Baluchistan, and this line practically marks the limit of monsoon rainsall.

In November and December the temperature at Jacobabad falls as low as 50° F., and though the pressure gradient is also low, steady winds in the form of shallow or feeble storms begin to blow from north-west. These are mainly continental winds and therefore are dry. Bur when they pass over portions of the seas, such as Persian Gulf, they carry some moisture which is condensed and precipitated by northern winds. As a result of this storms pass successively across central Asia and occasionally also over northern Sind. Thus slightly cloudy skies and occasional showers of rain are the predominent weather conditions in winter in Sind. The seasonal character of the rainfall though meagre and fitful may be recognised all over Sind.

The amount of rainfall received, is more in summer than in winter. The actual Monsoon period commences from about 9th July and ends on or about 23rd July.

The rainfall at Nagar-Pakar is in striking contrast with the rest of Sind. Not only does this area receive the advantage of its height but touches, to some extent, the fringe of South West Monsoon current. Central Sind receives slightly more rain than Upper Sind, while in some years there is hardly any rain (less than 2″) in parts of Upper Sind. Even in years of great floods there is not more than 10 to 12 inches of rainfall in Sind (except Nagar-Parkar). The lowest rainfall occurs at Jacobabad where the average is 3.7 inches. It is worth-while to note that the average number of rainy days in a year in Sind is 7 only.

As mentioned earlier the rainfall in Sind is not only scarce but also irregular, so that for every one season of good rains, there are two or three or even more of droughts. At times again the whole amount of rain for the season falls within a couple of days and there is prolonged scarcity for the rest of the year. The result is terrific floods and the destruction of crops at one time and severe droughts at another. "Over the Indo-Gangetic Plain, variability is at a maximum in Central Sind, which is at once the seat of the most niggardly and also the most variable rainfall in whole of India"*.

SEASONS AND WEATHER TYPES.

For Indo-Pakistan as a whole, the year is popularly divided into three seasons, the cold season, the hot season, and the rainy season, but for Sind the most convenient divisions would be only to *i.e.* (1) long dry hot season from March to October and (2) a short cool winter season from November to February.

The Hot Season :—The characteristic features of the Hot Season are high temperatures, low humidity, clear skies and moderate to strong winds. This

*Williamson, A.V., and Clerk, K. G. T., The Variability of Annual Rainfall of India Quart. Jour. Roy. Met. Soc. 56 pp. 42 & 43.

monotony of oppressive heat is broken by a few cloudy days and occasional showers. These rainy days though few and far between, correspond to the 'Rainy Season' of Indo-Pakistan.

In fact Sind is a part of the Great Indian desert and is one of the most arid regions of the sub-continent of Indo-Pakistan. It is a striking fact that the Thar Desert lies exactly in the centre of lowest pressures and the scantiness of its rainfall is at first sight surprising. It is the result of the previous history of the winds that enter it. On the west the air currents come from the north-west across the arid plateau of Baluchistan and they become even drier in descending to the plains of Sinds, and can yield no rain. The inflow from the east, north, and north-east consists of air which has lost its moisture during its passage up the Ganges Plain and when the air reaches into the desert, it is dried still more so that the Thar including Sind receives no rain from this quarter. There remains the south coast of Sind. At Karachi the prevailing winds are west and south-west and they and especially strong during the afternoon. Here, then, would seem to be a source of rainfall. But these on-shore winds are drawn in from the immediate continental shelf, where the air is by no means saturated by moisture, since it is derived from the north-west current just mentioned as blowing over the plateau of Baluchistan. The wind can pick up but a small amount of vapour during the short passage over the sea, and this is rendered less effective, so far as the rainfall is concerned, owing to intense heating over the desert sands, which is by itself a result of cloudless skies. Owing to the heat the air rises and cools and if the ascent continues high enough clouds would be formed and precipitation way take place but before this can happen the rising air is caught up by the very dry upper current from the west which is known to exist here and are carried away.

The south-west monsoon of the Arabian Sea which gives such heavy rains to the Western Ghats does not reach the deserts of Sind; its north-ward boundary is the Gulf of Cambay and results in a slightly higher rainfall (over 14 inches) In Nagar Parkar penensula.

Almost all Sind and western Rajputana receive a mean annual rainfall of less than 9 inches, of which nearly 80% comes during this season. The summer (hot season) rain, in part, though light, is associated with rare depressions formed over the plains and, in part, occasional local heavy thunder storms in hot hours. Jacobabad has the lowest recorded rainfall of three inches during the Rainy Seanson, four inches during the whole of the year. Sometimes there is no rainfall for a year, at other times much more than the mean annual amount of rainfall may fall in few hours in sudden down-pour. The mean annual rainfall at Hyderabad is 7 inches, but 13 inches fell in the course of three consecutive days in August 1865, 10 inches in one of them. Doorbaji had 34 inches on one occasion within two days, the annual mean Being 5 inches. These sudden floods are more fatal to plant life than the drouhgts that usually prevail, for they wash away the surface soil and cover it up with sand, and they also do great damage to property. Most of the rainfall which goes to make up the mean annual total is of this spasmodic type. The air in tne desert is very dry but the coast has a fairly high humidity owing to the sea breezes. The sky is cloudless and the heat extreme.

It may be interesting to point out that over a large portion of Sind and the adjoining area on the east and north-east the rain is associated with north easterly components of upper winds and even of surface winds. In this region a monsoonic depression and its neighbourhood north-easterly or easterly winds give a very good chance of rain.

In lower Sind, particularly there would be north-easterly winds upto about 2 kms., above mean sea level and easterly or south-easterly winds higher up, a low pressure area can be judged apart from circulation by the weather at places like Bar Mir (Sind-Rajputana border) and Umerkot. The rain at most of the places in Sind would be preceded by thermodynamic dust strom of the 'andhi' type. They would be followed by thunder shower.

THE WINTER SEASON

During the winter months a series of low pressure waves or areas travel from west to east across northern India. These depressions when marked, are similar to the extra-tropical cyclones, where different sectors and fronts can be identified. They revive by drawing more southerly fresh moist tropical air when passing above the seas and bays in the south-west of Sind, and secondary depressions or disturbances get formed. For instance in the lower Persian Gulf and the adjacent Oman, secondary low pressure areas formed in midwinter and later. The secondary from Oman passes over Baluchistan and the North West Frontier Province. The secondary from the Gulf of Aden would almost simultaneously be approaching the north Arabian Sea off Makeran. It is also possible that the latter is induced as secondary low when a disturbance is passing over Baluchistan, quite distinct from the one that has moved from the Gulf of Aden. The secondary low pressure areas off Makran and off Kathiawar effect northern and central regions of. India.

Rain during this season may fall along the Makran coast and the adjoining region associated with two distinct isobaric types :

(*a*) A low pressure area of a western disturbance can be located over Baluchistan and North West Frontier Province and its secondary would be over the north Arabian Sea off Makran. A high pressure ridge would be passing between the two, with its tip directed towards the west. The rain starts at the western most part of the ridge and travels eastwards in regular way with a definite time sequence. It gi ves sufficient notice to forecaster to anticipate rain in the most easterly longitudes The time interval between a place like Jiwani (Makran) and Karachi is 6 to 8 hours in the month of December and more in January and February. The explanation of the weather is the normal one of an extratropical depression and there is nothing special about it.

(*b*) The low pressure area of the western disturbance is not as well marked over Baluchistan as in the previous case. A high pressure ridge, an off-shoot of the seasonal Arabian High projects eastward. The high pressure area of northwest Indo-Pakistan gets 'compressed' and shows a wedge of high pressure from the north. The other low pressure area to complete the whole picture would be over Kathiawar and Cutch. The rain starts at the eastern most point. The rain belt, therefore, may travel westwards along the Makran coast and revive the low pressure area of Baluchistan. The progress of rain may then resemble that of usual western disturbance, an outstanding example is the rainfall of Karachi on the 6-7th January 1945, when the rain started with hardly any warning.

CLIMATIC DIVISIONS

In the foregoing pages climatic conditions of Sind have been treated ; and it remains to divide the area into climatic divisions. A considerable number of classifications of the climates of the world have been devised by various authors and in them different geographical aspects have been emphasised. For instance Koppen emphasised on annual and mean temperatures, precipitation, temperature efficiency and precipitition effectiveness. Triwartha relied on simple classification taking descriptive elements of climate themselves. Ahmed mentions : "In the determination of climatic regions of a country the emphasis should be on the regional characteristics and not on certain predetermined aspect of climate"*

Thus an improvement on the above mentioned aspects of the climatic divisions could be made by combining descriptive elements on the one hand and elements of relief, vegetation and human occupance on the other.

Sind, accordingly, is divided into four climatic divisions and into six sub-divisions, as given below.

I. Deserts & Steppe Lowlands

(i) Kohistan

(ii) Indus Basin

(a) North Basin

(b) South Basin

(iii) Desert

II. Arid Highlands

*Ahmed K. S., Presidential address Geology and Geography section, Pakistan Science Conference, 1950

III. Dry Marine

(i) Delta

(iii) Cutch

VI. Marginal Monsoon.

Deserts and Steppe Lowlands (I)

This region includes a major portion of the Indus plain. The average annual temperture is 80.2° F., while the range of annual temperature is as high as 26° F. The hottest months are May, June and July, the temperature rising upto 107° F. January is the coldest month with a mean minimum of about 45° F. Dust storms are frequent in summer over the area.

The rainfall which is less than 8 inches, is concentrated in four months, from June to September, July and August receiving the greatest amount of rains, October, November and December being the driest months. Rainfall although meagre shows monsoonal rhythm, It is very uncertain, the variability of summer rainfall is greater than 40%. There is gradual decrease of rainfall from north to south. Although there is a secondary maxima of winter rains but it is weak, except in the north where it is more prominent. The climate of the area can be summarised as "High summer temperatures and late summer monsoon rains".

Within the region there is some variation as regards summer rains, winter rains and temperatures. Thus subdivisions of the region become necessary and are as follows :—

(*i*) Kohistan. Annual average temperature 79° F. rainfall 5.4 inches, mostly in July and August.

(*ii*) Indus Basin.

(*a*) North. Annual average temperature 80.2° F. rainfall 3.7 inches, mostly in July and August.

(*b*) South Basin. Annual average temperature 80.8° F., rainfall 7 inches, mostly in July and August.

(*iii*) Desert. Annual average temperature over 81° F., rainfall 8.96 inches, mostly in July, August and September.

Arid Highlands (II)

This region consists of the Kirthar Highlands from north to south. Winters are cold especially in the north because of the height of the Kirthar and summers are hot. Both the annual and diurnal ranges of temperatures are high. Rainfall is scanty and uncertain, from 4 to 6 inches. Dew is common in winters.

Dry Marine (III)

(*i*) Delta—This region includes the coast of Sind which extends from Cape Monze on the west and upto the mouth cf Eastern Nara of the east. The annual average temperature is 79.8° F., the rainfall amount to 9.7 inches which falls mostly in the months of July, August and September. Land and sca breezes are experienced on the coast all along from Cape Monze upto a little beyond the mouth of the Eastern Nara. The Breeze during summer days is very strong and reaches upto Hyderabad where it is harnessed through wind-traps into rooms to make them cool.

(*ii*) Cutch—A small strip of coast beyond the mouth of the Eastern Nara on the eastern side is not much influenced by the sea as this portion is actually on the north of the Runn of Cutch which is not a sea. It receives sea water only for about three months when the monsoon is active and dries up when the water has receded. The rainfall here is slightly more than in the delta.

Marginal Monsoon (IV)

This is the smallest region in the area and comprises of the small peninsula of Nagar-Parkar in the extreme south-east corner of Sind. This region is on the margin of the Tropical Monsoon Climate on the one hand and Hot Desert on the other. The annual temperature is high and the range is also great, thus it is akin to the desert ; while the rainfall amounts to 14.85 inches annually which falls mostly in the months of July, August and September. In July alone the rainfall is 6.12 inches. The amount of rainfall and the rhythm indicate affinity of Monsoonal character.

Climatic changes

There are several records to show that Sind experienced a better and more favourable climate in pre-historic days. The excavations of Mohen-jo-daro and of other kindred sites distinctly indicate a wetter Sind in the pre-Aryan period. Of the later records were the forests which were full of wild animals and the remnants of those forests can still be seen.

The admirable researches of Dr. Khan* show that in the Chaleolithic age of Mohen-jo-daro the rainfall of Sind must have been 20 inches average annually. Dr. Normand **has opined that more rain in the summer season was possible in Sind and Baluchistan at the time of Indus Valley Civilization. "A very much greater change in meterological conditions is required to explain a copious rainfall in winter, unless a change in geography of Sind's surrounding is simultaneously postulated"*. "From the presence of many drains and pipes and burnt bricks of Mohen-jo-daro, figures on seals of animals living in moist climate such as rhinoceros, tigers and elephants and of trees on painted pottery, it can be summarised that Sind must have seen wetter years in the millenniums before Christ"** Remains of elephants and rhinoceros are actually found on the eastern side of Kirthar Range.

Raverty***has noticed in Arabic geographies a reference to the green

* "Historical Geography of the Punjab". Thesis unpublished
**Dr. Normand was Director Meteorological Department of India (Undivided)
*Marshal, Sir John ; Mohen-jo-daro and the Indus Civilization, 1931. p. 12.
**Majumdar, N.G., Exploration in Sind. Mem. Arch. Sun. Ind. 1927. No. 48.
***Reverty H.G., 'The Mehran of Sind and its Tribularies'. Jom. Asia. Soc. Beng., Vol. LXI, Pt. I, 1843. P. 70.

(Hariana) and cultivable lands now lying barren. A big forest between Lakhi and Khanpur in Larkana district was actually utilised by the 'Daudpotras' for their 'Shikarghas'.

There is a suggession made by some people that Sukkur Barrage which is functioning since 1932, would help Sind to secure more rains. Considerable data must be collected and more time must elapse before the moteorologists of Sind can come to any definite conclusion. It is not impossible that more extensive water supply, perennial irrigation, afforestation and continuous evaporation may cause slightly greater precipitation of rainfall in Sind in years to come.

SOME GEOGRAPHIC CONTROLS IN THE SUBMONTANE REGION OF WEST PAKISTAN

BY

Dr. MISS MARYAM K. ELAHI

The regional study of an area involves various physical and human factors which control the economic activities of its inhabitants. Our sub-montaine region bounded on the South by the Salt-Range escarpment includes the Cis-Indus districts of Jhelum, Rawalpindi, Attock and Hazara. In the trans-Indus parts of the region are the dissected hills of Kohat while to the north and south of them are the plains of Peshawar-Mardan and Bannu drained by the Kabul and Kurram rivers respectively.

It forms a distinct unit, physically, climatically, economically and socially. Within its limits, physiography and structure have controlled the area under cultivation, the rainfall regimes have given a pattern of crop distribution in Rabi and Kharif. Percentage variability of rainfall determines to a great extent the success of the crops.

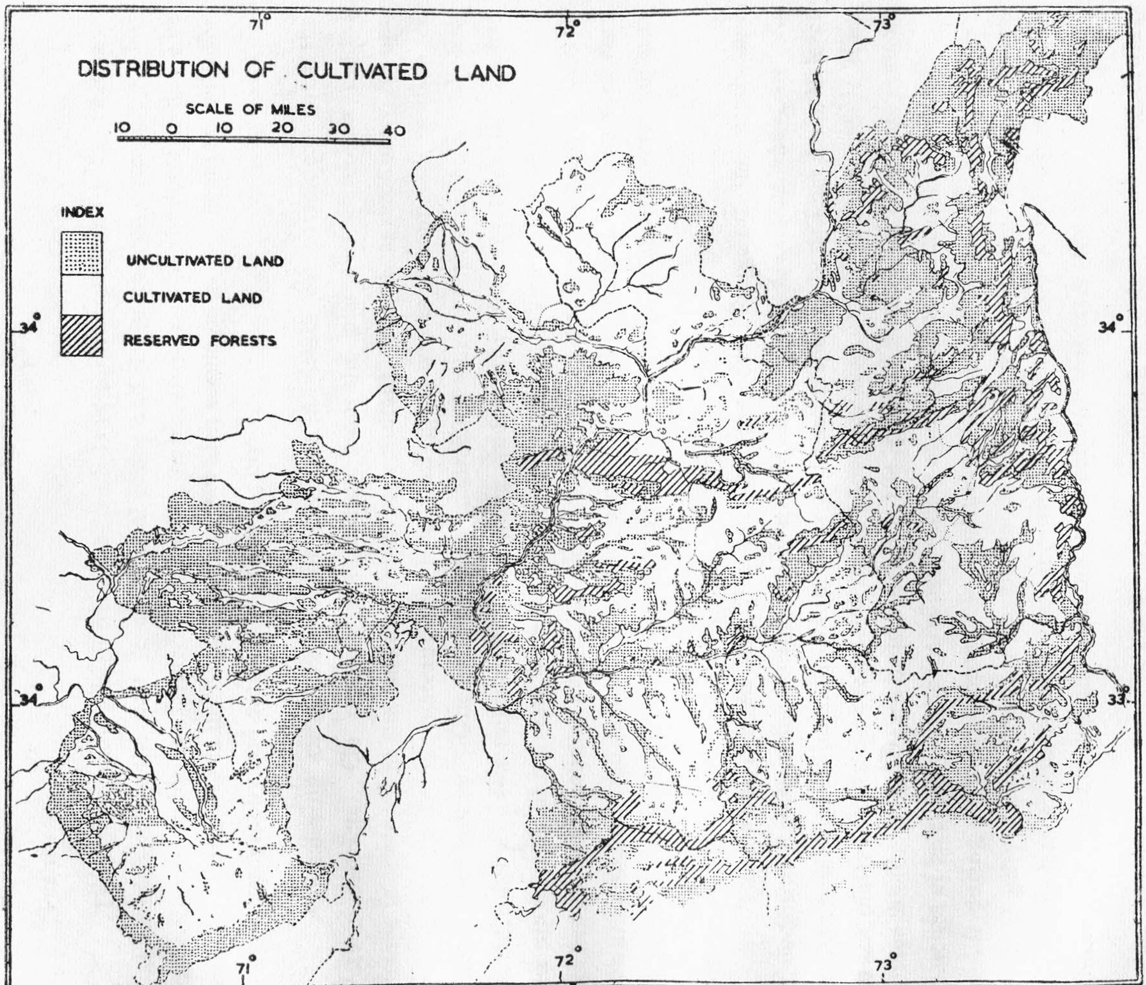
As a result of these controls on agriculture which is the main occupation of the people the distribution of population is greatly determined by the productity of the land. Human and social controls are no less important than the environmental limitations as it is the man who brings under control certain natural phenomena or as is the case in our region, accepts the laws of nature and strengthens the physical and climatic boundaries.

To discuss in details these various controls one would classify them as under :—

(1) Physical and

(2) Human.

The Physical personality of the region and action and interaction of various climatic phenomena have limited the area under cultivation in the region to only 38%. The percentage of cultivated area, however, various in different parts of


DISTRIBUTION OF CULTIVATED LAND
SCALE OF MILES
10 0 10 20 30 40
INDEX
UNCULTIVATED LAND
CULTIVATED LAND
RESERVED FORESTS
71°
72°
73°
34°
33°

the region as the following table shows :

Jhelum	41%	Mardan	68%
Rawalpindi	45%	Kohat	18%
Attock	39%	Bannu	38%
Hazara	27%		
Peshawar	51%		

The figures show a high percentage of land under cultivation in Peshawar and Mardan where the vast level alluvial plains and the abundant water supply has made it possible for the farmers to cultivate more than half of the total area. The least cultivated area is in the Kohat district which seems to be in keeping with the rugged topography and scarcity of water supply.

Considering these values, for the area in detail we commence with the Potwar districts. On crossing the Jhelum from the plains of Panjab, a radical change is observed in the landscape and the resultant type of agriculture. As one approaches the Potwar plateau, the level land gives way to a confused medley of hillock and hollow. One enters a stony mooreland where nature is noticeably less bountiful than a few miles south, and strong and sturdy peasants have to combat the uncertainty of harvests with their limited resources. Vegetation is thin, trees are few, and the country even in good years when every patch of cultivated land is sown, looks bare and rocky. The map showing the distribution of cultivated area brings out the relationships of topography and watersupply in determining the area under plough.

The potwar plateau stretches between the Salt Range on the south and Kala-Chitta Range in the north, while the Makhad-Janda area and the foot hill tracts of Rawalpindi bound it on the west and east respectively. The general level of the plateau varies between 1500-2000′ above scaleved. Only at few places it rises above 2000′. Dry stream beds intersect the plateau surface, leaving only small patches of level land in the interflues. Most of the streams are seasonal only coming to life during the rainy season. In most cases the agricultural land is rather away from the dry stream beds-for fear of floods that come unwarned. The bleakness of the landscape increases as one approaches the rough and stony areas towards Indus in the west and to the foothills in Rawalpindi district in the east.

Permanent streams in the Potwar Plateau are few as River Soan, Wadala Kas, Sil and Pindigheb sil. But none of these streams in the potwar are of much use for irrigational purposes. The roughness of the land around, the low level of the streambeds and the seasonal nature of the streams are great handicaps in the way of developing any irrigation system. Few wells are to be seen near the larger stream beds, which irrigate the sil.soan circle-where the water table is high and the task of constructing the wells is less difficult and costly and also the amount of water available from the wells is satisfactory.

While the physical factors have thus limited the cultivated land in the Potwar to only 41% of the total, the wide-spread distribution of upper Tertiary rocks with some favourable dome structures have supplied it with oil—a valuable asset besides agriculture. In brief a low water table, thin soil covering and lack of irrigation possibilities make it a hard land for agriculturists yet in the absence of other resources land is the main source of subsistance.

Figures show the highest percentage of cultivated land in Peshawar and Mardan districts. Most of the area is an alluvial plain drained by river Kabul, Swat and their tributaries. The western part of the plains—the so called Doaba area—a low lying fertile alluvial tract is one of the most intensively cultivated areas of Pakistan. The ample water supply from the rivers and the fertility of the plains has led to the development of large irrigation canal system which irrigates 71% of the cultivated area in Peshawar and 63% in Mardan—a great contrast to the Potwar plateau area where hardly 4% of the cultivated area is irrigated. The effects and limitations of low rainfall are thus irradicated to a great extent in Peshawar and Mardan and the security of the harvests is thus guaranteed.

The Cis-Indus continuation of the Swabi plains in Attock district forms a fertile oasis of Chach plains—where prosperity is closely related to the fertility of the soil and to the high water table which has given place to the numerous wells which yield plentiful water at all seasons.

Bannu district has only 38% of the total area as cultivated. Most of it lies in the Bannu Doab—a long narrow tract between Tochi and Kurram—forming the garden area of the district. It is a highly irrigated and intensively cultivated tract. In southern and southwestern parts of the distric the cultivated area is restricted more by the aridity than by its physiography. Daman areas are also barren because of the alluvial fan structures with coarser material and shifting braided channels. Such Area intersected by numerous dry stream beds are in no way attractive for the peasants.

Kohat and Hazara districts show considerable low percentage of cultivated area—18% and 27% respectively.

Most of the Kohat district is hilly and rugged, is cut and sliced by the streams following east and south east to the Indus. The cultivated areas are restricted to the long narrow tracts along the streams where there is some fertile alluvium and water available for irrigation. Whereas in Kohat physiography as well as watersupply are adverse to the extensive cultivated tracts, in Hazara it is only the former factor that has given small percentage of cultivated area.. Rainfall is ample and the surface drainage shows no dearth of water supply but the inaccessibility of the mountainous parts—difficulty of terracing the steeper slopes have confined most of the agricultural land to the few plain areas and the lower and gentler slopes along the valleys. The fertile plain areas as Pakhli plains, Haripur plains and Mangal and Rash tracts are capable of supporting great population densities.

Climatic Controls :—

Influences of climate are no less pervasive than the physiographic control in providing space and resources for the inhabitants of a region. Agriculturists in our region are more or less what the sun, wind and rain has made them. The agricultural scientists have paid little attention to the mirco-climates. The region happens to be in the subtropics and no part of the region below 5000, is too cold for successful growth of winter crops. Only the higher parts produce one crop a year—during summers.

The greater control however is exerted by the amount of rainfall received during the year, its seasonal distribution and its variability.

The distribution of annual rainfall shows that a small area in the south western part of the region received 10″ of rainfall during the year. The amount of rainfall increases from south-west to north-east where the rainfall is more than 50″, with the amount of rainfall is connected the variability of rainfall which affects the success of the crops. The accompanying graph showing the total average annual rainfall received in each district and the percentage variability of rainfall leads to the following conclusions.

(*i*) variability tends to be low where the rainfall is ample *e.g.* in Hazara and Rawalpindi.

(2) Variability is higher where the rainfall tends to be low or moderate 17″23″—Jhelum, Attock and Peshawar and Mardan.

The proportional map showing the average percentage of crops failed studied with the variability percentages in each district, shows that the districts with high percentage variability—like Kohat, Attock, Jhelum, Bannu and parts of Rawalpindi have crop failures ranging from 15-20% of the total sown-uncertainty of rainfall results in uncertain harvests. The noticeable absence of crop failures in Mardan and Peshawar is the result of ample supply of irrigation water which masks the effects of high variability of rainfall in these areas. In Hazara, the abundant rainfall with its low percentage variability is a security against crop failures.

Most of the crop failures are connected with the Barani Rabi Crops as the variability of winter rainfall is greater than the summer (monsoon) rainfall. In most of the region, two crops are grown in a year, Rabi and Kharif and the acreage under these depends upon the available resources. In an area like our region where only 21% of total cultivated area is irrigated, the climatic conditions favour the growth of Rabi crops. About 62% of the cropped acreage is given to Rabi crops. The relative importance of Kharif crops increases only in areas of greater summer rainfall or where there is high percentage of irrigated acreage to ensure the heavy demands of moisture during the summers when loss through evaporation and transpiration is great. Thus in Hazara greater acreage is sown under Kharif crops than under Rabi crops. In Rawalpindi both Rabi and Kharif crops almost balance each other. In Mardan and Peshawar inspite of low summer rainfall (July to September) below 10″—the Kharif crops attain considerable importance due to the irrigation facilities in these areas.

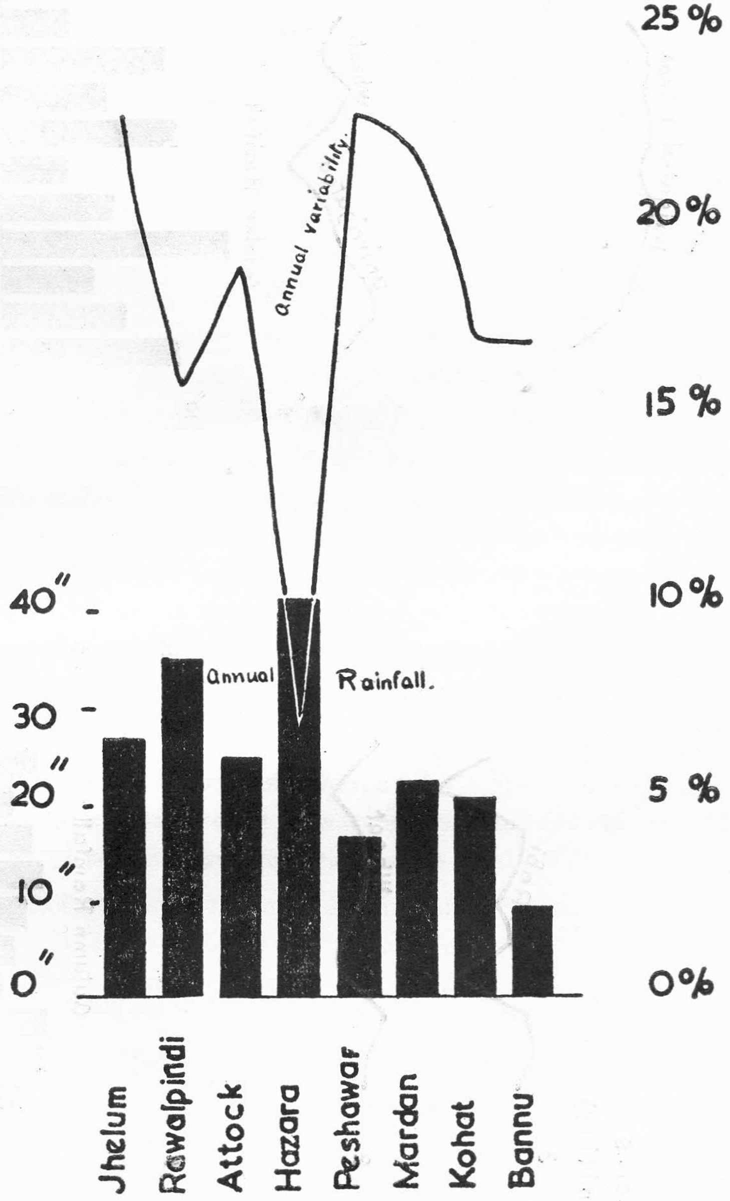
The limitations imposed by the environments are also well exhibited in the distribution of individual crops during Rabi and Kharif.

Wheat which occupies 75% of the cropped acreage in Rabi, shows a widespread distribution in the region. Its importance only diminishes in the hilly tracts of Hazara and Murree where its limit for successful growth is below 5000, above which height barley replaces wheat. In Mardan and Peshawar where the available resources of soil and water favour the intensive agriculture, wheat acreage is reduced to 34-40% of the total cropped area.

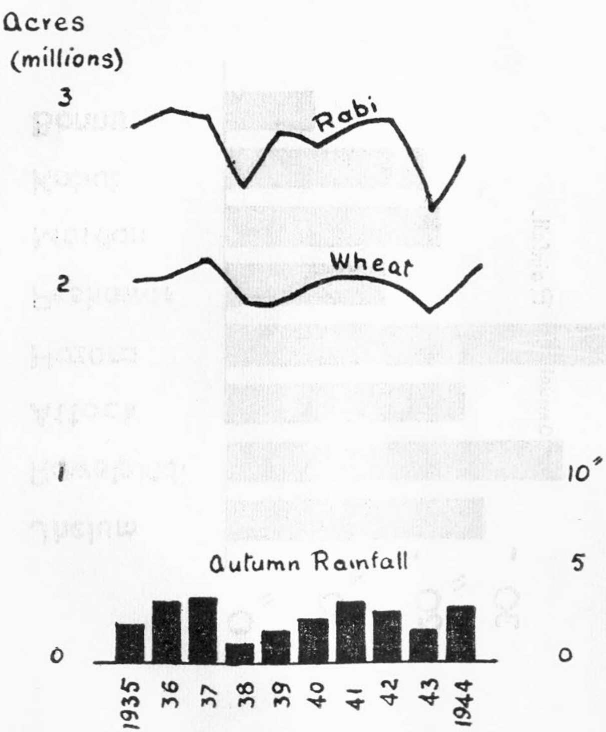
As most of the wheat grown in our region is unirrigated acreage under wheat fluctuates from year to year with the fluctuations in the amount of autumn rainfall. The accompanying graph clearly shows that a rainfall of 3-35″ in autumn (September November) provides enough moisture for the widespread sowings as the acreage under wheat in 1936-38, 41-42 and 44-45 indicate. On the other hand rainfall below 2″ reduces the acreage under wheat and in these years a simultaneous increase under gram takes place specially in Bannu. Hence autumn rainfall is one of the major factors controlling the acreage of wheat from year to year. The least effected are the north eastern parts of the region where autumn rainfall is most reliable.

Average yields of wheat are also affected by the amount of winter rainfall. The graph shows that yields of wheat per acre decrease both when the winter rainfall is deficient or when it is in excess. Other things being equal, the optimum conditions are obtained with a well distributed rainfall of about 6″ with sunny intervals that advance the growth of the plant. The maximum output of 9½ maunds per acre was obtained during 1937, when the winter rainfall was 6·5″. The second highest yield was obtained in 1943 when the winter rain amounted to 5 6″. Relatively lower yields during 1940 with rainfall of 6″ shows that though a major factor in determining the yields of barani wheat, amount of rainfall is not the only factor. Hailstorms accompanying some of the disturbances during the winter months with high winds damaged the crop considerately during 1940.

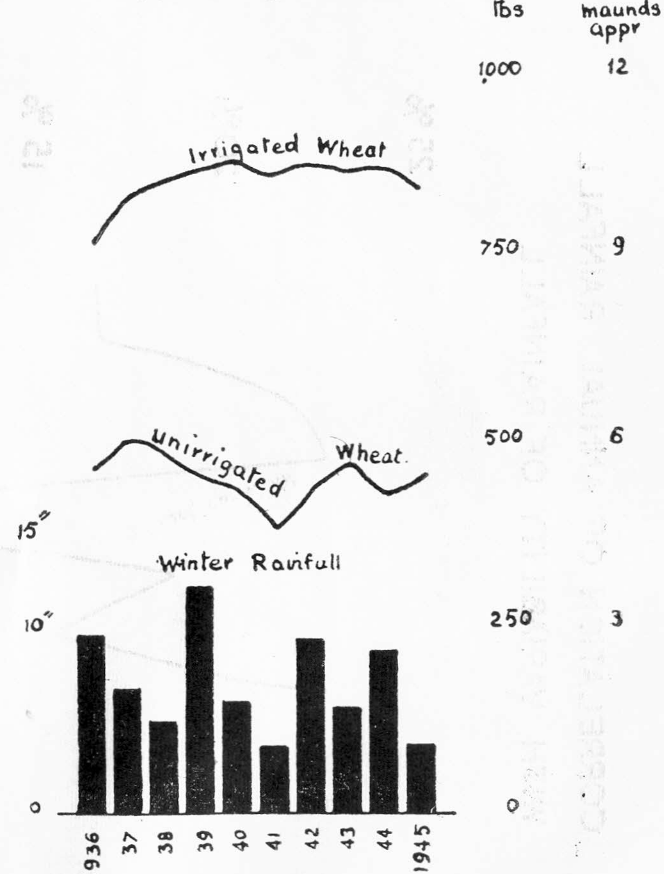
CORRELATION OF ANNUAL RAINFALL WITH VARIABILITY OF RAINFALL



CORRELATION OF AUTUMN RAINFALL WITH RABI & WHEAT ACREAGES.



CORRELATION OF WINTER RAINFALL WITH YIELDS OF WHEAT



Lower yields are obtained when the rainfall exceeds 7″ or it is below 4″. In the first instance it gives more fodder than grain, while in the second instance, grain shrivels due to lack of moisture.

Winter rainfall has very little effect on the yields of irrigated wheat, *e.g.* in Peshawar and Mardan yields remain more or less constant.

The second crop to be considered is maize, a Kharif crop. It occupies a little more than a quarter of the acreage under wheat. Unlike wheat, the distribution of maize shows great concentration in certain areas controlled by these factors:

1. Ample water supply—rainfall or irrigation all maize crops need watering after every 10 or twelve days.
2. Rich soils.
3. Skilled labour.

While the temperature records during the summer show that no part of the region with the exception of northern mouutainous parts of Hazara, is unsuitable for the growth of maize, though the length of the growing period which varies from 65-70 days in Hazara to 90-95 days in Peshawar, Mardan and Bannu effects the yield of maize.

The distribution of maize shows that there are two belts of great concentration.

1. North eastern submountain belt including Hazara district and parts of Rawalpindi district in Murree Tehsil.
2. (*a*) Peshawar-Mardan maize belt extending into chach plains of Attock Tehsil.
   (*b*) Bannu Doab.

These two belts grow about 85% of the total maize crop of the region while the remaining 15% is distributed in Potwar, mainly in the sil-soan area and other small patches where soil and water conditions allow its growth.

In the first belt most of the maize is unirrigated depending on the summer monsoon rainfall. The 15″ isohyet of summer monsoons (June to September) forms the dry margin for maize in this belt. With rainfall 15″ during summer monsoon months of June to September and rich alluvial soil in the small plains and valleys of this belt, maize grows vigorously and yields are heavy.

The second maize belt is confined to the vast stretches of alluvial plains of Peshawar and Mardan, where the irrigation from canals and wells have provided ideal conditions for heavy yielding crop of maize. Along with the development of irrigation in this area, a substantial increase in the acreage under maize has occurred.

Yields of maize also show considerable respect to the environmental conditions. In the highly irrigated tracts of belt II maize yields vary from 15-20 maunds per acre. In belt I where most of the maize depends on the monsoon rains, the yields are usually less than 15 mounds per acre, the dıfference being accounted for more by the shorter growing period which favours the growth of 'Satheri' maize—a local variety suited to the local conditions. In Mardan and Peshawar the longer growing period favours the growth of Pili and Chitti maize (yellow and white maize) which are heavy yielding varieties.

The distribution of other important Kharif crops—Jowar and Bajra which occupy an acreage almost equal to maize (512, 878 acres) show entirely a different picture. These crops can grow over relatively poorer and drier lands and hence the distribution is rather widespread over the Potwar and the trans—Indus parts of Kohat and Bannu districts. The two maize belts have no room for the relatively poor yielding crops like Jowar and Bajra. In fact what maize is to the well watered areas, Jowar and Bajra are to the drier tracts.

The area under cash crops is limited by the environmental conditions as well as effected by the human control. Cash crops like sugercane and Tobacco along with the heavy demands of water need heavy manuring of land to keep up the yields and the fertility of the soil and skilled labour. Moreover the growth of cash crops is only practical in areas where some intensification of agriculture has taken place as in Peshawar, Mardan, Chach plains and Bannu Doab. Here the average yield of crops is higher than in other parts of the region and smaller percentage of cultivated land under food crops makes these areas self sufficient in food, Over most of the Potwar and drier areas of Kohat and Bannu cereals occupy 90% of the cultivated area, because of the case with which these crops yield an average harvest with little fertilizers, or skilled labour. Taking the region as a whole, only about 3% of the cultivated area is under various cash corps of which 95% is under sugarcane and Tobacco the acreage under sugarcane has expanded considerably in Peshawar and Mardan plains as a response to the expansion of canal irrigated area.

In keeping with the general pattern of agriculture in the region, Market gardening has also received very little attention. Even in the rich fertile plains of Peshawar-Mardan where there is plenty of irrigation water, the area under fruits and vegetables is very small. Only about 1·5% of the total cropped area of the region is under fruit orchards and vegetables. Perhaps even more important than the natural factors of climate soil and water supply are the absence of cold storage facilities and quick transport. Over and above all is the limited market for fruits in any form in an area where the standard of living is low and fruits do not form a part of the daily diet of the common man.

Human Controls.

Natural conditions in our region as we have seen have effected the varied aspects of agriculture which is the main occupation of the people. It seems that man has accepted these controls. He has made a faint effort to cross the natural boundaries set by the climatic and soil conditions and that too he has done through trial and error method and not through scientific approach.

Man has not only accepted the controls but in some ways he has gone too far in rather accentuating the destructive forces of nature. The bad land topography in potwar area as a result of soil erosion brought about by overgrazing and deforestation in the hillier parts stands as a witness to the follies of man. The classification of area in our regions shows that only 11% of the area is under forests—including the poor open forests of Salt Range, and Kala-Chitta Range where stunted trees of wild olive hardly give any idea of real forests. Only good patches of forested area are found in Eastern Hazara and Murree where 15% of the area is forested. Hills of Kohat are almost devoid of any natural vegetation.

As a result of scarcity of natural vegetative cover, the streams coming down the bare slopes saw away the slopes and gullies are formed. These gullies grow in size from year to year untill they become fixed ravines that reduce the area of the yields and rob the farms of their valuable land. Carefully terraced fields along the slopes are destroyed in no time by the flooding of these ravines in rainy season. Potwar and trans—Indus district of Kohat are quite often the scenes of such disasters. In Jhelum district alone more than 65,000 acres of cultivated land has been lost during the last 30 years—almost averaging more than 3 square miles a year. The erosion has been most active in Pind Dadan Khan Tehsil along the Salt-Range slopes, in Jhelum Tehsil in the Khaddar tract, in parts of Rawalpindi Tehsil and Gujar Khan, in Makhand Jandal area of attock and in Teri tehsil of Kohat.

The deforestation of the catchment areas has led to the silting up of the stream beds like those of sil, soan, Wadala Kas and Bunha—they all have shallow beds and are flooded often during the summer monsoons and swallow the adjoining cultivated land. Some effort is being made in the way of torrent training to bring these devastating floods under control.

Deterioration of land has also taken place through the prevailing system of land Tenure. The agricultural population consists of land lords, peasant proprietors and tenants. In the region about 46% of the cultivated land is tilled by the owners themselves and it is this land that gets the better attention of the cultivator. Jhelum and Rawalpindi have 53% and 59% of the land thus cultivated respectively. The relatively high standard of cultivation with laborious terracing, embanking and manuring in any part of these districts is a sure index to the ownership of the land.

In Attock only 39% of the land is tilled by the owners while the rest belongs to the landlords who give it on lease to the peasants. Similarly in other districts more than half of the total cultivated land is cultivated by tenants.

38·6% tilled by tenants with rights of occupancy.

11%....................without........................

4% free of rent.

The effects of tenancy on the agricultural land are surely not healthy. Though in general the methods of agriculture are backwards and unscientific yet whatever improvement takes place as the introduction of better types of ploughs, fertilizers and seeds, it is the owners land and not the tenants that benefit most out of these.

Tenants make little effort to improve the productivity of the land and are more careless in the matter of rotation, manuring and proper tilling. There is a saying that goes to explain the condition of land held by tenants. " He who stays for a night in an inn does not go to the roof to stop a leak, he shifts his bed".

Another tendency among the tenants is that they devote most of their lands for growing food crops—this is because they are usually given marginal land, with relatively low fertility.

For all the bad conditions of land under tenancy the tenant is not to be blamed alone. The landlord shares a greater responsibility as he is in a stronger bargaining position. Conditions would change in this human control could be removed.

Whereas the tenants' land suffers from lack of proper care the small peasant proprietors' land suffers from the wide spread disease of small holdings and their subsequent fragmentations. The (customary) law of inheritance has reduced the owners holding to an average of 5·5 acres in the region. Majority of the peasants have to cultivate small parcels of land, the effects of which are seen in the poor returns, low standard of living and the limited capacity of the owners to improve the methods of agriculture. Small size of the holding is also in the way of partial machanisation of agriculture. The population in the absence of restrictive forces has increased by 54% from 1891—1941 and 9% since January 41—51. The increase has been greater in areas of high productivity and as the productivity in our region as we have seen much depends upon the available watersupply, we should look for the smallest holding where moisture supply is greater.

The graph correlating the amount of rainfall received during the year and the size of holdings in each district shows that the holdings are smallest in Hazara 2·6 acres—closely associated with the high productivity per acre depending on the ample moisture supply.

Widespread irrigation has off set the effects of low rainfall in Peshawar and Mardan where the average size of the holdings is 3·3 acres. It is difficult to imagine a more wasteful system than cultivating such small holdings and that too split up in plots of all sizes and shapes ranging from an acre to a quarter of an acre.

In other districts like Jhelum, Rawalpindi and Attock holdings are on the average larger than 5 acres in keeping with the lower productivity of land.

A number of cooperative societies have started work on the consolidation of holdings but the progress has been very slow as it seems a gigantic task to convince the illiterate farmers of the evils of the fragmentation of holdings. Peasants are reluctant to exchange their pieces of land of heritage. Only about 6000,00 acres has been consolidated so far in the region. Consolidation of holdings is only a partial solution in the absence of any modification in the law of inheritance.

The fact that 65% of the working population of our region is dependent on land for their subsistence is a clear index as to how closely the population distribution is connected with resources of land which so far as we have seen are controlled by multifareons physical and human factors.

The various controls have resulted in the average low productivity per acre and per capita. The expansion of area under cultivation has mostly taken place in Peshawar and Mardan. On the whole there has been an increase of 5% in the total cultivated area. The population during the last 60 years has increased by 60%. This means that where as in 1891 there were 459 people per cultivated square mile, now there are 797 people per cultivated square mile, an addition of more than 300 people per cultivated square mile. This average density of the population per cultivated square mile is rather great for the land to support under present circumstances, when one acre of land produces on the average about 6—7 maunds of food grains—It makes the region only self supporting in food supply for 9—10 months in the year.

The study of the distributional maps and the yields of crops gives a general impersion that the average density of population per cultivated square mile is great in the maize belt and where the yields of wheat are higher—so to say in areas of fertile soil and plenty of water supply *e.g.*, Peshawar Mardan, Hazara and Bannu Doab. Areas producing Bajra and Jowar as Kharif crops and barani wheat as major Rabi crop with low per acre production have only a population, density of 502 persons percultivated Square mile. These correlations can be studied in detail in various population belts.

1. Submontaine belt—comprising of Hazara—district and Murree and Kahuta Tehsils of Rawalpindi.

2. (*a*) Peshawar, Mardan and Chach plains.
   (*b*) Bannu Doab.
   (*c*) Hangu and Kohat Tehsils.

3. (*a*) Potwar Plateau.
   (*b*) Trans—Indus tehsils of Marwat and Teri.

4. Salt Range and Riverain tract.

I. In this belt maize is far more important as a food crop than wheat. Maize yields one and half times of that of wheat and in some cases almost twice as much. Thus it is capable of feeding more people per acre. The average density of population in this belt is a little more than 1,000 (1053) per cultivated square mile which is partly accounted by the high productivity of land and partly by the forest and pastural resources which supplement the agricultural resources. The highest density of 1111 per cultivated square mile is in the heavy maize producing area of Abbottabad Tehsil, the lowest being in Haripur tehsil 745, where the acreage under maize is about half of that in Abbottabad.

II. In this belt both wheat and maize flourish well and there is practically no acreage under Jowar and Bajra which are relatively poor yielders. The average density per cultivated square mile is 951. The exceptionally high density (1627) in Peshawar Tehsil is mainly due to the urban population of Peshawar city—In parts of Hangu and Kohat Tehsil the high density of population is maintained by the intensive system of cropping in the valley lands and also by the pastoral industries that provide a part time occupation for the peasants. It is in this belt that changes in population since 1891 are most marked.

III. Barani wheat is a widespread winter crop in this belt while the scarcity of water supply during summer has favoured the growth of Jowar and Bajra—with the result that one acre of land produces only about 5·6 maunds of food grains. The average density of population per cultivated square mile in this belt is only 502, which is quite high in view of the per capita production. In the western part of the Potwar, with the decrease in the amount of rainfall, the density of population falls as low as 300 persons per cultivated square mile (in Tallagang).

IV. In the Salt-Range and riverain tracts the average density is above 700 persons per cultivated sq. mile—in this belt great contrasts exist as the distribution of settlements suggests. The density in certain areas of Salt Range and Khaddar tracts of Jhelum Tehsil may be as low as 200 while in the central part of the riverain tract it may be as high as 900 persons per cultivated sq. mile.

The above distribution of population in the light of the existing productive capacity of the land shows that inspite of the lower density in the Potwar Plateau and the trans-Indus dry areas of Teri and Marwat, the pressure of population is great. The general backwardness of the agricultural industry, low standard of living and illiteracy are all in keeping with almost a total absence of industrialisation through lack of capital and initiative. The rural economy of the region is manifest in the slow current of its trade and transport.

The earth is dry and so is the air. Rainfall is low over most of the region. Nature possesses great powers over man who is weak. Working on their separate small holdings the peasants are unarmed and helpless in the face of natural calamities. To superimpose his own boundaries on those of nature, man needs a cooperative force. And he has yet to learn to give back to the earth in order to take more out of it.

LAND UTILISATION SURVEY OF MOHAR VILLAGE

By

A. SATTAR

In the Punjab, agricultural land is in plenty. Still it is not unlimited and this is particularly true of the old-settled areas. Such land-use surveys are taken in hand with a view to find out the channels in which the efforts at improvement should be directed in order to get the maximum profit for the longest period of time out of the available land. The methods of agriculture are centuries old, the holdings are small, the cultivation is careless and there is little effort at reclamation of the areas once gone out of use due to careless cultivation or some other causes. We need improvement to increase our agricultural output in order to meet the demands of our growing population and at the same time to maintain the exports of agrcultural commodities which earn us a major part of our foreign exchange so necessary for our over all agricultural and industrial progress.

The Village Mohar is two miles south of Narowal in Sialkot district. It is about 650 ft. above sea level and its total area is 850 acres. The population of the village is 560 persons, about three-fourths of whom are peasant cultivators. After partition the Sikh Jats were replaced by refugee Muslim peasants. In addition some 'kamins' or menials have also been allowed land allotments because they could not earn their living under the existing poverty-stricken conditions. The net effect of the change was to reduce the average size of holdings and to increase the poverty of the people. The mean annual rainfall is 31". The climate has a modified Monsoon regime and the village belongs to the "Sialkot—Gujrat" region of the "Sub-humid submontane north" as classified by Dr. Kazi S. Ahmad in his "Climatic Regions of West Pakistan". Irrigation is necessary for successful agriculture, as the rainfall is insufficient and variable. Thirty wells in the village irrigate about 500 acres out of about 700 under cultivation.

The soil is alluvial and differs little from place to place as regards its mechanical composition. The village peasants make a practical classification of the soils, based on fertility and water-absorbing capacity which factors determine the suitability of a soil for particular type of land use. The classification is as follows :

(*i*) *Nyaeen*:—It is the most fertile soil type because it profusely receives human and cattle waste. This belt of 'nightsoil' extends on all sides of the inhabited village area varying in width from one to several hundred feet. When water stands in nyaeen fields, these give out a rather unpleasant smell.

(*ii*) *Roi:*—The soil is sticky due to a comparatively larger percentage of clay particles in it. It gets hard when dry. As most of this soil lies a little lower than the surrounding fields, water stagnates there after the rainy season. Thus this soil is particularly suitable for rice.

(*iii*) *Bet:*—This soil is sandy and is found on both sides of the stream Budhi. The larger sand particles are deposited close to the channel whenever the stream spreads over banks at flood times. This variety is not very hospitable to agriculture because the sand absorbs water very rapidly, leaving the soil dry, and the sand is not fertile.

(*iv*) *Maira:*—This variety is the common loam of the Doabs (Inter riverain tracts) of the province, and is particularly suited to dry-farming in these areas of insufficient rainfall. Its fertility is surpassed only by Nyaeen, and the soil is renewed occasionally due to floods.

(*v*) *Dushai:*—This category contains saline soils. Salts are washed to the sub-layers during the rainy period and then the fields might be used for agricultural purposes, but soon after salts reappear on the surface making the soil useless for cultivation.

The area of the villege has been classified under the following four categories for the purpose of land-use study.

1. *Forested Area:*—Including all areas under natural or planted forests.

2. *Area not Availble for Cultivation:*—Including areas used by the people for residential purposes, footpaths, cart tracks sites of wells and graveyards as well as the area covered by ponds and the rivulet.

3. *Cultivable Waste:*—Inculding lands where agriculture is possible if attempts are made at improvement of the soil.

4. *Cultivable Area:*—Including the lands which have been cultivated or which have been left fallow.

In the village no area is exclusively given to the growth of forests, but trees may be found along the banks of ponds on boundaries of the fields, around wells or along various tracks. The absence of forested area is due to the agricultural needs of the dense population who have brought all the available area under the plough. Moreover the fuel needs have exhausted all forests.

AREA NOT AVAILABLE

The area under this category has increased from 63 acres in 1939, to 70 acres in 1952, and may further increase with growth of population and rise in the standard of living. Out of the total, residential area occupies 24½ acres, sites of wells 7 acres, the stream 4 acres, graveyards 2.8 acres and the ponds 2.2 acres. The remaining 31 acres are made unavailable to agriculture due to irregular cart-tracks, foot paths etc.

The area under ponds and the stream varies from season to season depending upon the water they contain. During the rainy season these extend over much larger areas but the figure includes only such land as is rendered unavailable throughout the year.

CULTIVABLE WASTE—LANDS

The land-use record of the past twenty years shows a considerable variation in the land under this category. In 1933, 112 acres were cultivable waste gradually increasing to 131 acres in 1939. This increase was due to the low market prices of the agricultural produce and it became unprofitable to cultivate the marginal lands. The peasant could not afford to use manures and chemical fertilizers because of his precarious economic and financial condition and, therefore, the relatively less fertile fields were abandoned. The beginning of the World War II in 1939, resulted in a rapid increase of the commodity prices and the value of land multiplied accordingly. The peasants fell back to the abandoned lands and by 1944, the cultivable waste-lands had been reduced to 118 acres.

After the partition there has been a very rapid increase in the cultivable wastelands. In 1950, there were 145 acres under this category. The refugees had little resources for the use of manures. Moreover, there was no security of land tenure and therefore no one would invest money in land.

Some of these lands have been reduced in fertility due to careless one-crop farming or injurious rotations. But scientific analysis and the required treatment of the soils could bring these lands under the plough. Most of the cultivable waste—lands are situated to the south-east of the village, across the stream Budhi. There are no wells in that area and floods are frequent during the rainy season. The soil of these lands has a large percentage of sand particles and, therefore, is incapable of preserving moisture. This necessitates greater supply of water which is no available because there are no wells there.

"Shamilats" are also included in this catagory. These lands were originally demarcated as grazing lands or for outdoor recreations of the villagers. At present these lands are used to little advantage because the grass growing there is generally poor in quality.

Most of the cultivable waste—lands serve as rough pastures for the village cattle. After the rainy period such lands are green with grass. Cattle graze about freely on these lands. But in the dry season, on the other hand, these lands are bare of vegetation.

CULTIVATED AREA

On the average about 700 acres are used for agriculture. But the total cultivated area varies from year to year. Certain marginal lands may or may not be used duriug a particular year, depending upon the trend of the market prices of agricultural produce and the general climatic conditions.

In 1934, the total cultivated area was 573 acres, but then by a slow and steady increase the figure reached as high as 914 acres in 1944. This was due to the World War II. After the war and the partition the total cultivated area again began to decrease till in 1942, only 650 acres were cultivated.

Obviously economic conditions very largely determine the total cultivated area during a particular year. The market prices of the commodities produced should be sufficient to cover the necessery outlay on seeds, fertilizers, irrigation, repair of field equipment, transport etc. and should leave a reasonable margin of profit to remunearte the labour of the peasant. But the actual use of ploughed land depends on other factors as well, *e.g.*, the suitability of certain soils for particular crops and the availability of irrigation. Natural fertility, depth of soil and the ease of ploughing are other factors affecting the use of land.

The village Mohar is a part of the old-settled areas of the Punjab where land has been passed on from generation to generation. The division of land has resulted in very small holdings and consequent poverty of the peasants. The density of population in the district of Sialkot, of which this village forms a part is more than seven hundred persons to the sq. mile. Every peasant naturally devotes a very large portion of his land to food crops which are the primary needs for himself and the existence of his family. Moreover the prices of foodgrains are more stable and thus their cultivation offers greater security as compared to cash crops, the prices of which may very greatly in accordance with the variable demands. The subsistence of the farmer throughout the year depends on his stooks of foodgrains which he also barters for various household necessities at the village shop. Thus, crops other than foodgrains attract but only his second thought. Cereals are followed, in total acreage by fodders, sugarcane, cotton etc. The various crops are grown in different seasons so that it is more appropriate to consider various crops in the order of their importance and in their respective seasons.

The agricultural year is divided into two seasons—"Hari" or Rabi and "Sawani" or Kharif. Of these Rabi is the more important season of agriculture. It is a busy time of the year both for the peasant and his cattle, for the latter because they have to plough and irrigate more lands. On the average about 400 acres are cultivated during the Rabi season. Among all the crops grown here wheat accounts for the largest area under any single crop, occupying generally sixty to seventy percent of the area cultivated in Rabi. In 1950—51 Rabi season 223 out of 337 acres cultivated were given to wheat. "Nyaeen" and 'Maira' soils are most hospitable for wheat.

Among other Rabi crops, barley generally occupies about 25 acres, pulses and gram about 35 acres, and different fodders have about 80 acres. After the partition there has been an all round decrease in acreage but more so in the area under fodders.

'Kharif' is especially important in the areas of the north Punjab because of relatively greater rainfall. Moreover, there is a greater need of cereals in particular and other crops in general due to the greater density of population. Generally thirty to forty percent of the total cultivated area is sown during Kharif. In 1950-51, 249, acres were under Kharif crops. Rice is the most important crop during this season, though the area it occupies varies from year to year depending upon the timely arrival of the Monsoons, the total amount of rainfall received and also the degree of success of the previous Rabi crops. If there is abundance of wheat and the prices are low the peasant does not risk using unfavourable land and rainfall circumstances. In 1950, seventy acres were under rice out of which twenty were destroyed by the heavy floods. In 1951 the wheat harvest was satisfactory. The rainfall during August and September, 1951, was only 3.7" as against the average of 14" for these months. All these factors taken together reduced the rice acreage to 54 in 1951, out of which 34 acres were irrigated and the rest was 'barani' land which failed totally. Sugarcane is an other important crop, generally occupying 40 acres. The cane is locally crushed for indigenous production of 'gur' and 'shakkar'. Cotton occupies about 35 acres and is entirly of 'Desi' short-staple variety. It is again used locally for indigenous 'Khaddi' cloth. Fodders are not important during this season because there is plenty of natural grass.

The question of land use has arisen out of the natural consciousness of man for the proper and scientific use of his land and environment. Certain set of natural conditions—of soil, climate, hydrography, topography etc. have been placed at man's disposal and it is for him to use them as best as he may.

Fot us in Pakistan the question of land use has especially become very important because of the enormous food deficit that we face today. Food production has to be increased to make up the deficit, and not only that we must be surplus in our agricultural out-turn so as to be able to get in exchange equipment for industrial build-up of the cuntry.

In the village surveyed, and so also in all the old settled area, there are defects in implements of husbandry, methods of farming, irrigation mechanism, and the treatment afforded to the soil. In addition there are handicaps suffered by the man behind the plough who is totally ignorant of the modern advances in agriculture and who never comes to know of the advice offered by national and foreign experts.

The wooden plough has been criticised for years, for its inability to break the soil sufficiently deep. It wastes the energy of the bullock due to its defective construction and a large amount of avoidable friction. Similarly the broadcasting method of sowing, the harvesting of the crop, the primitive form of threshing are also defective. The persian wheel is insufficient and wastes energy due to unnecessary friction. The soil is not allowed to recoup its fertility by scientific rotations or by synthetic manures. In this village lands are divided and subdivided into 1900 units, thus the average land unit is less than a third of an acre, while some units are as small as one-eighth of an acre.

The agricultural research has recognised these problems long since but the action taken hopelessly falls short of any reasonable expectations. Our problems are not so much connected with more and more research as they are to putting into practice the experience gathered so far. We must pay more attention to field work now. The education and instruction of the husband man with the help of village training centres must be in forefront of any advancement scheme. The schemes for provision of finances and the supply of implements and manures at reasonable rates must also be taken in hand quickly. The rural population should be mobilised to take an active part in supplementing official effort for agricultural improvement.

In the end we may claim that with all the handicaps the poor peasant, having accumulated experience through the ages, is making a good job on land. He tries to do whatever he is convinced of. His understanding is purely practical so far. Given education and better facilities there is little reason to doubt his capacity to stand proudly among the world farmers.

PHYSIOGRAPHY AND STRUCTURE OF S. W. MAKRAN

BY

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Makran forms the southern part of Baluchistan. It skirts the Arabian Sea board and constitutes the western most extension of Indo-Pakistan subcontinent. The region remained terra incognita for a long time as far as its geology was concerned. A very scanty information exists regarding the geology of Makran as a whole. Among the published works which throw some light on the subject, are reports of W. T. Blanford and E. W. Vredenburg of late Geological Survey of India. Their reports touch only the fringes of the region. Vredenburg passingly describes the eastern part of Makran in his "Report on the Geology of Sarwan Jhalwan and Makran and the State of Las Bela". Blanford's note refers only to the coastal geology of the region and even this from a passing boat. These reports are essentially geologic in character and as a result devote very little attention to the physiography of the region. District gazetteers as usual contain a good deal of information but they are far from scientific. Very recently under the auspices of Geological Survey of Pakistan an attempt has been made to work out the geology of the region. And this paper is only a part of the work carried out in this direction and deals with the physiography of its south-western part lying between Pasni and Jiwani on the coast and Turbat-Mand Valley farther inland.

Physiography of a region is the shape and character of its landform. It is the result of interaction of a number of complex factors. Among those involved are the compositions of rock types, their disposition or structural behaviour and finally the role of multiple agents of denudation and deposition. A number of these variable factors operating on continental or even smaller scales produce homogeneons units having more or less distinct physiographic characteristics. These units with identity of physical environment are classified as physisgraphic divisions.

In undivided India in the late thirties and early forties of this century a very lively discussion arose among the geographers of India on the subject of its physiographic divisions. India was parcelled into a number of units. Dr. Pithawala proposed a scheme of Major Division, Provinces, Sections and Sub-sections, to be followed by another entirely new scheme by Dr. K S. Ahmad. It is interesting to note that Baluchistan which includes Makran did not receive a square deal in any of these schemes of classification. Strangely enough the whole unit of Baluchistan plateau does not find its place in the map of "Physiographic Divisions of India and Burma" prepared by Dr. Pithowala (vide Physiographic Division of India by M. B. Pithawala; Jour. of Madras Geographical Association 1939. PP. 426) Dr. K. S. Ahmad has distinctly separated Baluchistan Plateau in his map of physiographic Region of India, but perhaps by mistake it has been omitted in the subsequent text of the paper (wide physiographic Divisions of India by Dr. K. S. Ahmad I. G. J. 1941 PP. 250).

✓ In the scheme of Physiographic Division of Indo-Pakistan subcontinent Baluchistan plateau is a distinct physiographic province rather than a unit. This province is divisible into a number of units depending upon the dominant variations in its lithological set up. It is the variation in the rock types in the region that gives differential characteristic to its units. Climate and hydrography are less dominant factors as compared with the lithology. Makran with the predominence of mudstone in its rock types assumes a distinct physiographic aspect as compared with other regions of Baluchistan and as such should be treated as a separate unit The precise delimitation of the boundaries of such units is being left for future work.

Broadly speaking the region comprises of extensive tracts of level mudflats, occurring as coastal plains or as enclosed synclinal plains hemmed in by the bounding sandstone ridges or as eroded cores of anticlines. The sandstone ridges run parallel to the east-west direction of the coast. The outstanding lines of ridges that constitute dominating features of landscape are harder sandstones outcropping on the flanks of folds. Geologically the rocks are very young and probably range from Oligocene to Lr. Miocene and even subrecent. They essentially consist of calcareous mudstone with thick series of sandstone bands occurring in between. Based on lithological consideration the Makran Series is sub-divided into three stages :—

Upper Mudstone stage.

Middle Sandstone stage.

Lower Mudstone stage.

The sub-recent shelly conglomeratic limestone occurs on the top. The rocks are thrown into a number of plications with a distinct east-west alignment. The folds are gentler and wider apart near the coast but become more complex and closer together farther inland. Faults are also canspicuous and have share in the physiographic make up of the region.

The dominant factor in the making of the physiography of this region is the soft and easy weathering mudstone that makes the extensive level plains whether exposed in the core of an anticline or in the centre of a syncline. The hardar sandstone bands stand out conspicuously as prominent hill ranges on the flanks of anticlines or synclines. The east-west directional trend of the physiographic elments of the region is entirely due to the structural alignment of the rocks bestowed by the Himalayan Orogeny. Faults have played a part in providing passages to not very extensive and powerful streams that drain the region. They have also provided interesting geomorphlogical features by dislocating extensive blocks.

As far as the role of agents of denudation is concerned it is well to remember that the region enjoys a desert type of climate. The rain is scanty and uncertain, and the temperatures are extremes. Sporadic and torrential rain finds its way down the mountain slopes in nearly straight courses in order to join minor streams following the general east-west alignment. The consequent result is the trellis type of drainage pattern. The rivers cross the ranges mostly along the fault lines. The sharp bends in the courses of streams as a rule are very common. Torrential rains erode mudstones into a maze of gullies and produce characteristic badland topography. Winds blow up finer particles and deposit them in the low lying flats. The sandstone bands stand out against the onslaught of wind and rain and form the outstanding hill ranges of the region.

Physical Features :—

A cursory glance at the topogrophical map of the area reveals a definite alignment of the orographical features throughout the region. Series of parallel ranges of hills and mountains are seen to lie in an east-west direction. The intervening space between these ranges gives rise to the formation of valleys of varying width and extent. This over all picture of the topographical alignment extends right upto the sea-board.

Regarding the relationship between the structure and the topography of the region, Vredenburg has remarked that the hills are formed of the synclines and the anticlines invarriably give rise to valleys. But all along S. W. Makran no such specific relationship between the geological structure and the topography was seen to exist. It is the lithology rather than the structure that governs the topography of this region. Middle Sandstone stage of the Makran Series wherever exposed gives rise to the formation of prominent mountains, where as the Upper and Lower Midstone groups get denuded easily and form the low lying stretches of lands forming flat plains and valleys. It is only the covering caps of shelly conglomerates that protect these from denudation and form the flat topped coastal hills.

Along the coastal strip, apart from the general unidirectional alignment of the structural elements, the topography presents a picture different from the one seen more inland. Here the hills in contrast with those met with in the interior are low and flat topped. These are composed of the uncompacted Lower Mudstone group of the Makran Series. The flat top of the hills is formed of the horizontal, sub-recent shelly conglomerate or littoral-concrete lying unconformably on the marls dipping at varying angles.

These hills are seen fringing the coast at intervals right from Pasni to Jiwani. The general height of these flat topped hills lies between 640 and 410 ft; with the exception of Jabal Mehdi (12 miles north of Gwadar) which rises upto 1344 ft. above sea level. The series of hills with flat tops and conformable heights particularly attract the attention. The differnt heights of the series of tops *viz* 416' of Jabal Zarain (4 miles south of Pasni) and 640' of Ras Shamal Bandar, 641' of Ras Kappar look quite significant. Perhaps they are the silent witnesses of the uplift of the sea bottom in a not very distant past. The flat tops with littoral concrete or shelly conglomerate are the remanants of the sea botton that has risen higher up.

Fram the coastal hills, wherever the protective covering of the conglomerate has been removed, the underlying soft marl yields readily to the agents of denudation. Out of these a maze of unoriented peculiarly sculptured group of hills and hummocks are formed, giving a typical picture of bad land topogrophy. All along the coast in between the lines of flat topped hills, these fantastically carved hillocks of gray marl are particularly seen to attract the attention of any coastal traveller.

The plain which stretches along the coast is flat and is composed of loess. The plain rises abruptly from the sea shore. At Ras Shamal Bandar there is a sheer steep rise of about 30 feet from the sea shore to come to the level plain. These raised plains add another evidence to the rise of land or the recession of the sea.

Away from the coastal strip, more inland the configuration gets more rugged and uneven. The sandstone ranges assume more impressive dimensions. At places the highest summit even goes beyond 4000 feet above sea level. Koh-i-Daram a faulted block removed away from the general strike has a maximum height of 3152 ft. above sea level. Gokhprush Band which forms the southern flank of the Kech-Nihang valley (Turbat Valley) is even higher and rises to about 4346 feet. Hor and Chakuli ranges that are nearer the coast are lesser in height. They do not record the heights of more than 2383' and 1395 feet respectively.

Enclosed in between these mountain ranges are formed some of the extensive plains of this region. Kulanch, Chilari, Nigwar, Dasht, and the Turbat valley plains are some of the more important areas which afford some agricultural patches wherever some water is available. They are flat level plains formed by the deposition of material brought down by the streams and covered by the wind blown loess. As has been seen in the case of mountains, the height of these plains increases away from the coastal strip. Kulanch and Chilari plains are about 200 ft. above sea level where as the Kech-Nihang valley (Turbat Valley) is not less than 500 ft. in height. These are intermontane valley fills.

Raised Platforms :—

Among the numerous interesting geomorphological features exhibited in this region, the development of raised beaches along the sea coast, and the parallel occurrence of raised gravel platforms farther inland are most arresting. As has been pointed out, the coast is marked with the occurrence of flat topped hills all along its extension. Astalo island not very far from the coast also exhibits the same flat topped characteristics. This very interesting feature is seen to occur at different levels in different places. Astalo's flat platform is only 211′ above sea level, while the flat tops of Jabal Zarain, Ras Shamal Bandar are 416 and 640 ft. respectively. Besides these distinct knicks at certain levels have been noticed to occur towards the sea shore in Jabal Mehdi and Jabal-Sur. There should be no difficulty in explaining the cause of their formation. This appears to be due to isostatic readjustments in the form of uplift of the sea bottom. The difference of about 200 ft. in these three levels quoted above seems quite significent.

Much more detailed palaentological and geomorpholoical work is required to be done to fix the ages of these periodic rises in the recent times. In order to detect a possible link of these movements with Quarternary cycles of glaciation, they will have to be correlated with the known raised beaches of other aegions *viz.* Mediterranean or Western Europe.

Farther inland the river valleys exhibit a series of terrace like gravel platforms on their sides. Five distinct levels of about, 10,20,25,35, and 50′ and even higher levels have been noticed to occur at different places. Some of these gravel platforms extend for miles only to be cut by the streams rejuvenated by the later uplifts. At places only small patches of certain levels remain to tell the story of a destroyed surface. It will be incorrect to suggest that these five different levels point to the occurrence and completion of five distinct cycles of erosion.

Considering the absence of the characteristic topographic features associated with the mature stage of a cycle of erosion in Makran, it is thought that these gravel platforms are no more than the indication of different uplifts that took place at not very long intervals. The interval between the different uplifts does not seem to have been lang enough for the completion of a cycle of erosion.

How far these raised gravel platforms are connected with the raised beaches along the coast is not known. However, it is quite probable that both are the simultaneous products of the rise of land and sea bottom, all along this region. For the precise correlation of the two a much more detailed work is required. A very wide and extensive level tract of land fringes all along the southern side of Gokhprush Bund. This belt forms an apron to the mountain belt and starts right from the very foot of the range. The plain is covered by a mantle of pebbles forming an armour and protective covering against the onslaught of the agents of denudation. The pebbles are sub angular to semi rounded. They seem to have been deposited by seasonal streams coming down from the mountain. Later occasional rain wash and wind sifting has removed finer particles from the top and left only a mantle of tightly packed pebbles. This pebble armour may be similar to serir of Libya or reg of western Sahara.

Structure and Its Interpretation :—

Makran situated between the two ancient blocks of India and Arabia occupies a very interesting place as regards the structural relationship with adjoining areas. The sturctural trend of Makran has a special bearing with the tectonics of Sind, Oman and southern Persia. It may throw some light on the unsolved problem relating to the possible inter-connections between the structures of these neighbouring regions, which is disputed between the major hypotheses on world tectonics.

Regarding the tectonic relationship between the mountains of Sind, Oman, and souther Persia nearly all the authorities, like Argand, Sues, and Krenkel are agreed to the fact that the mountains of Oman and Sind are the parts of the unsubmerged outer loop of the Zagros System. (Suess Vol. iii p. 750, Krekkal. p. 35' Argand p. 205) However, Kobar does not see eye to eye with these authorities and assumes a "branching of the Zagros System between Bandar Abbas and Karachi, the Oman and the Kirthar ranges forming the opposing flanks of this two sided orogene which have strikes due south and eventually circumscribes the whole African continent" (G.M.Lee. The Geology and Tectonics of Oman and parts of S.E Persia. Q.J.G.S. Vol. IXXXIV, p. 586), *vide* plate No. 2.

The general trend of the rocks of Makran is from east to west. The rocks are folded into a series of anticlines and synclines with their axes running in the east-west directian.

This general east-west trend fits in very well with the idea of the outer loop of the Zagros System which joins the Kirthars with the mountains of Oman. Makran lies in the central belt of this flattened loop where the development of folds with east-west strike seems quite natural.

Kober's idea of the two side orogene however does not quite satisfactorily explain the east-west trend of the Makran rocks in view of the southerly trend of the Kirthar and of Oman ranges forming the opposing flanks of the bilateral orogene. Lee however suggests an explanation for this discordant trend of some of the rocks of Oman and of Baluchistan coast by sticking to the major hypathesis of Kober. He envisages the approach of Arabian and Indian blocks during late Tertiary times, whence the Himalayas and the Zagros systems were formed. These moved blocks left the coast of Baluchistan without any continental support and the strained plastic sima then exerted pressure to form the structures found in Makran and Oman coasts. How far credence can be given to such an hypothesis is very difficult to say. Much work, however, remains to be done in Sind, Baluchistan and Oman to come to any definite conclusion with respect to these conflicting schools of thought.

The Pliestocene and sub-recent shelly conglomerates and lime-tone lie uncomformably on the folded Makran Series. The conglomeratic limestones are practically horizontal, and do not show any effect of folding. The Mekran Series on the other hand is comparatively much folded, and even faulted. The probable age of these folding is supposed to be late Tertiary, possibly Pliocene.

There is no uniformity in the degree of plication throughout the region. The whole area comprises of a series of synclines and anticlines of increasing complexity farther away from the coast. Near the coast in the south the folds are gentler but give place to complicated folding in the north The axes of all those anticlines and synclines run from east to west in direction. Even the minor folds also conform to this general trend. The folds towards the south are gentler and broader as compared with those occurring away from the coast. Except for the isoclinal folds in the north, the synclines in the south are generally shallow and assymetrical in nature. The anticlines are "concave anticlines". The term "concave anticline" will be explained in sequel where the individual structural features are deseribed. Besides folding, the region has also been affected by a series of dip faults. The general trend of these dip faults is from NE-SW and WNW-ESE Examples of strike and scissor-faulting are also found.

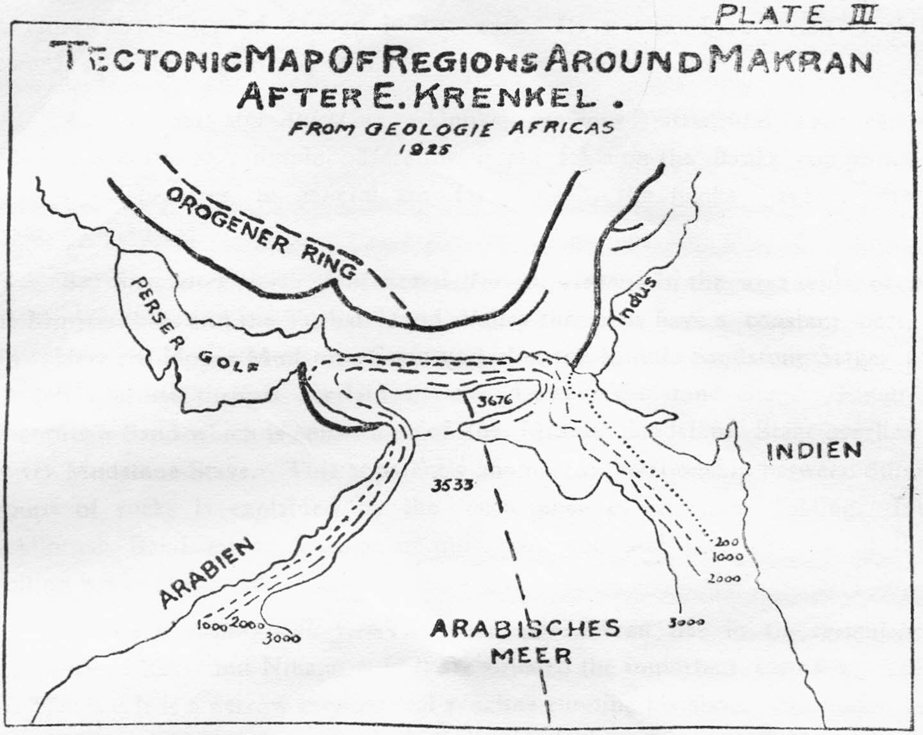
In the following paragraphs a brief description of the major structural units in the region are being given :—

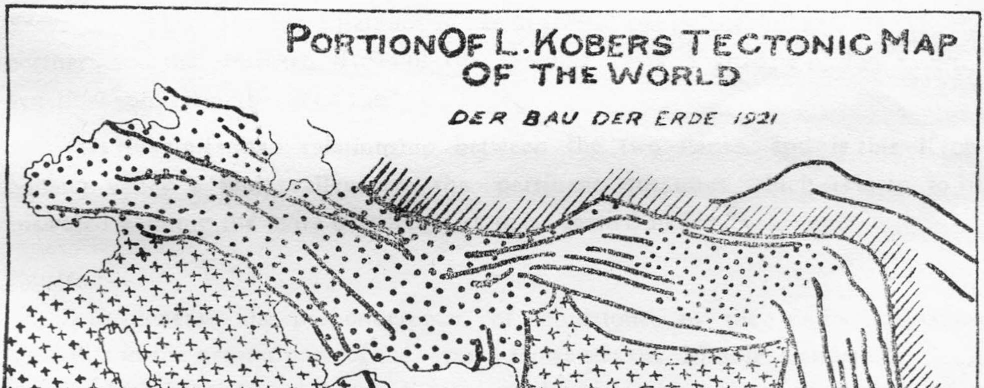
1. *Shamal Bandar Pasni Syncline:*—A broad shallow syncline occurring along Pasni and Shamal Bandar port, has been named after these places. It is a broad shallow syncline with flanking dip of only 15°. The axis runs east-west and occurs just north af Pasni. It could be traced to extend right upto a few miles north of Gwadar in the west. This syncline is formed in the Lower Mudstone stage and its greater part is covered by the loess deposits that occur all along the coast.

2. *Chakuli Anticline:*—The Lower Mudstone Stage extends right upto the foot of the Chakuli Range. Between the Shamal Bandar syncline and the Chakuli ranges the mudstone forms into a comparatively narrow anticline. The anticline here shows a peculiar characteristic. The flanks of the anticline arch downwards and assume a concave appearance. The beds on the axis of the fold are nearly vertical. The dip gradually decreases away from the axis and in the flanks it goes as low as 15°. This type of anticline has been named as "concave anticline". The axis of the fold runs east-west and can be traced to extend upto Kabri in the east and Saur Kaur in the west.

3. *Kulauch Syncline :*—Kulauch syncline is situated between the Hor and Chakuli ranges. It is an extensive level plain covered almost entirely with loess. It is an assymetrical syncline, with its northern limb dipping at 60°. The southern limb dips only at an angle of 15° towards north. Its axis runs east-west and passes

PLATE III


TECTONIC MAP OF REGIONS AROUND MAKRAN
AFTER E. KRENKEL.
FROM GEOLOGIE AFRICAS
1925
OROGENER RING
PERSER GOLF
Indus
3676
INDIEN
3533
200
1000
2000
ARABIEN
1000
2000
3000
ARABISCHES
MEER
3000


PORTION OF L. KOBERS TECTONIC MAP
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BLOCKS

through Nokhbur, an important village situated in the centre of the valley. The syncline extends beyond Jowran in the east. Its westward extension is shifted towards north by the shifting of Koh-i-Daram by a fault.

4. *Minjami-Hor-Anticline :*—Unlike previous structural features, this anticline is not so very simple. Here the minor folds on the flanks complicate the structure. The dips in general are fairly steep, the flanks have a dip of about 60°—80°.

5. *Structures North of Minjami-Hor-Anticline:*—In the area lying between the Minjami hills and the Turbat-Mand Valley the beds have a constant northerly dip. Here the Upper Mudstone Stage underlies the Middle Sandstone Stage, while the latter in its turn is overlain by the Lower Mudstone Stage. Finally the Gokhprush Band which is constituted of the Middle Sandstone Stage overlies the Lower Mudstone Stage. This apparently anomalous relationship between different groups of rocks is explained by the occurrence of isoclinal folding. Inside Gokhprush Band minor foldings are quite common and the existence of thrust faulting is also suspected.

6. *Kech-Nihang Valley:*—The heart of Makran lies in the agriculturally rich valley of Kech and Nihang. In it are situated the important towns of Turbat and Mand. It is a narrow assymetrical syncline running for about 200 miles from east to west. Its southern flank is formed of the extensive Gokhprush Band with its moderate and varying dips. The northern flank is much steeper and the dips are as high as 90°. The mudstones on the northern limb have been metamorphosed into slates, whereas in the Gokhprush Band they hardly develop distinct cleavages. This apparent difference in the degree of the metamorphism between the northern and the southern flanks of the syncline casts a shadow of doubt on the synclinal connection between the two.

Is there a faulted relationship between the two flanks, and is this Kech-Nihang valley a fault valley, are the pertinent questions which remain to be answered pending the more detailed work to be carried in future.

Faults :—

In general the preponderence of mudstones in the region obscures the faults in the greater part of the area. However the Middle Sandstone Stage and the thicker sandstone bands in the mudstones wherever present, bring out clearly the existence of faults either in the form of displacement and dislocation of beds or by developing clearly the topographical features associated with faults.

In general the beds are mostly affected by the dip faults. The greater majority of faults run in NE-SW direction, however the one of the biggest fault, Koh-i-Daram fault, along with others have a direction of NNW-SSE. The sandstone ranges throughout the region show the displacements along the dip faults.

Hor Range particularly shows the effects of dip and block faulting. Most of the mountain passes and the river channels across the ranges are invariably along a fault outcrop. Rivers like Dasht and Shadi-Kaur provide excellent examples of transversly crossing the east-west running ranges at Bundgh Koh and at Kabri respectively along the faults.

The amount of displacement in the beds varies from few inches to more than ten miles. Koh-i-Daram is an excellent example of the faulted mountain where the Middle Sandstone Stage comes directly against the Upper Mudstone Stage exposed in the Kulauch-Chilari syncline. Here the sandstones have been displaced through more than six miles. This mountain seems to have been block faulted as it appears to be bounded on the west also by a fault. The displacement associated with the fault on the west is much less than the one found on the east. The biggest displacement of about ten miles is thought to have taken place along a fault running four miles west of Kabri

Kabri area is fairly well served by a number of faults. A dip fault running NE-SW provides a passage for Shadi-Kaur river to cross the intervening range. About four miles south of Kabri a strike fault running east-west cuts the thickness of the Middle Sandstone Stage to nearly half. The fault scarp is well marked and runs four miles towards the west.

An interesting example of scissor faulting with its striking structural and topographical manifestations is seen in Kumbi hills about four miles south-west of Chakuli. Here the Kumbi hills composed of sandstones of the Middle Sandstone Stage rise abruptly within the coastal plain underlain by the Lower Mudstones. The most interesting features developed due to this faulting is the abrupt change of strike to NE-SW from the regional E-W trend. The fault scarps to the north and east are conspicuously developed and stand out clearly against the flat coastal plain. The block of hills disappear within a short distance of six miles. The whole phenomenon may be the result of the combination of block faulting coupled with the scissor faulting. However, only two faults running E-W and NE-SW are exposed. It is quite likely that the other faults are obscured by the recent deposits.

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SOME CONTRIBUTIONS TO GEOGRAPHY BY SPANISH MUSLIMS

Paper contributed to the centenary of the Royal Spanish Society

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The history of geographical knowledge, an important field of modern geographical investigation is drawing much attention and many useful contributions have been made to this branch of study by both Eastern and Western scholars. It is being realised increasingly that Muslim contribution to the science of geography marks a definite stage in the progress of geographical thought and knowledge. There have been many works on the various aspects of the History of Geography, but the proper history of Muslim Geographical thought has still to be written, and I believe that the scholars in Spain will contribute to this field of study in an important manner.

The modern scholar finds its content amazingly vast and effects far-reaching into many fields of human endeavour. A full appreciation of the importance of Muslim geography can best be obtained in contrast to the state of ideas and knowledge in contemporary times as well as the period preceding it. The Greek and Roman Contributions to geography had reached their high water mark with the works of Cladius Ptolemy and with him the story of ancient discovery and geographical thinking virtually came to an end. Thereafter Greek and Latin literature contained little of real geographical importance and gradually the Dark Age of Geography set in. This long period of several hundred years is characterised by a negation of the spirit of enquiry and general aversion to scientific thinking. This phase, unfortunately, coincided with the early centuries of the Christian era and in many respects the psychological atmosphere was detrimental of the general acceptance of the pre-Christian geographical ideas and theories. Fiction and fantasy replaced serious geographical thinking.

Muslim contribution to geography is intimately related to the intellectual renaissance which characterised the rise of the Islamic civilization. Its growth and development is closely linked with the dawn of a new scientific spirit which so markedly set reason above authority. The Arab's assimilation of both classical and oriental lore and their cementing by their own genius, led to a remarkable quickening of the scientific impulse. They were never servile imitators of the models of the past. "They possessed a will, a mind, and a marked capacity of their own, which impressed its individual stamp on all they received or borrowed from without." Their scientific effort was truly a Synthesis. This was as true of geographical science as of other arts and sciences. Throughout the centuries *i.e.*, from the 9th to the 15th, we come across an array of rationalist thinkers and scientists who not only resurrected the classical age, but also laid the foundations of experimental science. The spirit of tolerance, larger outlook, and craving for learning and extending the frontiers of knowledge characteristic of rational Muslim mentality is typified in the product of such men as Al-Biruni, Ali Ibn Sina, Masudi, Ibn Rushd, Idrisi, Ibn Bajja, Ibn Khaldun etc. It is not surprising therefore, that such a psychological make up which permeated many sections of the Muslim Communities never stood in the way of investigation into the causes of natural phenomena. Thus Geographical science during these times was closely linked with cultural and scientific progress and continued to attract the attention of intelligent people as long as there was a continuity of cultural development. Stanislas Guyar rightly remarked, "During the Middle Ages the history of Muhammadanism is the history of Civilisation itself". Indeed geographical work was a product of the efforts of the historions, mathematicians, astronomers, great travellers and geographers. In those ages the cultivation of scientific knowledge did not have the sharp frontier of our own time.

Yet many modern geographers fail to appreciate fully the significance of Muslim geographical thought in influencing Mediaeval Europeon geography and the renaissance geography. In fact, the evidence against this view is too weightly and too long and it is not my purpose to lay it down at the moment. I will only rest content by saying that contrary to such commonly accepted views, the evidence of the penetration, permeation and positive influence of Muslim geographical conceptious in Europe is clear and pointed in works such as those of Plato of Tivoli, Micheal Scotus, Robert of Chester, Hermanus Allemanus, Constantino Africano, Adelard of Bath, Roger Bacon, Marino Sanuto the Elder, John Mandeville, Joannes Sacrobesco, Vincent of Beauvais Friar Albert, Gossuin of Metz, and even Dante, to mention but a few. The ideas were passed on not only in terms of astronomical and mathematical aud descriptive geography, but also in cartography and physical and analytical geography, in fact, the influence embraced a wide field of geographical thinking. The chennels for the passage of the ideas and influence of this knowledge were many. The long wars of the Crusades apart from their religious animosity and bitter struggles between Muslims and Christians served to transfer both scientific ideas and notions of material comfort from the advanced east to the backward west.

With the expansion of Muslim power, around and across the Mediterranean, there developed many centres of intellectual and cultural activity, where from the 10th to 13th Century also flourished an extensive translation activity. Egypt, the Syrian Coastal towns, Sicily and South Itlay, and above all, Spain, were the scenes of this remarkable study and acceptance of Muslim ideas worthy of translation into Latin. The libraries of Toledo, Cordova, Seville, Palermo, Alexandria and Antioch were full of such works in Arabic. There were more commentaries than translations of Greek originals and a large number of Muslim works on astronomico-mathematical and geographical subjects. In this story of cultural and intellectual contact, the influx of eager students to Spain from all over Christendom was remarkable indeed. The School of the Archbishop of Toledo under the Supervision of Archdeacon Dominico Gondislavi and with the co-operation of the Hebrew Scholar Johannes ben David, in 20 years rendered into Latin a large number of Arab works on science and philosophy. The first translation of the "Almagest" of Ptolemy from Arabic into Latin was made by Gerard of Cremona in 1175 A.D. Likewise, the same sholar, after coming from Italy into Spain, translated among other things Banu Musa's works, Al-Khwarizmi, Al-Ferghani, Al-Nairizi, Thabit bin Qurra, Al-Biruni's Commentary on Khwarizmi, the Tables of Jabir bin Aflah and Zarqali. There were other translators also. Many northern cities of Spain *i.e.*, Tarragona, Leon pamplona, Segovia etc., were the places where many of these scholars settled down and worked. It will be no exaggeration to say that the Spanish—Arabic learning exerted its influence over many parts of Western Europe and the intellectual avenues leading out of the Spanish cities and crossing the Pyrenees wound their way through Provence and the Alpine passes into Lorraine, Germany and Central Europe, as well as across the Channel into England. For the last named country, Adelard of Bath's name is associated with useful translations into Latin.

Thus we get the other side of the picture, namely, the contact of the Islamic and Western Cultures in peaceful relations occupied in the pursuit of knowledge. The influence of this scientific transmission including the geographical ideas on Scholasticism and later renaissance geography was thus considerable.

To this survey of the transmission of Muslim geographical ideas to Europe, I would like to add a brief reference to the works of some Spanish Muslim geographers.

Spain also produced several geographers of outstanding merit—men who travelled widely, observed minutely and wrote exhaustively. Al-Bakri (Abu Ubaid 'Abdullah b. Abdul Aziz) was born at Cordova in 432 A.H. (1040 A.D.) and died there in 487 A.H. (1094 A.D.). He wrote a 'Geographical Dictionary' (Mu'jam Ma Ista'jam), and also a book on "Routes and Kingdoms" (Al-Masalik wal Mamalik). Bakri seems to have studied a wide range of subject-matter before compiling his own work. One of his main sources was the Spanish geographer Muhammad al-Tariqi, died 363 A.H. (973 A.D.), who had written about North Africa. Another source was the work of Ibrahim bin Ya'qub a Jewish merchant and slave-dealer, who was a Spaniard and had travelled through Germany and the Slave countries during the reign of Otto the Great.

A notable geographer was Muhammad bin Abu-Bakr az-Zuhri of Granada, who is one of those few writers who gave to their work the name of geography. He is the author of a 'Book of Geography' (Kitab al-Jughrafiyah) and lived towards 532 A.H. (1137 A.D.). It is said that in the time of Caliph Mamun, seventy geographers completed a work of which only a few pages are now preserved in the Bibliotheque National, Paris, No. 2220. This work was utilised by Al-Fazari and Al-Kumari and their work in its turn was used and enlarged upon by Az-Zuhri in his 'Book of Geography'.

One of the most famous Spanish writer on geography was Al-Mazini (Abu' Abdullah Muhammad b. 'Abdur-Rahim al-Mazini al-Qaisi al-Andalusi), who was born in Granada in 473 A.H. 1080 A.D.). He came to Egypt in 508 A.H. (1114 A.D) and went to Baghdad in 556 A H. (1161 A.D.). For a considerable time he studied in Khurasan and later at Alleppo and died at Damascus in 565 A.H, (1169 A.D). One of his works is a geographical description of his journeys (Tuhfat al-Albab wa Nukhbut al-A'jab). Another account of his journeys through Spain, Africa, Damascus Ardbil, the Caspian Coasts, Derband and the land of Khazars is known as 'Nukhbat al-Adhan fi 'Ajaib-al-Buldan'. Two more well-known works are: Al-Maghrib 'An Ba'd 'Ajaib al-Buldan' (dealing with the Maghrib) and 'Tuhfat al-Kibir fi Ash'ar al-Bahar' (dealing with sea voyages), a copy of which is said to be in the Historical Academy, Madrid.

Another geographer who seem to be a Spaniard was Al-Munajjim (Ishaq b. Hussain) who is supposed to have worked in the fourth century Hijra between the period 340 A.H. (951 A.D.) and 454 A.H. (1063 A.D.) in Morocco. His book deals with many cities (Kitab Akam al-Marjan fi Dhikr al Mada'in al-Mashhurah Bikul Markan—A Geographical Dictionary). The main importance of this work lies in the fact that the celebrated writers like Idrisi and Ibn Khaldun utilised it.

Abu Muhammad al-'Abdari of Valencia wrote an account of his journey through North Africa in 688 A.H. (1289 A.D.).

Ibn Jubair (Abu'l Hussain Muhammad Ibn Ahmad Ibn Jubair al-Kinani) was also of Valencian extraction and was born in 1145 A.D. Among his countrymen he enjoyed a high reputation as a poet. But to the geographer his greatest contribution is the journal which he kept during his first journey to the East in connection with a pilgrimage to Mecca towards the end of the sixth century Hijra.

He published this diary soon after his return to Spain under the title 'Rihlat Ibn Jubair' (Travels of Ibn Jubair). It became very popular both in the East and the West. His account throw interesting light on the geography and cultural and commercial activity of the Muslim parts of the Mediterranean lands. The writings of Ibn Jubair were untilised by many notable writers and historians after him, like Al-'Abdari, Al-Balawi, Ibn al-Khatib, Al-Maqrizi, Al-Fasi, Al-Maqqari and Ibn Battuta. In his later years he taught at Malaga and then at Fez and Ceuta and died in 1217 A D.

Ibn Sa'id al Maghribi (d. 1274 A.D.) wrote a notable geographical work called 'Kitab' 'Jughrafiah fi'l Aqalim' of which only an extract has been preserved. Though the treatment was on the basis of 'Climates' (Aqalim), the latitudes and longitudes of many places are added and facilitate the reconstruction into a map. The writer made use of many new facts including the signification story of Ibn Fatima's travels along the West African coasts and the descriptions of tribal settlements in North Africa after the times of Almohades (al-Mu' wahhidun).

Time does not permit more details, but from what has been said, it is ample to show the valuable heritage of geographical contribution that Spain has from its Muslim Geographers. Perhaps many a work which would throw more light on this topic, still lie buried under the dust of library shelves or private collections. The Spanish Scholars are the most suitable persons to discover and present them to the world.

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