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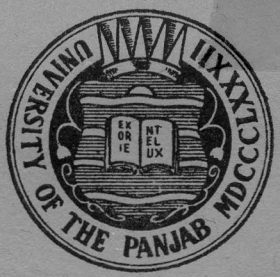

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VOL. XIV
NO. 1

ANNUAL SUBSCRIPTION:

INLAND	...	**Rs. 6**
FOREIGN	...	**Rs. 8**

All communications to be addressed to the Manager, Pakistan Geographical Review. Department of Geography, University of the Panjab, Lahore

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VARIATIONS OF MOISTURE TYPES AND THEIR BEARING ON SOIL EROSION IN WEST PAKISTAN

BY

KAZI S. AHMAD & MUBASHIR L. KHAN

Department of Geography, University of the Panjab, Lahore

Aridity, soil erosion and water-logging are some of the most important problems of our agriculture on which depends more than two-thirds of the population. All the three are closely inter-related. While irrigation has solved the problem of aridity on the one hand, it has promoted water-logging on the other. Similarly, while wind action plays a significant role in the landscape of the arid areas, great run-off, resulting from heavy rainfall, is responsible for soil erosion in areas, given to reckless grazing and unjudicious use of the axe. Moisture in the air has a bearing on precipitation, run-off and the plant life, which in their turn affect soil erosion.

The present paper has mainly two objects in view : firstly, to show the significance of potential evapotranspiration in determining the water-balance of our country, and secondly, to establish the extent of fluctuation of various moisture types and their bearing on soil erosion.

Potential Evapotranspiration

The values of potential evapotranspiration have been calculated from temperature and rainfall data (30 year normals) according to Thornthwaite's method* for 35 places scattered over various parts of the country (Map No. 1).†

Map No. 2 shows the distribution of average annual potential evapotranspiration in West Pakistan. The average annual water need reaches its maximum in the south-eastern part of the country, where it is more than 155 cms. Generally speaking, the water need decreases from the Arabian Sea coast (135 to 155 cms.) northward to the great Himalayas (75 cms.) with slight increase in the Hindukush-Karakoram belt (85 to 95 cms.). It also decreases westwards from Indo-Pakistan border (155 to 125 cms.) to the highest parts of Suleiman-Kirthar mountains (75 cms.) It increases considerably further westwards in the direction of Helmand-

*C. W. Thornthwaite "An approach towards a rational classification of climate" *Geographical Review*, Vol. 38, 1948.

†The temperature and rainfall data were made available by the Meteorological Department of Pakistan. But in case of five stations—Musakhel, Barkhan, Murgha, Urak and Shelabagh, all situated in the Suleiman Range, the temperature data were not available and were calculated by using the normal lapse-rate figures.

Seistan depression and its southern extension in Chagai and Kharan (135 cm.) The reason for this pattern is quite simple. In deserts evapotranspiration becomes more on account of the absence of clouds and due to higher temperatures. The high values in the Indus plain and Hamuni Mashkhel arca on the Pak-Iranian border are good examples. Multan having an annual precipitation of 17.62 cms. has a water need of 144.4 cms., whereas it is only 74 cms. at Musakhel situated in the same latitude in the Suleiman range, having an annual precipitation of 52.0 cms.

The effect of altitude in reducing the potential evapotranspiration is also obvious because of small actual evapotranspiration under lower temperatures.

The march of potential evapotranspiration follows a uniform pattern all over the country. It is highest in July and ranges from 19 cms. along the Arabian Sea coast to 11 cms. in the higher Himalayas (Map No. 3). It is negligible in the winter months. An interesting feature of the distribution of potential evapotranspiration in winter is that the 1,000-contour serves as the isoline of zero cm for January water need. It is highest along the coast (4 cms.) in sympathy with the no therms. (Map No. 4).

In West Pakistan the temperatures are the lowest during January ranging from 19.13°C at Karachi to below freezing point in the highest parts of the northern mountain ranges. Consequently, water need is lowest during these months. With the commencement of the spring season, the temperatures rise rapidly during March, April and May. For instance, at Sukkur the mean temperature for February is 18.52°C and it rises to 23.19°C in March, to 28.50°C in April and 34.16°C in May Throughout West Pakistan, as already stated, the temperatures reach maximum in June (Badin 33.05°C) or July (Drosh 29.50°C), and the highest water need occurs accordingly in these months. The water-need for the summer months is less than 48% of the annual water-need over the Indus plain, Potwar plateau, Bannu and Peshawar intermont depressions, southern Kirthars, Makran, Chagai and Kharan (Map No. 5). The percentege, however, increases with the increase of elevation so that all parts situated above 7000 contour have the highest percentage of summer concentration of thermal efficiency, (61.6%), a natural corollary to a more powerful sun.

In late summer the water-need is still very high, though it may fall slightly with the advent of rains. For instance, at Bannu, it falls from 21.8 cms. in July to 20 cms. in August and to 18.0 cms. in September. The corresponding figures for Gilgit are 18.8 cms., 17.1 cms. and 10.5 cms., for Kalat 12.8 cms., 11.7 cms. and 7.6 cms. and for Parachinar 15.0 cms., 13.4 cms. and 8.4 cms. From October onwards with the rapid fall of temperature there is a corresponding fall of water need. At Chaman it decreases from 6.8 cms. in October to 2.2 cms. in November and to 1.3 cms. in December and at Montgomery from 10.0 cms. in October to 3.8 cms. in November to 1.2 cms. in December. The corresponding figures for Panjgur are 7.9 cms., 3.2 cms. and 1.4 cms., for Rawalpindi 10.3 cms., 3.3 cms. and 2.4 cms. and for Hyderbad 15.0 cms., 7.2 cms. and 2.7 cms.

Precipitation

Map No. 6 shows the distribution of normal annual precipitation which has been prepared from the data of 375 rain gauge stations in the country. The rainfall is generally low and in general increases northwards from 9.25 cms. at Sukkur to 148.40 cms. at Murree and westwards to 51.60 cms. at Musakhel. There are, however, two exceptions to this general pattern of rainfall over the country. The trans-Himalayan arid region lying in the rainshadow of Himalayas receives very low rainfall, *i.e.*, Gilgit 12.95 cms. and Skardu 15.75 cms. This region is an extension southwards across the mountain wastes of Hindu-kush and Karakoram from the great arid zone of Central Asia embracing the deserts of Gobi, Tibet and Takla Makan. The second exception is the Hamuni-Maskhel and Dashti Tahlab area (Nokkundi 4.87 cms. and Dalbandin 8.01 cms.), which forms part of the Lut-Kavir-Seistan desert).

Apart from being generally meagre and highly variable, the precipitation in West Pakistan is unevenly distributed through the year. The rainfall is received mainly in three distinct seasons. (1) The cold season (2) The Spring and early Summer season (3) The late summer or the monsoon season. The cold season which lasts from January to February derives its precipitation from the western disturbances (normally 16 every year). Though meagre in amount this precipitation is highly valuable since at this time of the year, losses :hrough evapotranspiration are quite negligible. It is the major source of snowfall in the Himalayas, Hindukush and Karakoram. Western half of the Baluchistan plateau receives more than 40% of its annual precipitation during this season (Map No. 7).

During the spring season (March and April) the corresponding number of the western disturbances that visit the country is about 12 which indicates that on the whole the cyclonic activity is reduced by 25% during the spring months. On the other hand with the commencement of spring, temperatures rise rapidly all over the country, creating supra-heating among the lower layers of the atmosphere. This ultimately leads to convective instability, a kind of metastable condition which provides thermo-dynamic energy to be used by premonsoon thunderstorms. The thunderstorm activity is at its maximum during May and June and accounts for more than 40% of the total rainfall in the Indus plain, Himalaya and Hindukush ranges. Peshawar-Mardan, depression with adjacent mountains also receives more than 40% of its annual total during this season.

Monsoon season (July to September) is the most important in the amount of rainfall in West Pakistan. The monsoon rainfall is associated with the innumerable cyclones which develop along the oscillating Inter-Tropical Front either from the Arabian Sea or from the head of the Bay of Bengal. The monsoon rainfall constitutes more than 40% of the annual total in the Indus plain, the Potwar plateau and the Outer Himalayas. The east marginal deserts of Thar, Nara and Cholistan receive more than 70% of their annual total during this season.

Water Deficiency and Water Surplus

As already pointed out, rainfall and evapotranspiration, both of which are important climatic elements for our study, do not usually vary in the same proportion in amount or in distribution. In some places rainfall is more than the water-need throughout the year, the soil remains full of water and a water surplus occurs. At other stations precipitation is less than the water-need as a result of which the soil is desiccated, the vegetation remains in permanent want of water and the water-deficiency occurs. Still at other stations periods of water-surplus are followed by periods of water deficiency during which the stored soil moisture is used.

To study closely the nature of the water problems in an area, it is necessary to obtain the actual values of water-surplus and water-deficiency. This is done by comparing the monthly march of precipitation with potential evapotranspiration and working out the water balance at different stations. It was originally assumed that the soil could store in its zone of root-penetration a maximum of 10 cms. of water and that it would be removed from the soil at a rate equal to the water-need. The recent work of Thornthwaite and Mather* has shown that in cases of strong vegetation the amount of moisture in a soil may be at least 30 cms. and that the evapotranspiration rate is proportional to the amount of water stored in the soil. Appendix 1, gives the water balance computations for five stations situated in various parts of West Pakistan.

Map No. 8 shows the distribution of the average annual water-deficiency in West Pakistan. The region with the maximum water-deficiency is the middle Indus plain. Sukkur and Jacobabad and Sibi have an annual water deficiency of above 140 cms. thus forming the heart of the Great Indian Desert. The water-deficiency decreases northward from the lower and middle Indus Plain (130—140 cms. to zero in the Outer Himalayas rising again to about 80 cms. in the vale of Gilgit. It is about 20 cms in the Koh-i-Safed region and about 40 cms in the highest parts of Suleiman-Kirthar ranges. Another region of great water-deficiency comparable to Lower Indus plain is the Hamun-i-Mashkhel region of Chagai and Kharan (130 cms.)

Map No. 9 shows the avarege annual water surplus in West Pakistan. The outstanding feature of this map is the high surplus (80 cms.) in the Outer Himalayas which contributes the greatest share in the discharge of Indus and its tributaries. Another zone of water surplus (20 cms.) is the Koh-i-Safed, accounting for the discharge of the Bara, the Kurram and the Kohat and Teri Tois. The highest parts of the Suleiman, Toba Kakar and Kakar Khorassan ranges, have a water surplus of over 5 cms. in the year.

From the study of Maps No. 8 and 9 we can obtain much information about the water problems in West Pakistan. It has many areas of extreme water-deficiency and at the same time some areas of good water-surplus. This situation has created

*C. W. Thornthwaite & J. R. Mather, 1955 "The Water budget and its use in irrigation. U. S. Department of Agriculture. Year book of Agricultures, 346—58."

the problems of droughts and floods. The former points to the need of moisture conservation and careful irrigation. The latter rises the twin problem of the control of soil erosion and the use of surplus water. The movement of enormous quantity of water across the loose unprotected impermeable strata works havoc with the soil in the arid and semi-arid areas. It shows the importance of water-shed management and flood control. The necessity of making delay-reservoirs in the water-shed of the western mountains is also obvious from the figures of water surplus and water deficiency in these areas. The problem of removing non-beneficial vegetation in the streams of this region replacing it with desirable plants to effect savings of water is also worth considering.

Moisture Types

The water problem of West Pakistan as a whole can be studied by considering another important climatic element the moisture index which defines various moisture types in the country by weighing the water surplus and the water deficiency against the water need. Map No. 10 shows the various moisture types in West Pakistan according to Thornthwaite's scheme. The positive indices show the moist climates and negative indices, the dry climates.

As it is evident from the map, almost the whole of West Pakistan, outside the main Himalayan region, falls within the negative isarithmic zone. The whole of the middle and lower Indus plain, the south-western part of the upper Indus plain and by far the greater part of the Baluchistan plateau have arid type of climate. The intermont depressions of Peshawar and Bannu also have the same type. The Karakoram, Northern Hindukush and Sakezjarab (Hindu Raj) ranges again have an arid type, The north eastern part of the upper Indus plain, the Potwar plateau except for the district of Rawalpindi, the agencies of Khyber, Malakand, Mahmand, Kurram, N. Waziristan and S. Waziristan and the north-eastern lobe of the Baluchistan plateau (excluding those parts situated above 6000) have a semi-arid type —20 to —40). The Southern Hindukush and the Northern Himalayas also have the same type. The dry-subhumid type is found in the sub-montane tracts of Sialkot, Jhelum and Rawalpindi districts. Most of the Kohat district and Kurram agency around Hangu have dry sub-humid type.

In the north-eastern lobe of the Baluchistan pleteau, the country around Musakhel, Barkhan, Ziarat, Manikhaw, Shaghalu and Shelabagh also has dry sub-humid type, having good stands of natural forest.

The moist types, as seen from the map, are found only in certain restricted parts of the country. The one and the largest is the Himalayan region, a large part of which has humid climate. Perhumid climate is limited around Murree and to the north west of Muzaffarabad. On the crest of Kohi-i-Safed around Fort Lockhart, Shalozan and Karyan, wet sub-humid type of climate is found. Important moisture data for selected stations will be found in Appendix II.

Variability of the Moisture Belts

Map No. 10 shows the moisture types based on the normals for 1901—30. But in fact the moisture indices and moisture belts vary considerably from year to year. The moisture index is derived by weighing the water-surplus and the water deficiency against the water-need. From the stand-point of climate, water need is mainly a function of temperature which is a quasi constant element of climate. In West Pakistan, and particularly in its arid and semi arid zone, the mean temperatures of the same month in successive years do not show great variation. During the summer months differences do not exceed $\pm 2°$ to $\pm$ 3°F. In the winter months, however, they are slightly greater $\pm 4°$ to $\pm 5°$F but since the water need figures are quite negligible in these months, they do not cause appreciable variation in the values of monthly potential evapotranspiration.

In contrast, there is a great variation in the amount and distribution of rainfall both in time and in space.

Map No. 11 shows average annual rainfall variability in West Pakistan. The zone of maximum variability (50%) covers the Middle Indus plain which corresponds with the zone of maximum water deficiency in the country (140 cms.).

Monsoon rainfall which makes the bulk of annual precipitation in the Indus plain and the Himalayas is even more variable than that of the winter, the variability being as high as 10% in the Middle Indus plain, decreasing to 40% in the Himalayas, Western Hills and along the Arabian Sea coast. In certain years the monsoon rainfall has been as high as 170% of the normal with resultant floods, while in others it has been as low as 10%, of the normal dragging the country almost to the verge of famine. Such great variations in the amount of rainfall have always had bad effect on the economy of the country by causing crop failures.

The effect of this great variability of rainfall is manifest in the form of considerable displacement of the moisture belts in the country from one year to another. In Map No. 12 the moisture regions of 1944, the wettest year during the period, 1930—1955, are shown. The map bears a totally different picture of the moisture belts in the country. The arid types were limited only to the middle Indus plain, Chagai Kharan and the Trans Himalayan regions. Most of the country was occupied by semi arid and dry sub-humid types. Many parts of the Baluchistan plateau had wet sub-humid and humid types. The moisture types were almost static in the Koh-i-Safed region, although there was a considerable encroachment by the per humid type in the Himalayas.

1946 was the driest year in West Pakistan during the period, 1930—1955, except for the sub-montane areas of Sialkot, Jhelum and Rawalpindi which received rains in excess of the normal. Map No. 13 shows the distribution of moisture types in 1946. As may be seen from the map, the arid type covered most of West Pakistan. The dry sub-humid types completely disappeared from the Baluchistan plateau. The rest was according to the normal pattern except for a slight northward displace-

ment of the semi-arid type and southward creep of the wet sub-humid type to the south of Himalayas.

To assess more closely the frequency of persistence of the various moisture types the individual data of each year from 1930 to 1955 have been examined. The results have been shown in Table No. 1 and plotted in Map No. 14. The table shows the frequency of moisture types in various parts of the country expressed in terms of percentage of total number of years for each station given in the table. The map brings into relief a very interesting fact about the persistence of various moisture types. The zone of least persistence (60%) or zone of greatest moisture type variation is found in the semi-arid and dry sub-humid belts which is different from the distribution of variability of rainfall.

A study of maps of eroded lands shows that this zone of greatest moisture type variation is also the region where soil erosion is widespread. That there exists a correlation between the two may be explained by the heavy runoff in spells of rainfall occurring on soil loosened during the period of drought.

This point may be further elucidated in the following paragraphs :

1. The region lies in the transitional zone between the wet and dry climates, the border line separating the two, shifting constantly, according to the amount of moisture available, thus giving the region an arid climate for one year and humid climate for the other. The problem is different in the arid and humid and super-humid areas where the incursion of one into the other is rare and exceptional.

2. Although, the frequency distribution of rainfall in this region is not Gaussian as is usually found in the humid climates, it is also not strictly geometric which is an important characteristic of precipitation in the arid zones. The distribution of rainfall in time shows considerable disparity of mode and mean, a factor which is independent of the variability of rainfall. The rainfall in this region as we have previously said is much less variable than in the arid areas but the magnitude of deviation from the norm whether positive or negative is much larger than in the arid zones, a factor which seems to explain most satisfactorily, the liability of this region to frequent inundations from different moisture types.

3. Better average rainfall is only one factor in giving this region more run-off than the arid areas of the country, but more important and especially so from the point of view of denudation is the skewness of precipitation. The long term precipitation records show that the rainfall has positive skewness in most of this region which means that the mean is largely made up by the excesses or in other words, the excesses from the norm are more common and more violent than the deficiencies This phenomenon helps to explain why this region is subject to a maximum of erosion as we know that severest damage to the soil is done not through normal run off but through heavy rates occurring at very short intervals.

4. The region gets its precipitation either from the spring and early summer convectional thunderstorms or from the late-summer monsoon depressions. Both

these types of rainfall are equally flashy and torrential and unlike winter rainfall which is usually slow and protracted, place water on the soil more rapidly than it can percolate. The high diurnal ranges of temperature in spring cause exfoliation of the rocks, breaking their surface into breccia or powdering it into fine texture. The air which soon rushes into the spores and interstitial spaces produced thereof offers further resistance to the downward infiltration of water whereas active evaporation on the surface helps to remove moisture from the surficial layers of the soil. All this reduces the effectiveness of precipitation but gives a maximum of efficiency to the runoff which assumes great proportions because of the absence of sufficient plant cover.

5. Since the type of vegetation is mainly determined by the rainfall of driest years and not by the mean rainfall for a series of years, it follows that with a rainfall of less than 10 inches in certain years only vegetation with special provision for resisting drought can survive in this region. Such a vegetation it is obvious has little value as a protective device. Nor under these conditions can there be a sufficient accumulation of humus to prevent rapid run-off which might save the the soil further surgery by the running water. As for example, in the Pabbi-Hills of the Kharian ridge in this region, the maximum run-off in the afforested areas is less than 30 m^3 per second per square-mile whereas in areas devoid of plant-cover, the torrents yield as high as 480 m^3 per second per square mile.* The latter figures indicate an excessively high percentage of run-off about 90% of the rainfall of the torrential downpour, falling on a ground not soaked previously.

The oscillation of moisture types within wide limits, as in this region, creates several risks to agriculture. During years of incursion by wet types, agriculture may be successfully practised but it may become almost impossible with the encroachment of dry types. No similar risk exists in continuously arid and humid, regions where the economy is more or less permanently adjusted to these conditions.

Another menace to agriculture in this region, and a direct result of the greatest moisture type variation is soil erosion. In the Punjab region alone about 5 lakh acres have been permanently destroyed by soil erosion while 10 lakh acres are seriously eroded, 15 lakh acres are less affected and 10 lakh acres are under the threat of erosion.† The Unesco Mission that visited Pakistan in January 1952 concluded that about 50% of the cultivated acreage of the Rawalpindi Division was badly eroded. Therefore for effective agricultural planning in this area both these factors *i.e.*, greatest climatic risk and soil erosion should be taken into consideration.

Thus we find that West Pakistan can be divided into three sections, each having different set of problems and thereby different solutions.

(1) The Arid Zone

This covering the middle and southern Indus plain and the quadrangle of the Baluchistan plateau, has large water deficiencies and, therefore, requires large amount

*Gorrie, R. M. "Soil and Water Conservation in the Punjab" *Geographical Rev.*, Vol. 29, 1938.

†Abdul Aziz Anwar "Soil Erosion in the Punjab" Board of Economic Enquiry, Punjab Publication No. 111, 1955.

of water for irrigation without which agriculture is impossible. Scarcity of vegetation helps soil erosion, which is generally caused by the process known as deflation. Surfaces of many areas are lowered by the blowing away of sand. Differential wind-erosion sometimes promotes small hollows. Occasional heavy rains cause floods which pick up great quantities of comminuted rocks, thus doing great damage to the land. In this zone though the water-deficiency is persistently high, and the rainfall most variable, the moisture is adequate to support grass on which pastoral farming could be carefully developed. The growth of grasses would *ipso facto* control soil erosion. This is all the more necessary in the arid uplands where the surface flow of water in sheets during the rains is likely to denude the land completely of its soil cover.

In the plain areas where river water is available it should be judiciously used for irrigation in arable farming and the planting of gardens. Sub-soil water resources should also be exploited for the purpose where possible.

(2) The semi-arid and dry sub-humid zone

This is the zone where the associated moisture type undergo the greatest fluctuation. It extends over the sub-montane strip of the Indus plain (*b*) The Patwar plateau and (*c*) The Western Hills.

In this region with a moderate rainfall water dissection achieves notable results in areas of soft impervious rocks. If unchecked by the distributing action of a grass cover, myriads of water channels arise and the country is carved into what is called a bad-land or scab-land. Many areas in the Potwar plateau serve as its remarkable examples.

These lands, as classified above, are to be differently treated. In the sub-montane plain including the districts of Sialkot, Lahore, Sheikhupura, Gujranwala and Gujrat where facilities for irrigation exist, agriculture should be given the first place. In areas, unprotected by irrigation, cultivation should be regulated.

As discussed earlier, here the rainfall variability being comparatively low, we could easily get over this variability factor by the introduction of crops less susceptible to rainfall fluctuations.

In the Potwar plateau where there are no irrigation works and the mean rainfall is generally good, emphasis should be made on dry-farming and pastoral farming. The cultivation of crops should be extended to those parts in the sub-montane where it is possible to conserve the water of hill torrents by the construction of bunds. The part of the plateau which suffers from gully erosion should be levelled and reclaimed for pastoral activity or dry farming.

In the case of Western Hills arboriculture should be given a good place, supplemented with pastoral farming. Flood plains of the rivers if any and suitably terraced slopes could be used for cultivation.

(3) The Moist Zone

Which includes the wet sub-humid, humid and per-humid types and covers the area between the plain and the Central Himalayas. In this zone

there is no problem of water-supply. It needs attention for water-shed management, maintenance and expansion of forests for the control of floods and soil erosion.

TABLE I

Variation of Moisture Types at Selected Stations

Station	No. of years	Moisture Type	Moisture Type Distribution											
			Super humid		*Humid*		*Wet sub-humid*		*Dry sub-humid*		*Semi-arid*		*Arid*	
			Years	Percentage of the total No. of years	Years	Percentage of the total No. of years.	Years	Percentage of the total No. of years	Years	Percentage of the total No. of years	Years	Percentage of the total No. of years	Years	Percentage of the total No. of years
Multan ...	23	Arid ...	0	0	0	0	0	0	0	0	0	0	23	100
Peshawar ...	24	Arid ...	0	0	0	0	0	0	0	0	2	8	22	92
Karachi ...	26	Arid ...	0	0	0	0	0	0	0	0	1	4	25	96
Lyallpur ...	24	Arid ...	0	0	0	0	0	0	0	0	8	33	16	67
Montgomery...	24	Arid ...	0	0	0	0	0	0	0	0	6	25	18	75
Lahore ...	26	Semi-Arid	0	0	0	0	0	0	0	0	18	69	8	31
Drosh ...	19	Semi-Arid	0	0	0	0	1	5	1	5	17	90	0	0
Sialkot ...	24	Semi-Arid	0	0	0	0	2	8	8	34	14	58	0	0
Rawalpindi ...	24	Dry Sub-humid.	0	0	2	8	3	12	14	58	5	20	0	0
Parachinar ...	20	Wet Sub-humid.	0	0	3	15	14	70	3	15	0	0	0	0

APPENDIX I

	January	February	March	April	May	June	July	August	September	October	November	December	Years
LAHORE													
PE	0.8	1.5	5.3	14.0	19.8	21.1	20.7	19.8	10.3	9.7	3.5	1.3	127.8
P	2.6	2.4	1.9	1.4	1.4	4.1	13.6	12.8	5.5	0.8	0.2	1.1	47.8
St. Ch.	1.8	0.9	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...
St.	1.8	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...
WD	0.0	0.0	0.0	12.6	18.4	17.0	7.1	7.0	4.8	8.9	3.3	0.2	80.0
WS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MURREE													
PE	0.3	0.7	2.8	5.6	9.8	12.2	10.9	9.7	7.8	5.8	3.5	1.8	70.9
P	9.5	10.7	12.4	10.3	6.5	9.9	31.0	32.0	13.5	3.9	1.8	4.5	146.4
St. Ch.	0.0	0.0	0.0	0.0	—3.3	—2.3	0.0	0.0	0.0	—1.9	1.7	2.7	...
St.	10.0	10.0	10.0	10.0	6.7	4.4	10.0	10.0	10.0	8.1	6.4	9.1	...
WD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WS	9.1	10.0	9.2	4.7	0.0	0.0	20.1	23.2	5.7	0.0	0.0	0.0	82.0
PARACHINAR													
PE	0.4	1.1	2.6	5.3	9.3	14.4	15.0	13.4	8.4	6.2	3.1	1.2	80.6
P	5.0	6.5	10.8	10.0	9.7	5.0	8.8	9.2	5.2	4.8	1.0	3.0	75.0
St. Ch.	4.6	3.6	0.0	0.0	—3.6	—6.4	0.0	0.0	0.0	0.0	0.0	1.8	...
St.	6.4	10.0	10.0	10.0	6.4	0.0	0.0	0.0	0.0	0.0	0.0	1.8	...
WD	0.0	0.0	0.0	0.0	0.0	3.0	6.2	4.2	3.2	1.4	2.1	0.0	20.1
WS	0.0	1.8	8.0	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.5

(*Continued*)

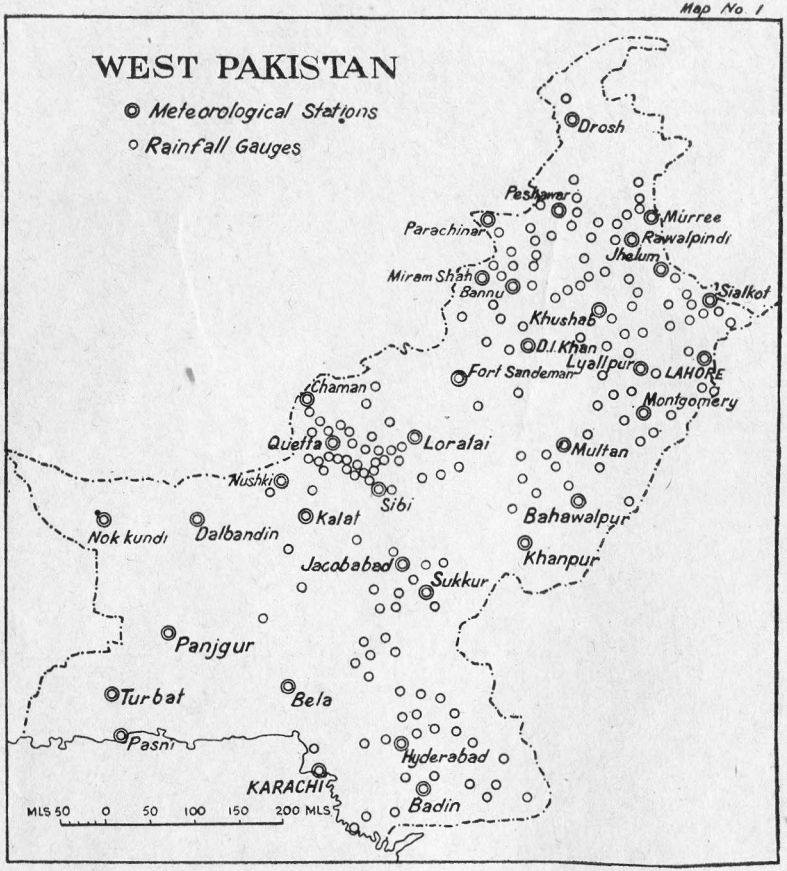
APPENDIX I—(*Coutinued*)

			January	February	March	April	May	June	July	August	September	October	November	December	Years
							QUETTA								
PE	...	...	0.0	1.0	9.2	6.1	9.9	13.2	16.0	13.0	8.7	5.1	2.3	1.0	80.1
P	...	...	4.8	4.9	4.3	2.4	0.9	0.4	1.1	0.8	0.1	0.3	0.7	2.5	23.2
St. Ch.	...	...	4.8	3.7	0.0	−3.7	−6.3	0.0	0.0	0.0	0.0	0.0	0.0	1.5	...
St.	...	...	6.3	10.0	10.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	...
WD	...	...	0.0	0.0	0.0	0.0	2.7	12.8	14.9	12.8	8.6	4.8	1.6	0.0	50.2
WS	...	...	0.0	0.2	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
							KARACHI								
PE	...	...	4.1	4.5	9.8	14.3	17.8	19.4	18.6	16.5	14.2	13.7	9.5	5.4	147.8
P	...	...	1.1	1.1	0.7	0.3	0.1	1.8	8.0	3.9	1.3	0.0	0.2	0.5	19.0
St. Ch.	...	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
St	...	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WD	...	...	3.0	3.4	9.1	14.0	17.7	17.6	10.6	12.6	12.9	13.7	9.3	4.9	128.8
WS	...	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

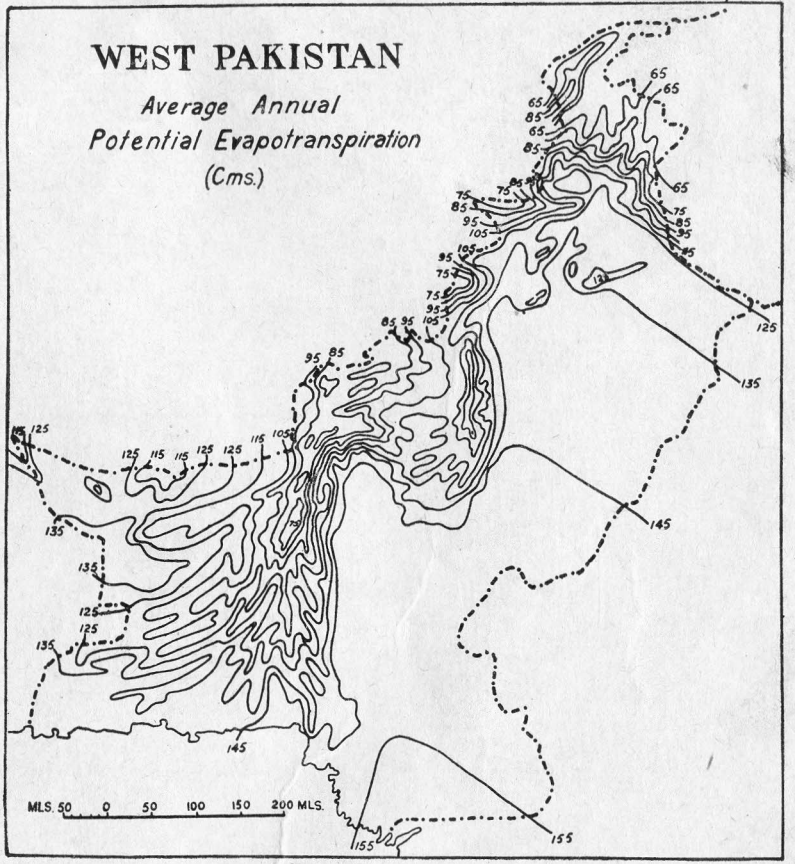
PE=Potential Evapo-transpiration.
P=Precipitation.
St. Ch.=Storage Change
St.=Storage.
WD=Water Deficiency.
WS=Water Surplus.

N.B.—All figures in centimeters.

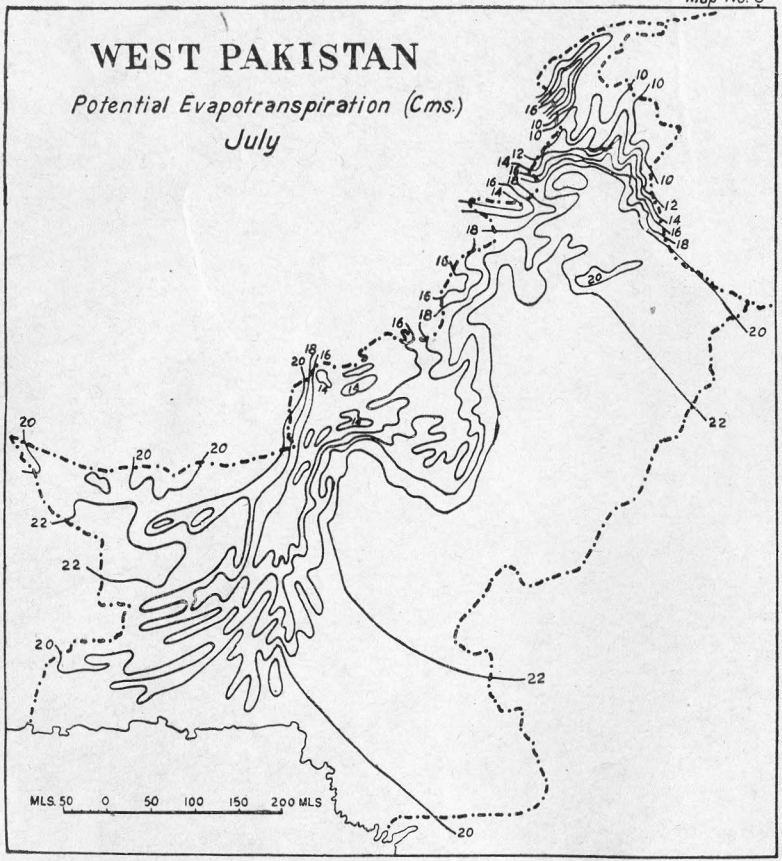
Map No. 1



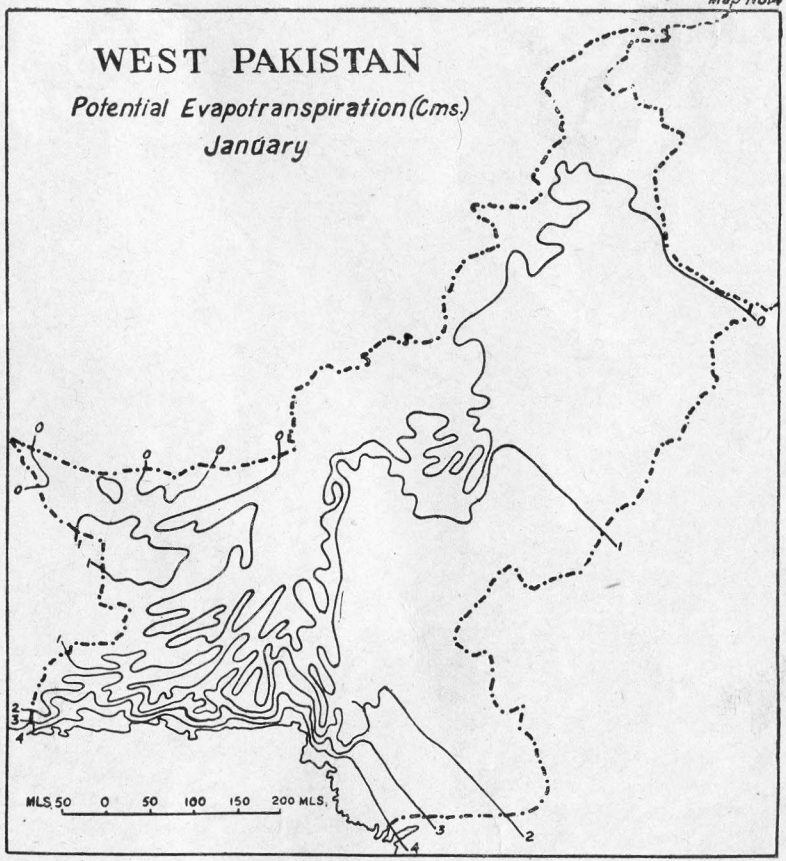
Map No. 2



Map No. 3



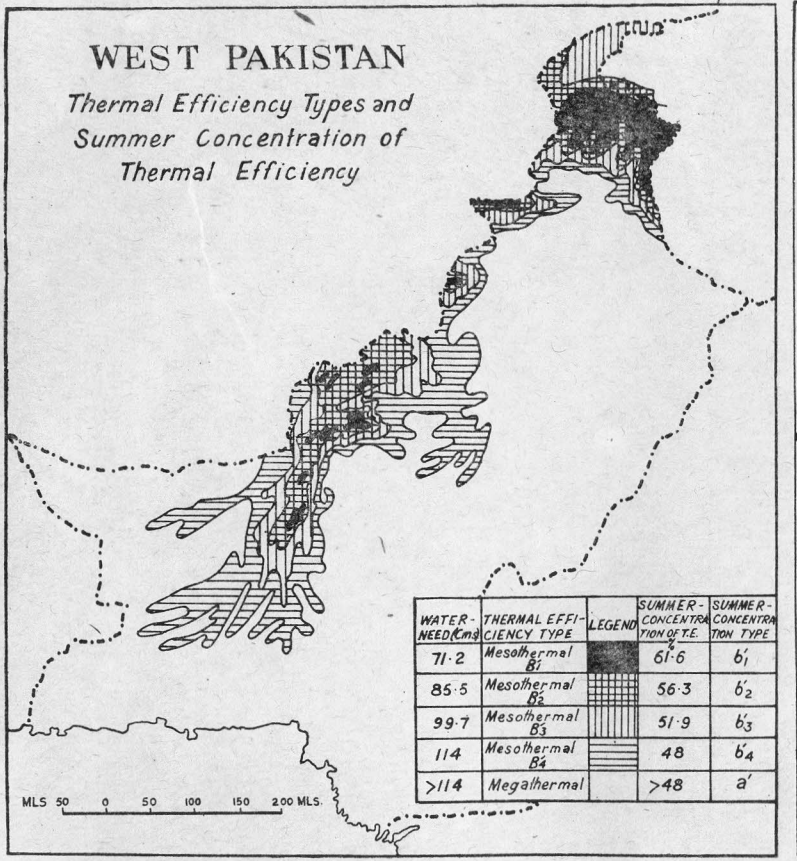
Map No. 4



Map No. 5

WEST PAKISTAN

Thermal Efficiency Types and Summer Concentration of Thermal Efficiency



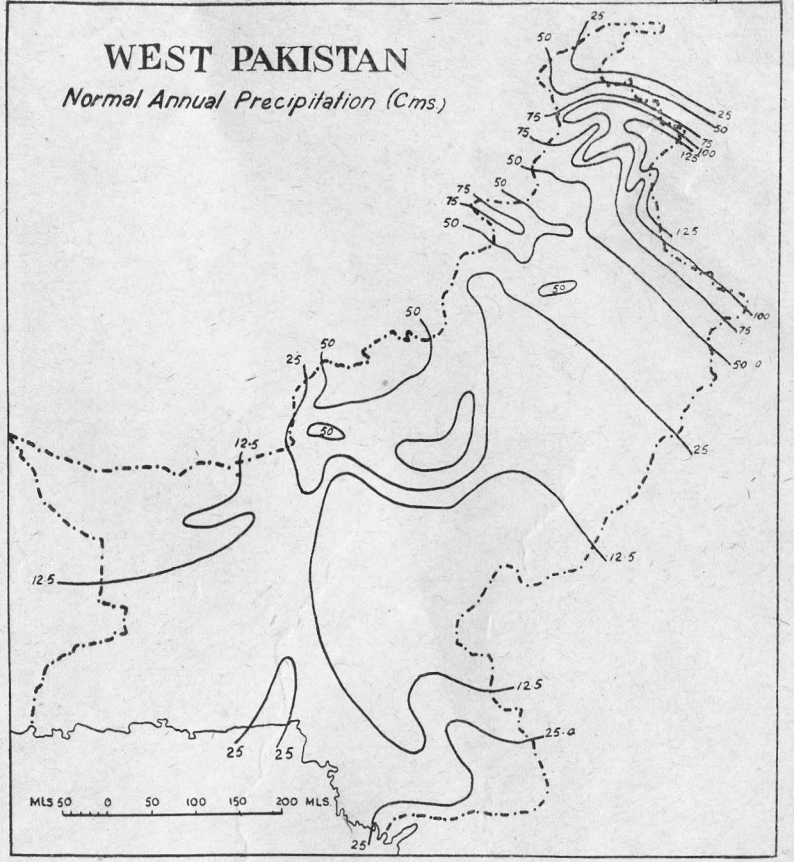
WATER-NEED(Cms)	THERMAL EFFICIENCY TYPE	LEGEND	SUMMER-CONCENTRATION OF T.E. %	SUMMER-CONCENTRATION TYPE
71·2	Mesothermal B_1'		61·6	b_1'
85·5	Mesothermal B_2'		56·3	b_2'
99·7	Mesothermal B_3'		51·9	b_3'
114	Mesothermal B_4'		48	b_4'
>114	Megathermal		>48	a'

MLS 50 0 50 100 150 200 MLS.

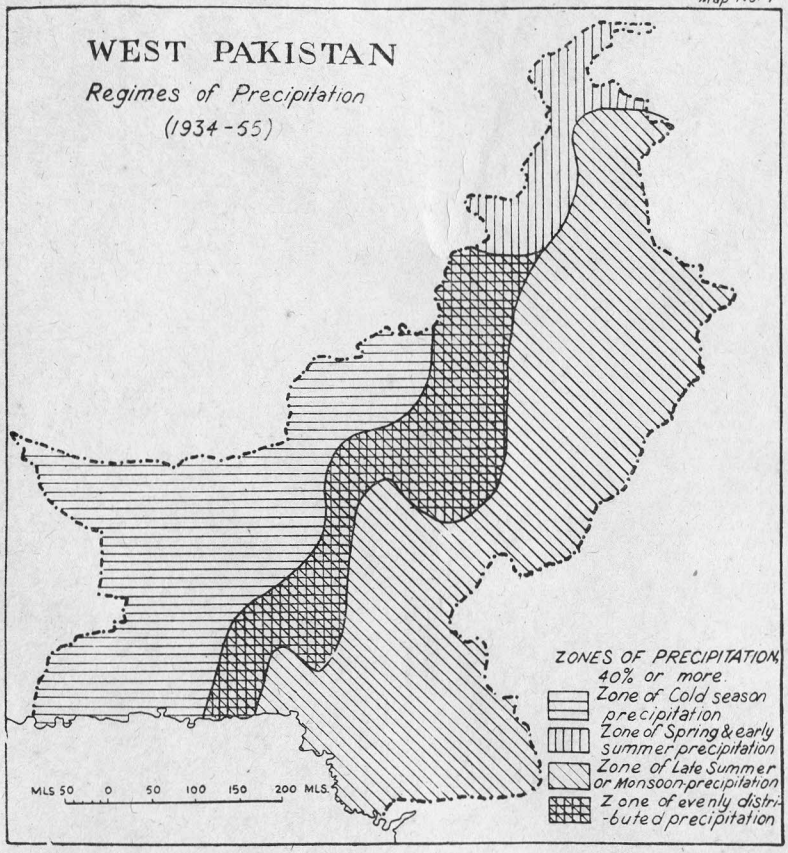
Map No. 6

WEST PAKISTAN

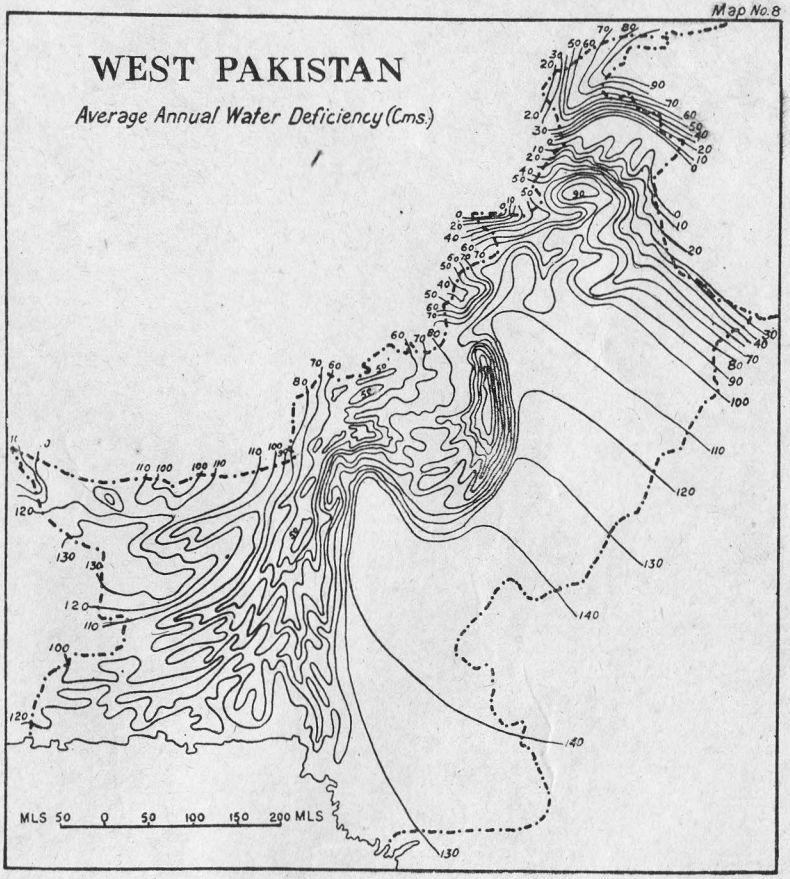
Normal Annual Precipitation (Cms.)



Map No. 7



Map No. 8

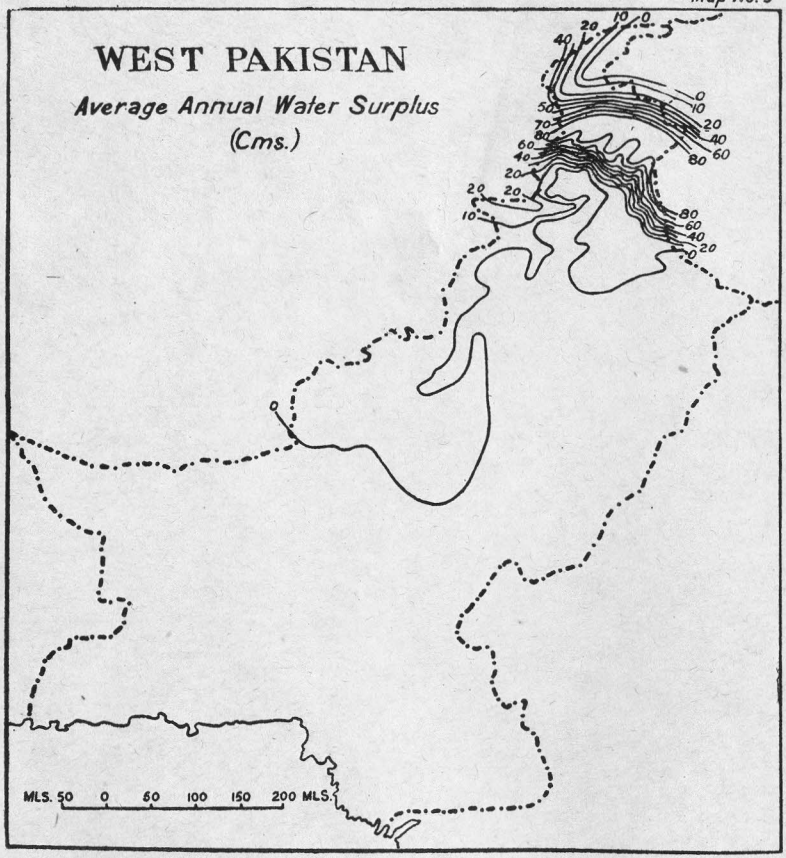


Map No. 9

WEST PAKISTAN

Average Annual Water Surplus

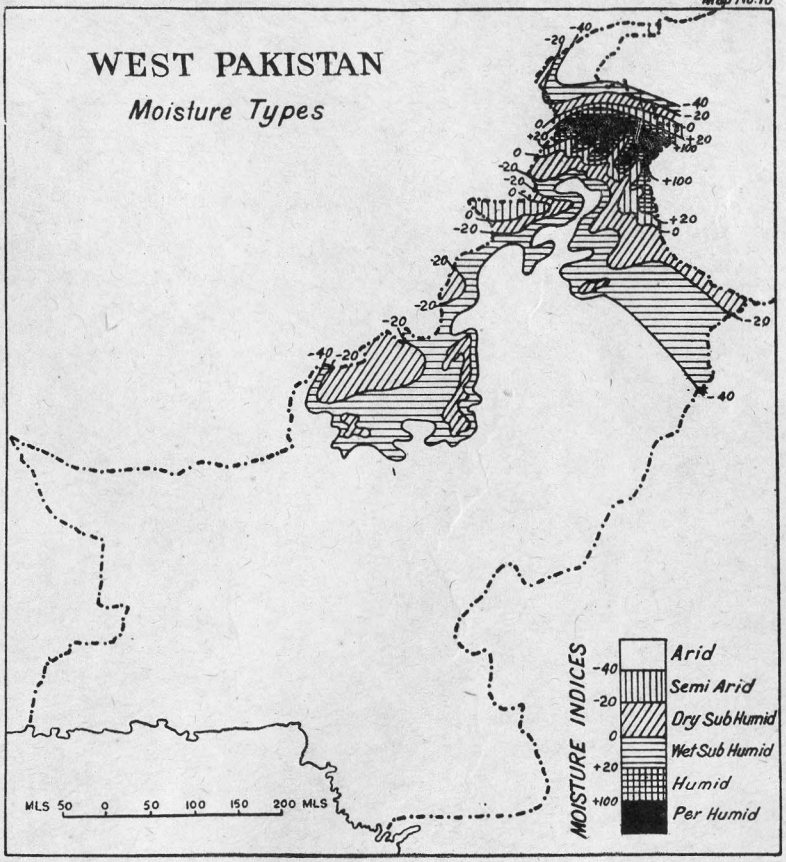
(Cms.)



Map No. 10

WEST PAKISTAN

Moisture Types

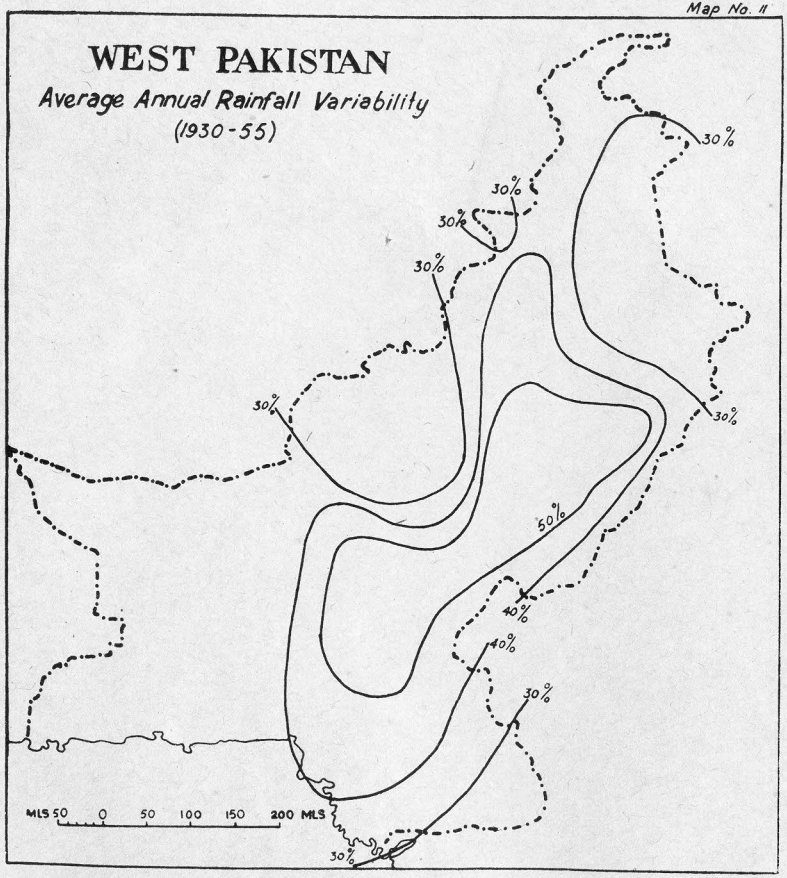


Map No. 11

WEST PAKISTAN

Average Annual Rainfall Variability

(1930-55)



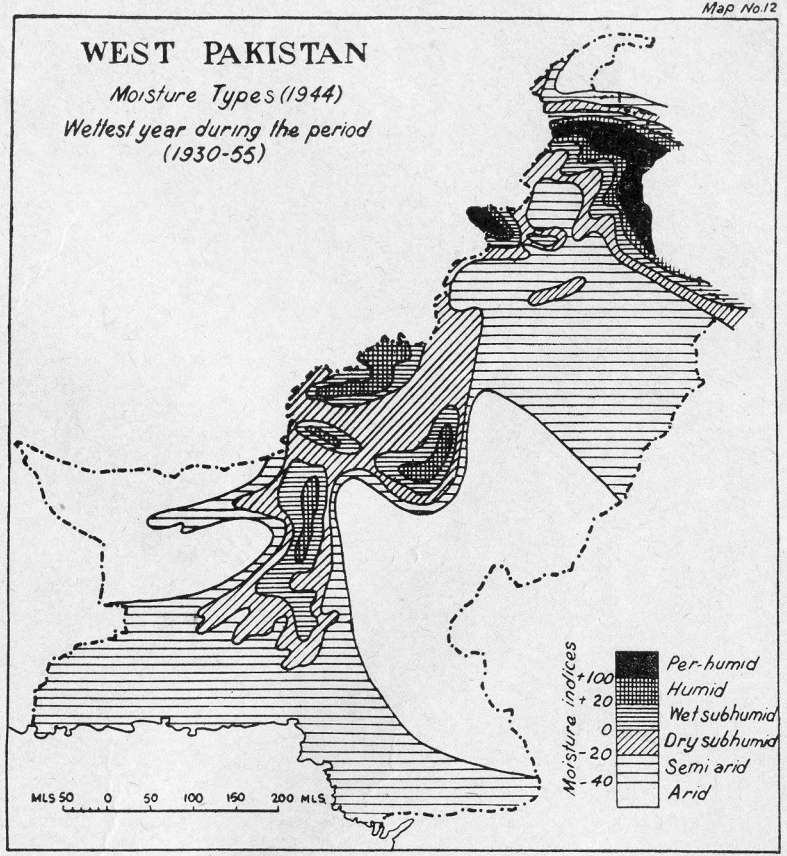
Map No.12

WEST PAKISTAN

Moisture Types (1944)

Wettest year during the period

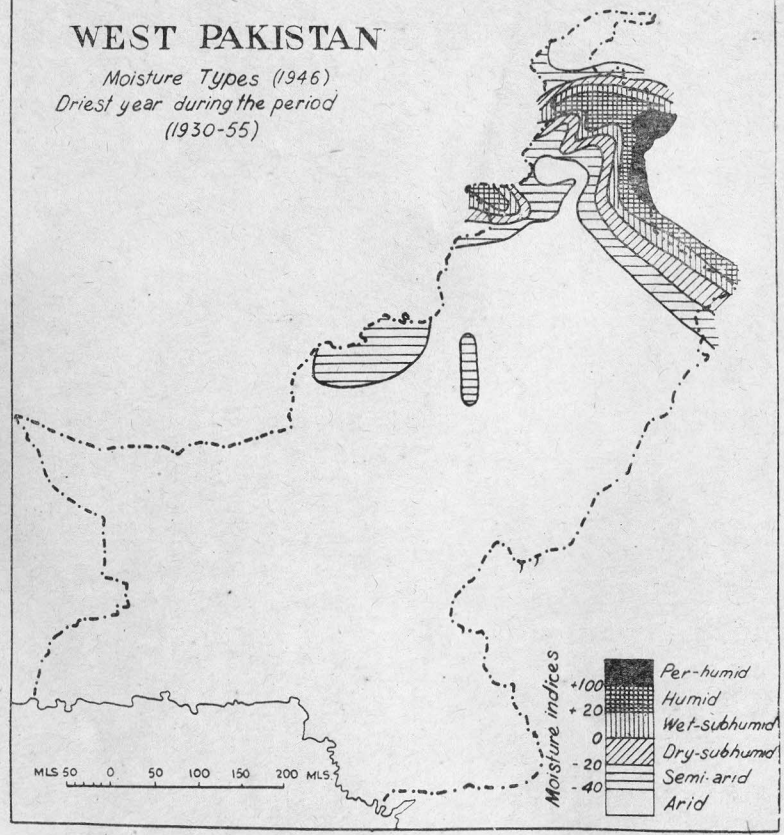
(1930-55)



Map No 13

WEST PAKISTAN

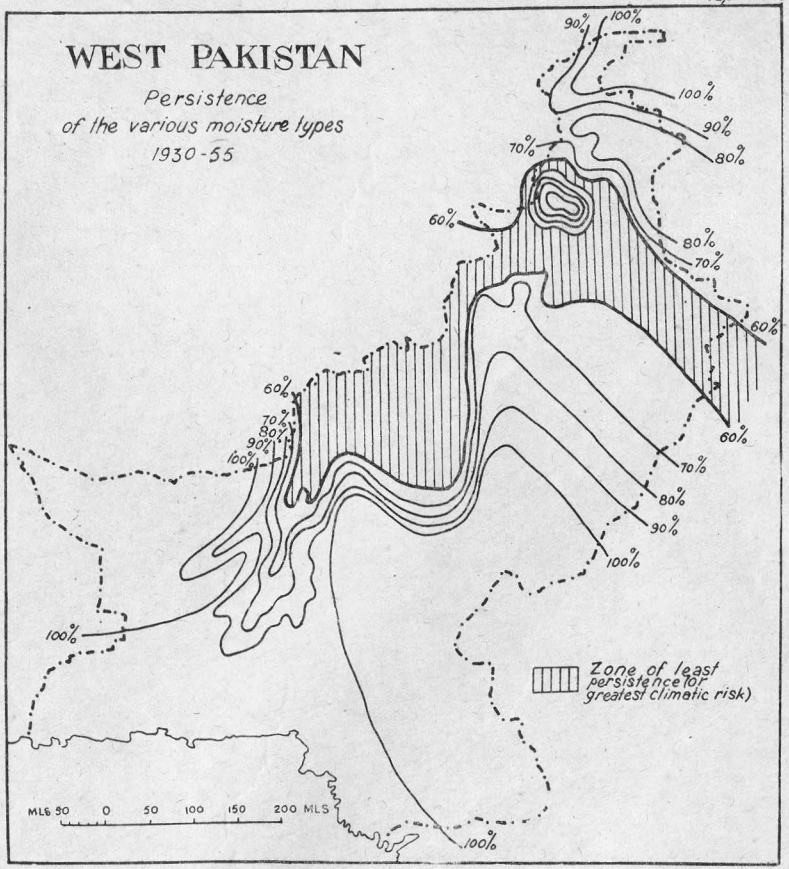
Moisture Types (1946)
Driest year during the period
(1930-55)



Map No. 14

WEST PAKISTAN

Persistence
of the various moisture types
1930-55



APPENDIX II—Moisture Data for Selected Stations

Station	Yearly water need	Summer concentration of T.E. %	Yearly precipitation	Water surplus	Water deficiency	Surplus percentage of need	No. of months with surplus	Deficiency percentage of need	No. of months with deficiency	Moisture index	Climatic type
Badin ...	158.2	38	24.2	0	135.0	0	0	85	12	−51	EA 'da'
Bannu ...	134	42	27.7	0	106.7	0	0	81	10	−47	EA' da'
Chaman ...	104.8	50	25.0	3	83.2	3	1	79	6	−44	EB'4 db'4
D. I. Khan ...	139.5	42	22.7	0	116	0	0	81	10	−50	EA' da'
Drosh ...	94.0	53	45.1	12.4	62	13	2	65	6	−26	DB'3 sb'3
Fort Sandeman	111.4	48	27.3	0	86	0	0	70	8	−41	EB'4 db'4
Gilgit ...	92.5	54	12.9	0	80	0	0	83	10	−49	EB'3 db'3
Hyderabad ...	154.7	38	17.7	0	137	0	0	88	12	−53	EA' da'
Jacobabad ...	152.2	38	9.0	0	143	0	0	94	12	−56	EA' da'
Kalat ...	72.5	60	17.4	0	54.8	0	0	76	7	−45	EB'2 db'2
Karachi ...	148.4	40	19.2	0	129	0	0	87	12	−52	EA' da'
Khushab ...	140.3	42	37.9	0	103	0	0	73	10	−43	EA' da'
Lahore ...	133.8	43	48.0	0	80	0	0	60	10	−37	DA' da'
Las Bela ...	150.9	40	20.9	0	120	0	0	86	10	−51	EA' da'
Lyallpur ...	135.9	42	30.1	0	107	0	0	78	10	−47	EA' da'
Miranshah ...	115.9	48	27.8	0	88	0	0	76	7	−46	EA' da'
Montgomery ...	140.8	41	25.1	0	114.2	0	0	82	10	−49	EA' da'
Multan ...	144.4	40	17.6	0	122.6	0	0	88	12	−52	EA' da'
Murree ...	70.9	62	148.4	82	0	0	7	0	0	+115.7	AB' 1rb'1
Nokkundi ...	134.0	42	4.8	0	129.3	0	0	93	10	−58	EA' da'
Panjgur ...	120.1	46	12.0	0	108	0	0	90	9	−54	EA' da'
Parachanar ...	80.6	58	73.1	14.5	20.1	17	3	25	6	+3	C2 B'2 sb'2
Pasni ...	140.4	42	15.4	0	126	0	0	90	10	−53	EA' da'
Peshawar ...	127.0	44	33.9	0	94	0	0	74	7	−44	EA' da'
Quetta ...	80.1	58	23.6	0.8	58	0	2	72	7	−42	EB'2 db'2
Rawalpindi ...	122.6	44	90.8	2.3	33.9	2	2	28	5	−14.7	C1 A' da'
Sialkot ...	130.7	44	79.5	0	53	0	0	40	6	−24	DA' da'
Sibi ...	151.9	39	14.0	0	140.4	0	0	87	10	−51	EA' da'
Sukkur ...	151.3	39	9.2	0	144	0	0	94	12	−56	EA' da'

QUETTA: A STUDY IN URBAN LANDSCAPE

BY

K. U. KUREISHY

Department of Geography, University of the Panjab, Lahore

Quetta is one of the modern settlements of West Pakistan. The name, Quetta, is a derivation from a Pashto word, Kwatta, meaning fort.[1] The immediate predecessor of the present settlement was Shal, situated at 'miri', which also means fort.[2] On its present site Quetta came into being after the treaty of Gandamak (1879) at the culmination of the Second Afghan War (1878) and the subsequent permanent lease from Kalat State to British India of Quetta and Bolan pass area (1883). But the Quetta region is the oldest urbanized area of Indo-Pakistan, if urbanisation is regarded to have dawned with the establishment of nucleated settlements. The archaeological evidence points towards the dawn of urbanisation in the sub-continent to have taken place at the end of the fourth millennium B.C. or early third millennium B.C.[3] *in the Quetta region.*[4] The tells of Tirkha, Kaisiano-Dozakh and Baleli recorded from the region belong to the earliest phase (termed as "Quetta Ware" by Piggott)[4] of the pre-historic culture of the plateau region of Baluchistan, a precursor of the Indus Civilization.

The pre-Harappa culture of the plateau was characterized by essentially small settlements of parochial character in response to the diversity of physical conditions in Baluchistan, with small hill-divided basins and narrow valleys. The geographical conditions unconducive to the formation of large-size settlements remained effective until the British occupation, when a new factor emerged into prominence; the strategic importance of the Khojak-Bolan pass come to be recognized by the British. This finally gave rise to the modern settlement of Quetta, now an agglomeration of large size, a 'city' of census definition. The conditions of agriculture operating in the umland of Quetta, with 10-20% of the area under cultivation, including a high percentage of fallow land, do not seem to favour the size the city has presently attained.

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1. *Baluchistan Dist. Gazett.*, Vol. V, Ajmer, 1907, p. 335.
2. *Ibid.*, p. 333.
3. *Archaeology in India*, Govt. of India, Ministry of Education, Dept. of Arch., Publication No. 66, Delhi, 1950, p. 31 ; S. Piggott, *Prehistoric India*, Middlesex, 1950, p. 67.
4. S. Piggott, 'Chronology of Prehistoric North-West India,' *Ancient India*, No. 1, Jan. 1946, pp. 8-26.

This modern settlement of British origin seems to epitomise the unauthentic but oft-repeated traditional tale in Sind of the destruction of numerous settlements through earthquakes. The famous Quetta earthquake came on 31st May, 1935, resulting in the destruction of buildings, later replaced by the new ones, 80.3% of which were recorded in 1951 as *pakka*, of earthquake-proof construction.

DEMOGRAPHIC ANALYSIS

The population of Quetta, 1901-1951, is given in Table I, and is plotted in Fig. 2. The increase of 59,759 during the last five decades was 243% of the population in 1901. The rate of increase has been variable. The decennial percentage increase was 38% during the decade 1901-1911, 44.5% during 1911-1921, 23% during 1921-1931, 7% during 1931-1941, and 30.8% during 1941-51. The increase was comparatively small during the decade 1921-1931, and was smallest during the decade 1931-41. The smaller increase during the decade 1921-1931 was mostly due to a smaller increase in the cantonment population compared with the preceding decades. The smallest increase during 1931-1941 might have been in a small measure due to the international trade depression but it is mostly explainable on the basis of the high casualties (22,000-25,000) as a result of the earthquake in 1935. In spite of the overall increase in the population size of the city during the interval, 1901-1951, its relative censal status was the same in 1951 as it was in 1901. Quetta was 10th in order of population size among the urban centres of West Pakistan at the time of the 1901 census. The relative censal status improved to 9 in 1911 and to 8 in 1921 to deteriorate to 9 in 1931 and 11 in 1941. The greatest deterioration in 1941 was, as explained above, contributed by the earthquake of 1935. The improvement of the censal status to 10 in 1951 is mostly attributable to the usual process of recovery and restoration. The overall stationary status during the period, 1901-1951, seems to be related to the following facts:

The important contributory factors, apart from the natural rate of increase (which does not substantially differ between the urban centres of the same population size), towards improving the population size of urban centres in West Pakistan are: (*i*) the status of the centre in the administrative hierarchy of settlements, including, in cases, its importance as a cantonment, (*ii*) the economic attraction offered by the centre to the outsiders by way of employment in its industry, trade and commerce, and (*iii*) any specialised function or functions of the centre. Out of these contributory factors, (*i*) and (*iii*) above seem to have been more important. Factor (*ii*) above, though not unimportant, does not seem to have been so much contributory in case of Quetta as in case of other urban centres of West Pakistan exhibiting a vigorous growth.

(*i*) Quetta has been the capital of a province and the headquarters of a number of Government departments. Its administrative status has, therefore, been high, with the resultant contribution towards improving its population size. The percentage of the cantonment population of Quetta to its total population (of the municipal

and cantonment areas taken together) has been high through the decades, as is shown in Table II. Table II further establishes that the percentage to total of the cantonment population of Quetta has been generally higher than or comparable to that of three other important cantonment cities of West Pakistan *viz.*, Lahore, Rawalpindi and Peshawar. During the period 1901-1921 the said percentage of Quetta was higher than that of Lahore and Peshawar, and comparable to that of Rawalpindi. During 1931-1941 the cantonment population of Quetta, expressed as a percentage of the city's total population, was higher than that of any of the three above named cantonment cities. In 1951, it was lower only than that of Rawalpindi, and higher than that of Lahore and Peshawar.

(*ii*) The economic progress of an urban centre, promoting short-distance (rural-urban) and long-distance (from other regions of the country) migration to it, is directly related in our country, with an essentially agricultural economy, to the general agricultural resources of the rural umland of the centre. The relatively small agricultural resources of the Quetta region as compared with those of the plains of West Pakistan, containing large urban agglomerations, are a limiting factor to the economic progress of Quetta. On that account the balance of rural-urban migration in favour of Quetta is small. The low density of rural population in the Quetta region should not favour large rural-urban migration. The small balance of rural-urban migration in favour of Quetta seems to have been borne out by the low percentage of the population of the city born within the district (Quetta-Pishin). It was 39% of the total population of the city in 1951. A lower percentage of the population of an urban centre of an origin within the district in which the centre lies, is indicative of a smaller rural-urban migration. The long-distance migration of *muhajirs* (refugees from India) as a result of the partition of the sub-continent accounted for 22% of the total population of Quetta in 1951. Such a migration to an urban centre, resulting from exceptional circumstances, as are associated with the partition, is of a nonrecurrent nature. However, other forms of long-distance migration to an urban centre (from other regions of Pakistan) may be more of the character of a process than an accident. One such form of long-distance migration in case of Quetta is connected with a well-marked specialized function of the city, its function as a summer resort. It is discussed in the following paragraphs.

(*iii*) Quetta is a hill station, one of the very few in West Pakistan, at an average altitude of 5,600 ft. above sea level. Its pronounced specialised function is that of a summer resort. "Its importance as a summer resort has increased during the past few years....."[1] The resort character of Quetta is partly borne out by the fact that the 1951 census registered a high percentage to the total, 61%, of the population of Quetta born outside the district of Quetta-Pishin. This figure for the Quetta-Pishin district (excluding Quetta city) was as low as 6%. Out of the 61% to

1. *Census of Pakistan* 1951, Vol. II, p. 22.

the total of the population of Quetta (of municipal area plus cantonment area) born outside the district, the *muhajir* population, as expressed earlier, accounted for 22%. The cantonment population formed 33% of the total population of Quetta in 1951. Therefore the two components, *muhajirs* and cantonment population, together accounted for 55% out of the 61% of the population of Quetta born out of Quetta-Pishin District. But the population of the cantonment area is not wholly of an origin outside the district containing the urban centre, although it is usually largely so. The percentage to the total of the population of the cantonment area born within the district (Quetta-Pishin) cannot be ascertained for want of data.

It may be pointed out that the 1951 census, to which the above figures relate, was held in the winter month of February (9th-28th February in various areas of Pakistan). Possibly, the resort character of Quetta could better have been manifest, in the census data, had the census commenced in summer. An idea, rough for obvious reasons, of the periodic swelling in summer season of the population of Quetta can be had by comparing the rocorded number of people, 84,343, with the inflated figures in summer, 100,000, estimated by the Census Superintendent of Baluchistan province, *Census of Pakistan*, 1951.[1]

The comparative percentages to the total in 1951 of the population of seven urban centres of origin outside the district, containing the urban centre, are given below. The seven urban centres are those for which the relevant published data are available. All these urban centres are in N.W.F.P.

Urban Centre		Percentage to the total of the population of the urban centre born out of the district containing the centre, 1951.[2]
Abbottabad	...	45.7
Bannu	...	41.2
Charsadda	...	2.2
D. I. Khan	...	29.4
Kohat	...	28.9
Mardan	...	13.5
Peshawar	...	32.5

Age and Sex Composition.—The age and sex pyramids of Quetta and some other selected urban centres, for which data are available, are plotted in Fig. 3. The marked features of the age and sex pyramid of Quetta, 1951, are: (*i*) The proportion of males to females is higher in invariably every age group. This agrees with an overall high sex ratio of the city (191 in 1951) and the presence in the cantonment of defence service

1. *Ibid.*, p. 22.
2. Derived from *Census of Pakistan*, 1951, Vol. IV, p. 34, Statement 4-F.

people, with fewer females. The high sex ratio of 191 in 1951 was obtained in the city in spite of its overall downward trend since 1901, as is exhibited in the inset graph of Fig. 2. (*ii*) In the working age groups of 20-24 and 25-29, the male population is remarkably higher than in other tiers of the pyramid, signifying the economic attraction offered by the city of employment in its trade, commerce, profession, industry and services, including defence services, to the outside people.

A more detailed and comparative study of the age and sex pyramid of Quetta with some other urban centres of West Pakistan is made in the following paragraphs.

The 0-4 to 15-19 age groups are broadly similar to those of other towns plotted in Fig. 3. In its male and female sections of tiers, 20-24 and 25-29, the pyramid of Quetta is similar to that of Karachi in so far as the male section in both cities of these two tiers bulges out, while the female population decreases. The pyramids of other towns indicate an increase in the length of tiers of these age groups of the working population, both in their male and female sections. The above said difference in the shape of pyramids of Karachi and Quetta on the one hand and Lahore, Multan, Rawalpindi, Sialkot, Lyallpur and Sargodha on the other, seems to establish a more marked tendency in the two former urban centres of the non-participation of the working age group of the female population into remunerative professions.

In the higher age groups the proportionate decrease in the female population of Quetta is more marked than in other cases. It may either be taken to mean a higher selectivity in high age groups of tourists and military population in favour of males, or a lesser average span of life of the female population of Quetta in the face of severe winters, or both. The lesser average span of life of female population seems also to have been established by a study of the age and sex pyramid of Baluchistan and States Union taken as a whole. The pyramid is not reproduced here, but is given in *Census of Pakistan*, 1951, Vol. II (p. 34). The remarkable disparity in the recorded number of centenarians in Baluchistan and States Union in favour of males (275) against females (174) in 1951 is also indicative, though not conclusive, of the lesser span of life of the female population in these areas.

URBAN LANDSCAPE

The urban landscape of Quetta with regard to the layout of roads, topography (height of the urban structures in relation to each other in terms of storeys), functional structure, congestion, urban sprawl and occupancy rate, seems to have been largely related to a complex of social (including historical and strategical) physical, economic and demographic processes. The street pattern of Quetta (see Figs. 1 & 5) is on the whole a strictly rectangular one, modified in parts towards the periphery of the settlement and in the cantonment area. The rectangular layout of streets is the Western element in evidence in our settlements of origin during the British period or in the anglicised portions of our older settlements. In the older settlements which ranked high in the administrative hierarchy

of towns during the British period, an admixture is found of the Western element of rectangular planning of streets and the Eastern element of an inarticulate system of intratown communications. The total absence of the Eastern element of urbanism obviously results from the absence of the history of the present settlement of Quetta before the British period. Unlike the better planning of streets in the cantonment areas of a large number of our larger urban centres, the modification in the rectangularity of streets in the cantonment and some peripheral areas of Quetta are related to the unevenness of the comparatively difficult terrain in these parts of the city.

The urban topography of Quetta relating to the height of structure in terms of storeys of buildings is remarkably uniform. An overwhelmingly larger number of buildings there is single-storeyed. It is mostly related to the high cost of construction of taller buildings of earthquake proof design. Partly it is related to the past demographic trends in the city. As explained earlier, the growth of the city in population has not been as fast as in the case of a number of more privilged cities of West Pakistan. The physical aspect of land of the environs of Quetta is not very promotive of a great horizontal expansion of the brick and mortar area of the city. Still, the city has not grown in the vertical direction. It seems to have been partly related to a comparatively small pressure of population on the hitherto developed urban area. The argument of a comparatively small pressure of urban population on the developed area of Quetta is based, apart from the earlier study of demographic trends, on an analysis of occupancy rate made later in the present paper.

The functional structure of the city (see Fig. 5) denotes a mixture of uses in the urban complex, with very little separation of functions. The urban functional area better separated is that of the cantonment. It lies to the north and north-east of the municipal area, and is not shown in Fig. 5. The mixture of uses, with only a few functions better separated, is typical of our urban centres. Physical planning of settlements, including the planning of functions in the urban complex, is a recent attainment of urban planning in the West. Therefore it was only vaguely understood at the time of the British planning of our urban centres.

The data bearing upon the rate of development of the urban land of Quetta (excluding the cantonment area) are given in Table III. The data reveal the zoning of density of buildings in the municipal area. But the zoning is remarkably much less pronounced than in old larger-size urban centres like Lahore, which has been subjected to the social processes of a much longer history than that of Quetta. The density of properties in Quetta by Municipal Wards, calculated on the total area of the Ward, inclusive of the developed land and that not under urban function, is not markedly variable over Wards I, II, III and VI (for the location of the Municipal Wards see Fig. 4). The density of properties per acre in this district of the city varies from a minimum of 21.3 in Ward VI to 23.1 in Ward II and a maximum of 29.3 in

Ward I. Parts of Ward VI are undeveloped, and the portion of Ward II between Sharah-i-Jinah and Sharah-i-Fatima form a part of the fashionable residential quarter of Quetta. Ward I forms the poorer residential quarter of the city. These variations of the density of properties over a large district of the city are not of a high magnitude in their comparison to those of other cities of West Pakistan. Also, these densities are much smaller than in the congested core of other cities. The density is low in the Civil Lines and the outer zone of Quetta. It is 2.5 properties per acre in Ward IX, containing the Civil Lines and Railway Officers', Post and Telegraph and Hospital Colonies. Wards IV, V, VII and VIII form the peripheral areas of the city, including large undeveloped areas. The minimum recorded density of 0.28 properties per acre in Ward X is misleading, as the undeveloped area of the Ward is disproportionately large, resulting from the latest revision of the municipal boundary on this side of the city. The comparative data relating to the density of properties in Lahore are given in Table VI. A comparative study of Tables III and VI establishes beyond doubt that the rate of development of the urban area in Quetta is much smaller than that of older large urban agglomerations of West Pakistan, represented by Lahore. It further establishes that the zoning of density of buildings in Quetta is much less marked than in Lahore. A comparatively low rate of development and a less marked zoning of density of buildings in Quetta are suggestive of a milder form of congestion even in the worse parts of the city. Congestion is not merely related to a high rate of development of the urban area but is also a matter of look, as determined by the height of buildings, with respect to the width of the streets on which the buildings abut. The streets of Quetta are generally broad and, as shown earlier, the buildings are not tall, being predominantly single storeyed.

The figures of density of dwellings in Ward IX being the lowest of all the Wards of Quetta, excluding Ward X (the misleading nature of the figures of which has been pointed out above), are indicative of the urban sprawl character of that Ward. The cantonment areas of our settlements are generally an example of an uneconomical use of urban land. In case of Quetta, the uneven surface of the cantonment has added much to its sprawl. The large extents of the cantonment area, much larger than that of the rest of the city, are partly attributable to its urban sprawl character.

The occupancy rate in Quetta by Wards was recorded as a result of field work on the basis of sample survey of 5-10% dwellings in the several Wards. Occupancy rate is the ratio of occupants (children under one year not being counted and children between one and ten years being counted as half person) to the number of habitable rooms (*e.g.*, bed rooms, or living rooms and dining rooms, but not kitchen, bath room or W. C.) in a single dwelling. It is a measure of the intensity of occupation of dwellings. A high occupancy rate is an evidence of shortage of accommodation or overcrowding of houses. The accommodation requirements of

families depend, among other things, upon their age structure. "The composition of the family may be such that a fairly high Occupancy Rate causes no great discomfort."[1] Generally speaking, an occupancy rate of over 1.1 in a dwelling is taken as an index to overcrowing, but statutary overcrowding in a single dwelling in Britian " is not deemed to exist until the Occupancy Rate rises between 1.5 and 2.0."[2] In an area containing a number of dwellings some of the more spacious dwellings are expected to be under-occupied. Therefore, considering an area (and not a single dwelling), an average occupancy rate (*i.e.*, total number of persons living in the area divided by the total number of rooms) of over 1.0 is "almost certain evidence of a shortage of accommodation".[2] The existing occupancy rate over large parts of the residental districts in England and Wales is under 1.0[2].

Considering the disparity between the standards of residential accommodation in the West and in the under-developed countries of the East, between the average family sizes (that of the Eastern countries being larger), and knowing that statutary overcrowding in single dwellings in Britain is not supposed to exist until the occupancy rate rises between 1.5 and 2.0, it can be reasonably argued that overcrowding does not seem to exist in Wards II, III, IV and IX. It seems to exist in a mild form in the remaining Wards. The disparity between the recorded occupancy rate of the Civil Lines (1.29) and that of the poorer residential district of Ward I (2.82) is not great. It may be pointed out that the recorded occupancy rate of a poorer residential locality of Lahore is 4.91. The evidence is, therefore, clear that overcrowding in Quetta is not as serious a problem as it is in some other large urban centres of West Pakistan. The evidence about Quetta is further supplemented by the census data given in Table V. The Table contains the percentage figures to the total of the overcrowded dwellings in the urban centres of Baluchistan in 1951. According to this Table dwellings having over 5 persons per room are regarded as overcrowded. Such dwellings are wrongfully described in the census report of the province as "congested". The Table reveals that the percentage to the total of the overcrowded dwellings (of census definition, explained above) in the urban centres of Baluchistan ranges between 0.7 in Pishin to 36.7 in Kharan ; that of Quetta being 8.6 is neither high nor low. It is noteworthy that the percentage figures of overcrowded houses for the rural area of Quetta-Pishin district, 14.0,[3] is higher than that of Quetta City.

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1. *The Density of Residential Areas*, Ministry of Housing and Local Government, Britain, H. M. S. O., London, 1952, p. 4.
2. *Ibid.*, pp. 4-5.
3. *Census of Pakistan*, 1951, Vol. II, p. 26.

TABLE I

Population of Quetta, 1901-1951

Year	Municipal area	Cantt. area	Total	Decennial percentage increase of total population
1901 ...	13,517	11,067	24,584	...
1911 ...	17,021	16,901	33,922	38.0%
1921 ...	27,220	21,781	49,001	44.5%
1931 ...	34,881	25,391	60,272	23.0%
1941 ...	36,460	28,016	64,476	7.0%
1951 ...	56,249	28,094	84,343	30.8%

Source :—*Census of Pakistan*, 1951.

TABLE II

Population of the Cantonment Area Expressed as Percentage of the Total Population (of municipal and cantonment areas taken together) of Lahore, Rawalpindi, Peshawar and Quetta, 1901-1951

	1901	1911	1921	1931	1941	1951
Lahore ...	7.9	8.0	8.7	7.0	6.0	7.0
Rawalpindi ...	46.3	46.0	45.5	36.0	36.0	35.5
Peshawar ...	23.0	24.5	24.0	28.0	24.5	27.7
Quetta ...	43.0	50.0	44.0	42.0	43.0	33.0

Source :—*Census of Pakistan*, 1951.

TABLE III

*Density of Properties by Municipal Wards, Quetta**

Ward	Area of the Ward (acres)	No. of Properties	Density Per acre
I ...	55.6	1,632	29.3
II ...	57.0	1,318	23.1
III ...	40.0	1,059	26.4
IV ...	87.2	1,470	16.1
V ...	65.0	883	13.6
VI ...	66.8	1,425	21.3
VII ...	223.0	2,209	9.8
VIII ...	320.0	1,941	6.1
IX ...	304.0	781	2.5
X ...	4,523.2	1,233	0.28

* Derived from the unpublished municipal data.

TABLE IV

*Occupancy Rate in Quetta by Wards, based on Sample Survey of 5-10% Dwellings in each Ward**

Ward		Occupancy Rate
I	...	2.82
II	...	1.67
III	...	2.0
IV	...	1.91
V	...	2.26
VI	...	2.68
VII	...	2.3
VIII	...	2.10
IX	...	1.29
X	...	2.19

* Based on field work.

TABLE V

Percentage of Overcrowded Dwellings (having more than 5 persons per room) to the Total Number of Dwellings in the Urban Centres of Baluchistan, 1951*

Urban Centre		Percentage
Nushki	...	10.0
Loralai	...	4.2
Chaman	...	3.9
Pishin	...	0.7
Quetta	...	8.6
Mach	...	15.6
Sibi	...	8.4
Usta Mohd.	...	14.8
Fort Sandeman	...	5.4
Kalat	...	1.7
Mastung	...	9.7
Kharan	...	36.7
Bela	...	11.7
Panjgur	...	2.1
Pasni	...	33.5
Turbat	...	35.8

* *Census of Pakistan*, 1951, Vol. II, p. 26.

TABLE VI (*a*)

*Density of properties per acre of the total neighbourhood area in some of the municipal assessment wards of the walled city and Krishnanagar-Santnagar, Lahore, 1952**

Ward	No. of properties	Area of ward as computed from the unpublished municipal map (in acres)	Density of properties per acre
B ...	2072	63.0	32.7
D ...	4013	80.0	50.2
E ...	2716	52.2	52.1
F ...	2890	90.0	32.1
G ...	1274	64.4	19.7
H ...	1484	62.2	23.8
I ...	1600	41.1	38.9
Krishnanagar-Santnagar	1660	139.5	11.9

* Derived from the unpublished municipal data.

N.B.—1. Wards A and C are excluded from the Table because these contain large areas under non-residential function, under archaeological buildings, including the Fort and the Badshahi Mosque.

2. Property is a structural unit owned by one person. It may include a house and (in case the property is on the market road) also a number of shops; all these together to be counted as one property. Two or more contiguous properties are counted as one, in case the owner gets it returned as such in the municipal records. Any property is recorded as one in the municipal records so long as the descendents of a deceased owner do not get it divided among themselves, and get it entered in the municipal records.

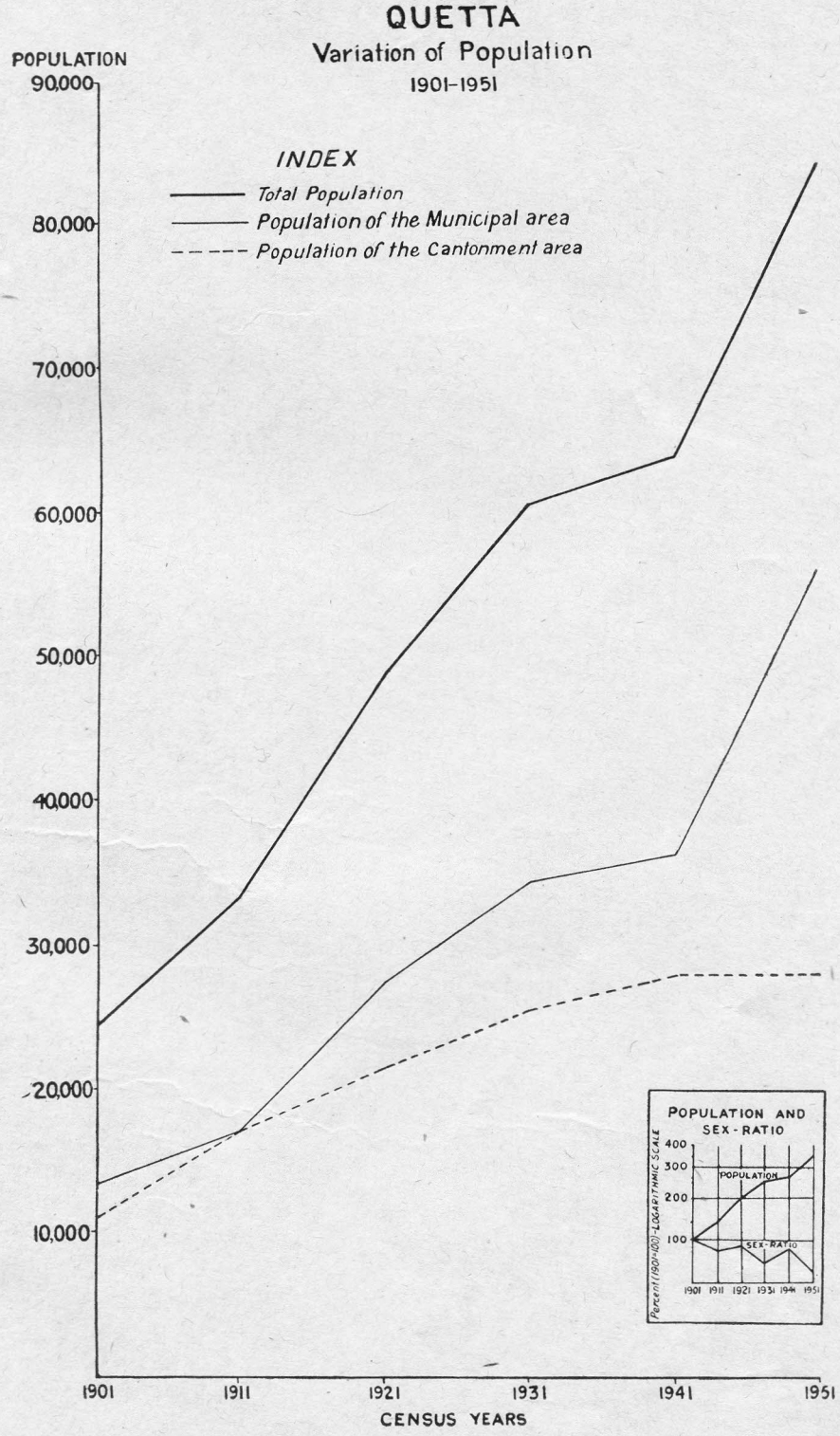
Properties of the above definition are only a conservative estimate of the number of residential buildings. The density of residential buildings is, therefore, expected to be higher than the figs. given in the Table.

3. No. of properties calculated for Krishnanagar-Santnagar area are less reliable because the area is not well-defined on the map, and, therefore, its acreage could not be computed with precision.

QUETTA AND ITS ENVIRONS

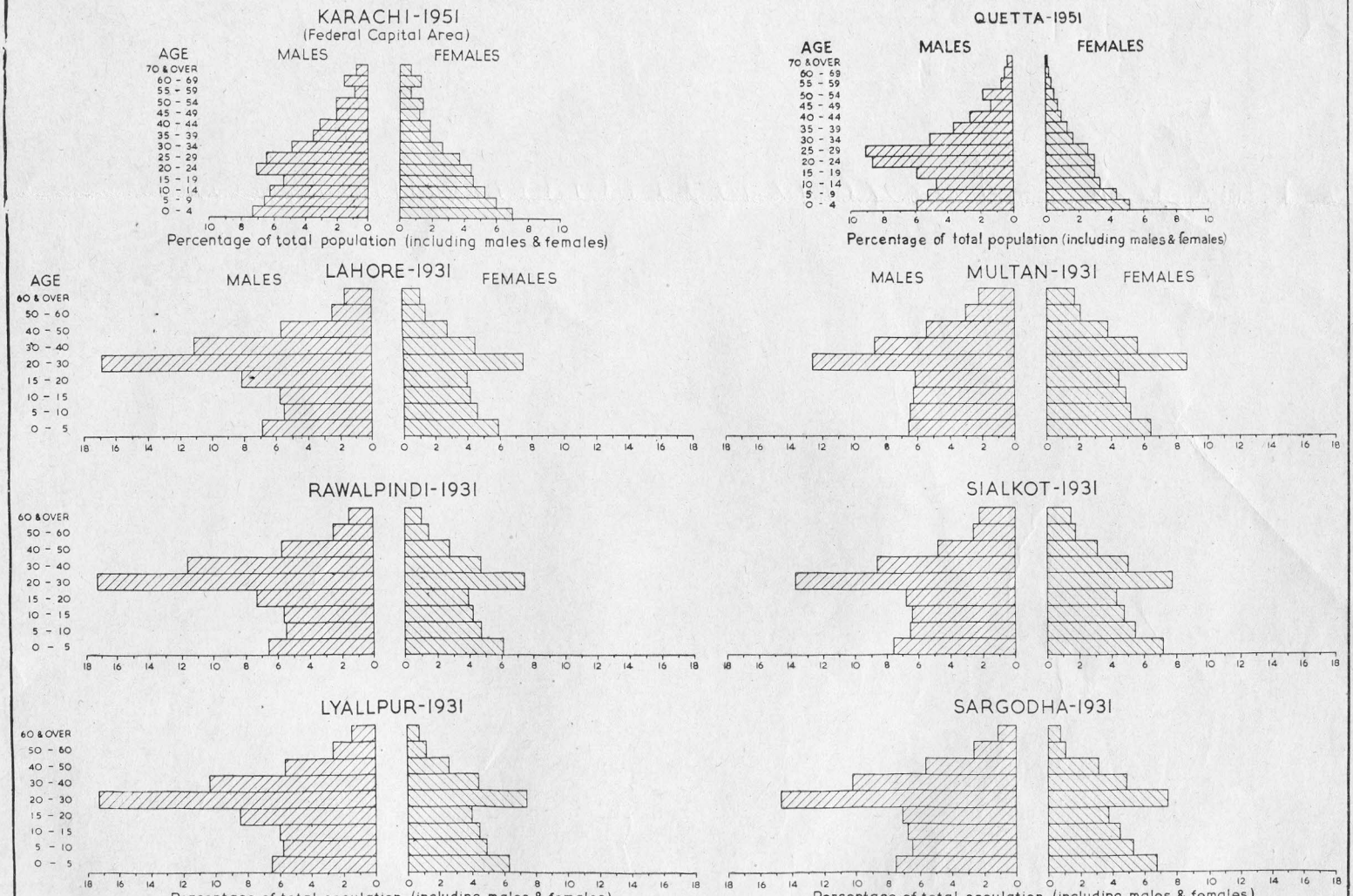
FIG. 1

Fig. 2


QUETTA
Variation of Population
1901-1951
POPULATION
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
INDEX
Total Population
Population of the Municipal area
Population of the Cantonment area
1901
1911
1921
1931
1941
1951
CENSUS YEARS
POPULATION AND SEX-RATIO
Percent (1901=100) LOGARITHMIC SCALE
400
300
200
100
POPULATION
SEX-RATIO
1901 1911 1921 1931 1941 1951

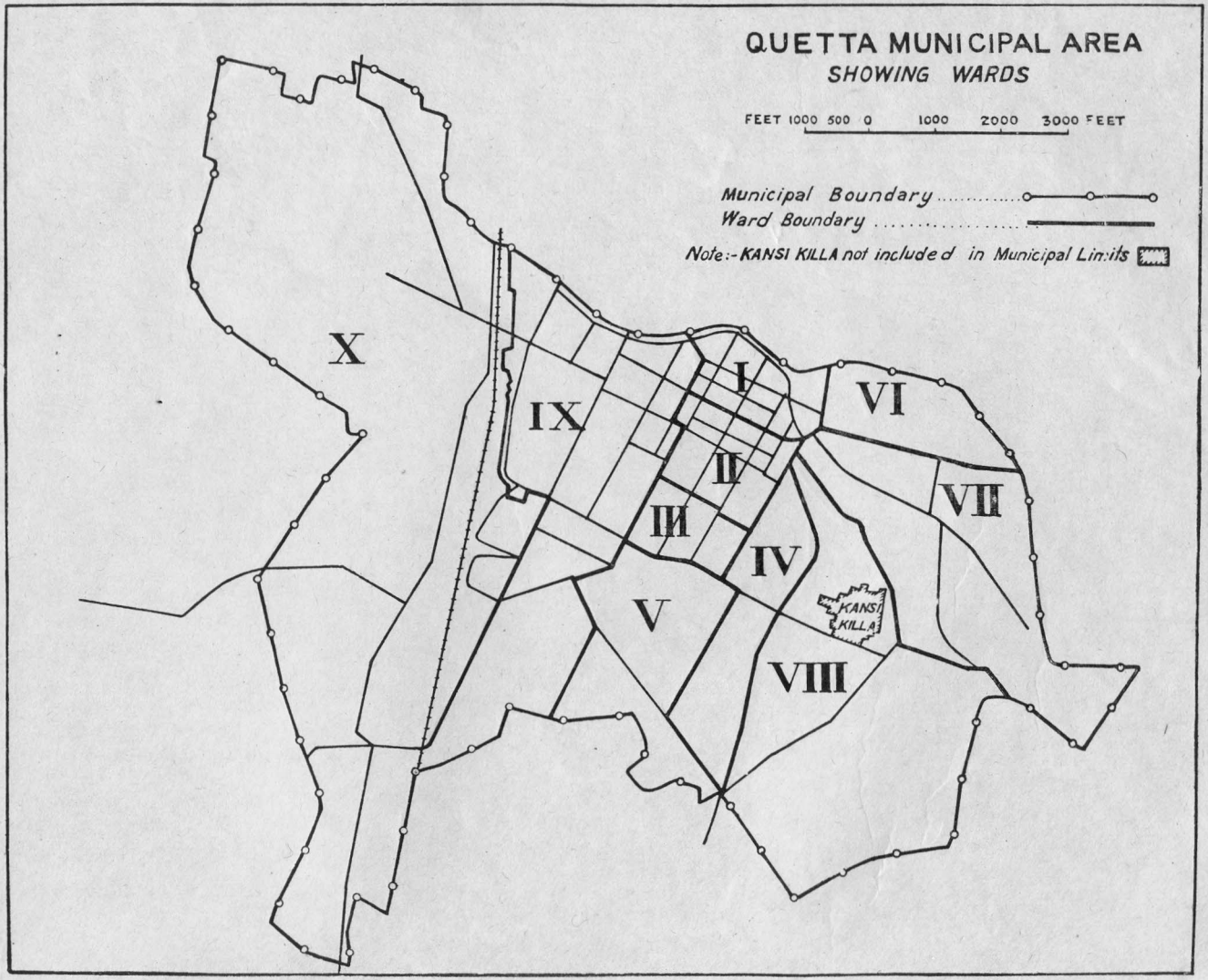
AGE AND SEX COMPOSITION

OF THE POPULATION OF KARACHI (1951) QUETTA (1951) LAHORE MULTAN RAWALPINDI SIALKOT LYALLPUR AND SARGODHA (1931)



N.B. Age and Sex Composition of Lahore, Multan, Rawalpindi, Sialkot, Lyallpur and Sargodha is shown for 1931, because later data were not available

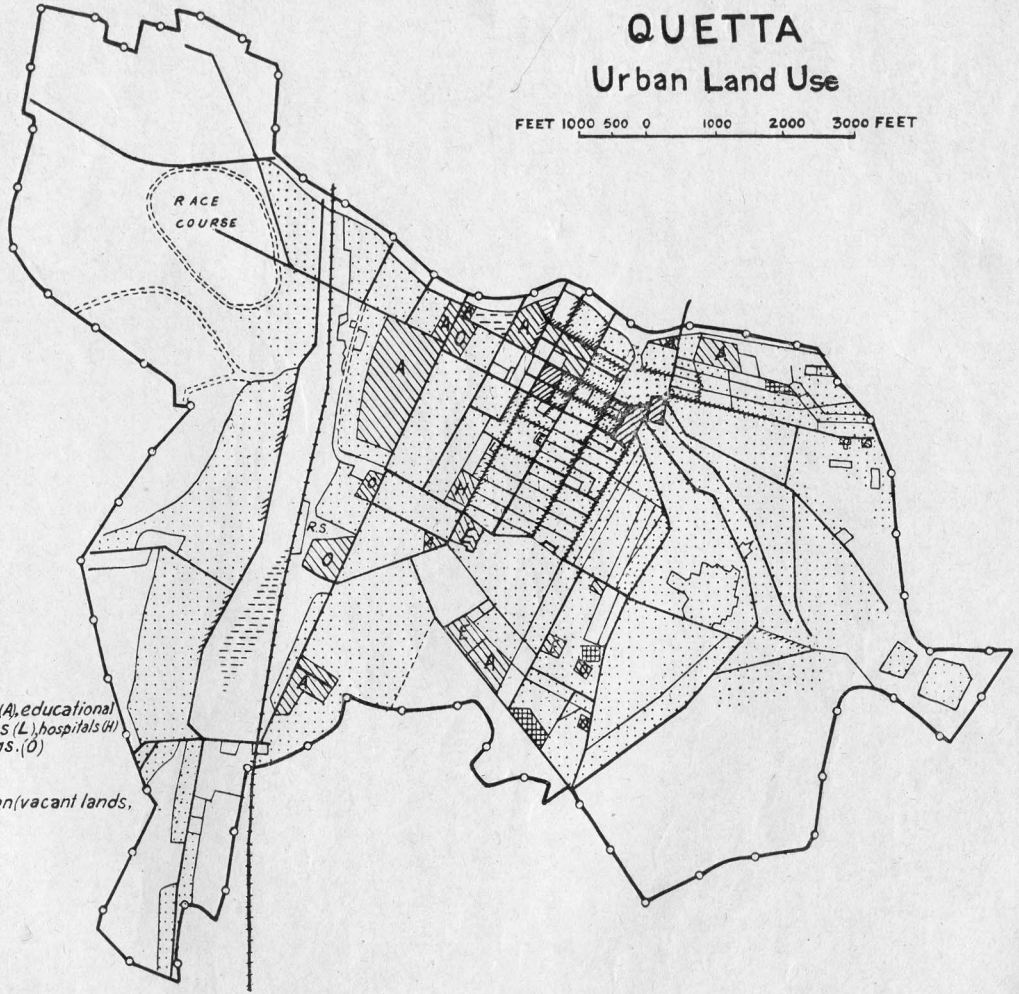
FIG. 4


QUETTA MUNICIPAL AREA
SHOWING WARDS
FEET 1000 500 0 1000 2000 3000 FEET
Municipal Boundary
Ward Boundary
Note:- KANSI KILLA not included in Municipal Limits
X
IX
I
II
III
IV
V
VI
VII
VIII
KANSI KILLA

QUETTA

Urban Land Use

FEET 1000 500 0 1000 2000 3000 FEET



- Industrial area
- Commercial area
- Residential area
- Administrative buildings (A), educational institutions (E), libraries (L), hospitals (H) and other public buildings. (O)
- Open recreational area
- Not under urban function (vacant lands, agricultural areas etc.)
- Municipal limits
- R.S. Railways
- Metalled Roads

N.B. The Land use was recorded by VI year students (1958-59) under the supervision of the present writer during the 2nd week of Oct., 1958.

TABLE VI (*b*)

Density of residential buildings (both constructed and sanctioned) per acre of the total area of the planned residential colonies of Samnabad, Samnabad Extension (134-Acre Scheme), Gulberg I, II, IV and V, Lahore, 1957*

Planned residential colony	No. of residential buildings	Total neighbourhood area of the colony (in acres)	Density of residential buildings per acre
Samnabad ...	289	70.8	4.1
Samnabad Extension (134-Acre Scheme)	979	134	7.3
Gulberg I ...	73	126	0.6
Gulberg II ...	600**	448	1.3**
Gulberg IV ...	75	85	0.9
Gulberg V ...	48	50	0.96

* Derived from the records of the Lahore Improvement Trust. ** Approximate.

N.B.—Since the residential buildings include both built-over and sanctioned plots, the present (1957) density figs. are expected to be lower than those given in the Table in colonies not yet fully developed.

COTTAGE AND SMALL-SCALE INDUSTRIES OF WEST PAKISTAN

BY

ZAKIA OSMAN

Govt. College for Women, Quetta

The role that Cottage and Small-scale Industries play in our national economy cannot be over-emphasised. Nearly 50% of the national income of Pakistan in the industrial sector is contributed by small industries*. This income can be further enhanced if a realistic and imaginative programme for the development of our Cottage and Small-scale industries is launched.

Cottage Industry products and handicrafts of a country portray the life and culture of its people, and furnish a link with the past. They are the outcome of a hereditary skill, and the product of the creative genius of the artist. The artisan, consciously or sub-consciously, imports in the product the cultural heritage and the art of the area that he lives in while executing his art. The blending of colours, the execution of curves and lines, the drawing of patterns and designs, illustrate the traditional art and culture of the region he belongs to.

Pakistan is a land of villages and the only direct way to build up our economy is to rebuild the village. The problems of our villages are many, the biggest of which is the one of poverty. The sub-division and fragmentation of holdings, and the pressure of population on land, are on an increase, with the result that agriculture, which is the main occupation of about 80% of the total population of West Pakistan, is becoming less remunerative. For such reasons the Famine Commission of 1880 urged the development of industries other than agriculture.

The question is what type of industrial programme should be taken in hand, keeping in view the meagre financial resources of our people. Since independence, much has been achieved by way of mechanised industries. But after spending crores of rupees on the establishment of power-driven factories, only a fraction of the total population has found employment in large-scale industries. According to the sample survey carried in 1955*, only 15.3% of the total population of West Pakistan was engaged in mining and manufacturing industries, big and small, and not more than probably 5% of this could be taken to be employed in large-scale mechanised industries. Further, for the employment of every single individual, we have to invest Rs. 1,000 in large scale industries as compared to Rs. 300 in Small-scale Industries.* Thus, both from investment as well as employment points of view the

* J. H. Usmani, Director of Industries and Mines, West Pakistan's speech reported in the *Pakistan Times* of Feb. 24, 1958.

promotion of Small scale Industries seems to offer a better solution of our problems. In fact, in view of the shortage of foreign exchange, large production of goods of common description is possible largely through the medium of cottage industries.

Once it is conceded that abrupt change from a predominantly agricultural economy, like ours, to an industrial economy, is not advisable, then we must seek some subsidiary occupation for the rural population, who cannot be supported by agriculture alone throughout the year. They may be encouraged to start Cottage Industries which will enable them to subsidise their income to a greater extent with little effort.

It may be offered as an argument, that the installation of big industries and for that matter the installation of huge machinery, will save labour and will prove more productive. But the fact that there is no paucity of labour in our country should not be lost sight of. On the contrary, the nation is faced with the problem of unemployment to which Cottage and Small-scale Industries offer a solution.

Also, as expressed earlier, Cottage Industries have a cultural value of their own, since they tend to preserve the cultural heritage of the nation and develop the artistic capacity and skill of the individual.

In our country, Small-scale and Cottage Industry products could be classified under the following three heads:—

(*i*) Small-scale industries producing ordinary consumer goods like hand-loom cloth, hosiery, shoes, bangles, sports goods, brass wares, cutlery and pottery.

(*ii*) Handicrafts *i.e.*, articles depicting the hereditary skill of craftsmen which have an artistic appeal and decorative value, and are usually made by hand.

(*iii*) Products of village industries, for example manufacture of *gur*, vegetable oil, implements and tools.

The distribution of some of the important Cottage and Small-scale Industries in West Pakistan is discussed in the following paragraphs. The distribution is not given here of some of the better known industries, for example sports goods and surgical instruments industries.

Handloom fabrics: Handloom fabrics are made all over West Pakistan but some of the best producing centres are Hyderabad, Sukkur, Multan, Lahore, Gujranwala, Lyallpur, Jhang, Gujrat and Peshawar. The products in this category include silk *saris*, scarves, shawls, tapestry, drapery, household linen, shirtings, hand printed fabrics, *khaises*, *daris*, *lungis*, turbans, and brocades.

Carpets and rugs: The carpets produced in our country are of high quality and Pakistan is rightly claimed as one of the foremost carpet producing countries of the East. Fineness of texture, closeness of stitch, softness of yarn and chastity of design are some of the qualities of carpets produced in this country.

The druggets, *namdas* and *gabhas* depict art in woollen products, and fall within the means of people of lower incomes. The types of carpet produced in our country are mostly Kashani, Caucasian, Shikargarh, Mogul, Turkomam, Mohri, Bokhara, Kirmani, Khurasani and a number of others. The principal centres where carpet industry is located are Lahore, D. G. Khan, Multan, Peshawar, Jhang, Leiah and Hyderabad.

Embroidery and needle work: Important centres of embroidery and needle-work are located at Peshawar, Quetta, Lahore, Hyderabad and Khairpur, and the work is mostly done by girls in the Industrial Schools. The embroidery done on silk or woollen fabrics is generally of Kashmiri, Phulkari, mirror-inset and Sindhi-desert type and portray the influence of local colour and strains of specialised elements, typical of the various regions.

Brass and ivory inlay work: The Chiniot Khojas are unsurpassed in their creation of inlaid and carved wood work. Their ivory work is also superb, and some of the finest specimens of trays, fire screens, jewellery-boxes and tables are made at Chiniot and Lahore.

Lacquer Work : D. I. Khan, D. G. Khan, Multan, Lahore, Khairpur, Hyderabad and Jacobabad are famous for the beautiful lacquer works where numerous varieties of vases, lamps, side tables, chandeliers, powder boxes, mirror stands, toys, chairs, bed steads and other articles of daily use and decoration are produced in this medium.

Pottery : The pottery of Hala, Bahawalpur, Multan, Gujrat and Peshawar is said to have had its roots in the traditions of the Indus Civilization. Pottery of a varied quality and design, ranging from the rustic pots and pitchers to the elaborately designed and profusely decorated wares, is produced in almost all the villages and towns of West Pakistan, but the most important centres are those named above.

Zari Shoes : The most typical patterns of Zari shoes come from Bahawalpur, Lahore, and Hazro in the Peshawar ragion. Some of the well-known varieties are Nagra, Potohari, Peshawari, and Saleem Shahi. The important centres of production are Hyderabad, Bahawalpur, Multan, Talagang and Chakwal.

Our Tribal Territories are also rich in raw material for cottage industries and handicrafts. A number of training-*cum*-production centres for the development of Mazrai, woollen and metal products, and the sericultural industry are established at Ali Zai in the Kurum Agency, Batkhela in the Malakand Agency and Parachinar and Wana in the South Waziristan Agency.

The production figures and value in Pakistani rupee of some of the products of Cottage and Small-scale Industries of Pakistan are given below:—

Industry	*Unit*	*Quantity*	*Value in Rs.*
1. Handloom cloth ...	Yards	36 crores	... 45 crores
2. Carpets and Rugs ...	Nos.	75,000	... 65 lacs
3. Hosiery and other knitted goods	Lbs.	20 lacs	... 55 lacs
4. Thread, Tape and Lace ...	Lbs.	8 lacs	... 24 lacs
5. Sports Goods ...		Not available	... 75 lacs
6. Furniture, Wood Turning and Toy Making ...		Do.	... 10 lacs
7. Tanned Leather (Upper) ...	Sq. Ft.	25 lacs	... 37 lacs
8. Sole Leather ...	Lbs.	12 lacs	... 16 lacs
9. Leather Foot Wear ...	Pairs	12 lacs	... 16 lacs
10. Leather Goods ...		Not available	... 50 lacs
11. Glass Bangles ...	Tons	1200	... 12 lacs
12. Bricks and Tiles ...	Nos.	$2\frac{2}{3}$ crore	... 120 lacs
13. Pottery ...		Not available	... 50 lacs
14. Washing Soap ...	Tons	40,000	... 4 crores
15. Perfumery and Cosmetics ...		Not available	... 20 lacs
16. Paints and Polishes ...		Do.	... 25 lacs
17. Surgical Instruments and Cutlery ...		Do.	... 37 lacs
18. Small Agricultural Implements		Do.	... 20 lacs
19. Locks ...	Dozens	6 lacs	... 18 lacs
20. Electrical Appliances and Fittings ...		Not available	... 50 lacs
21. Utensils ...	Tons	1,000	... 55 lacs
22. Sheets Metals ...	Tons	9,600	... 120 lacs
23. Wire Nails and Netting ...	Tons	800	... 20 lacs
24. Plastic ...	Tons	Not available	... 10 lacs
25. Embroidery work ...		Do.	... One lac

No separate figures for West Pakistan are available, except in the case of cotton handloom cloth, the total production of which in 1956 was 22 crore yards. However, as regards the industries mentioned above, most of them belong to West Pakistan and a major portion of production, nearly 75%, is contributed by West Pakistan. It may be observed that the small industries until 1946 struggled unassisted against the competition from large scale production and heavy imports. It was only in the end of 1946 that the framers of the Post War Reconstruction and

Development Plans started including the Cottage Industries for official support in the form of financial provision, technical advice and marketing assistance. It was only after independence that the Central and Provincial Governments of Pakistan paid special attention to the cause of the promotion of these industries. However, there are still problems which stand in their way of becoming a substantial and permanent source of income to the workers employed therein. Some of these problems are described briefly as under:

(*i*) **Supply of Raw Materials.**—The Small-scale Industrial workers are facing considerable difficulty in ensuring regular supply of raw materials. Limited by finance, their purchases of raw materials are usually small as compared to the large-scale producing concerns, with the result that they occasionally have to pay a higher price than the large scale concerns. The difficulty becomes more pronounced in the case of imported raw materials. It is not easy for the individual cottage workers to get import licences. They have to approach the commercial importers who charge high prices on this account.

(*ii*) **Capital.**—The Cottage Industry workers do not generally have sufficient capital for initial investment and subsequent working of their concerns. Besides, there are no regular agencies to provide credit on easy terms. It is obvious that no improvement can take place unless adequate credit facilities are available.

(*iii*) **Production Methods.**—Production methods tend to become out-dated for want of diversity of design either because of the short supply of capital or on account of the traditional attachment of the worker to a particular design.

(*iv*) **Marketing.**—Markets in most of the cases are strictly localized. Experiments have been made to enlarge the markets of certain goods of artistic value, but as these have certain limitations of quality and quantum of production it has not been possible to achieve any material success.

If the cottage industries are to survive as a potential earner of income for the cottage workers, it will be necessary for the Government of West Pakistan to give attention to the removal of the difficulties mentioned above. The steps taken by the West Pakistan Government in this respect are discussed in the following paragraphs.

The major step towards the solution of the problems and the promotion of Cottage and Small-scale industries on sound lines was the announcement by the Chief Minister in February 1958 of the establishment of the Cottage Industries Corporations as an autonomous body, with an authorised capital of Rs. 1 crore. It will make available loans on easy terms in cash and in the form of factory buildings, houses, machinery and equipment on a hire purchase basis. It will also finance the supply of raw materials and the buying and marketing of finished products of Cottage and Small-scale industries. The Corporation will also sponsor subsidiary Corporations or Public Companies, and prepare schemes for the development of Cottage and Small-scale Industries, including schemes of research and mechanisation.

The Provincial Government also have under consideration other measures for stimulating the development of Cottage and Small-scale industries and handicrafts. This will involve research in evolution and improvement of processes and techniques of production, which in their turn will call for improvement in tools and equipments. The Government are for this purpose contemplating the establishment of research and demonstration centres for handicrafts and Small-scale Industries in the Province.

The establishment of cottage industries development centres at all Divisional headquarters by the Directorate of Industries is another useful step. These centres will undertake the survey of all the important handicrafts produced in the Division and prepare a census of craftsmen and establishments engaged in Small-scale and Cottage production. For the promotion of handicrafts, master craftsmen will be appointed at these centres who will impart training to young boys and girls so that the craftsmanship may spread into a large number of families. A designer will be attached to each centre to help in the production of traditional handicrafts in shapes and designs which are in conformity with the modern requirements and tastes. The Mayo School of Arts, Lahore which has now been raised to the status of National College of Arts, will conduct refresher courses for the designers, and originate patterns which could be adopted for production by the development centres. The centres will also undertake the distribution of raw materials. The raw materials will be imported annually in bulk by the Directorate of Industries and stocked at these centres for the purpose of distribution. Approved artisans will be given identity cards against which they could draw raw materials from the centres. Sales and Display Depots will be attached to all the development centres where the things produced by the centres or any private establishments would be brought for display and sale. These efforts of the Government are expected to be helpful in restoring the Small-scale and Cottage industries to the position these deserve in our economy.

THE INDUS DELTA SUBMARINE CANYON

BY
S. R. ISLAM
Pakistan Navy

Introduction

The coast of the Indus Delta is dangerous to approach for a ship of deep draught, the shelving sand banks extending for many miles seaward. The coast is scarcely discernable more than 2 miles off shore. Discolouration of water is very marked and on the ebb tide extends for as much as twelve to fifteen miles seaward and in depths to twenty fathoms.

The head of the Swatch *i.e.*, the Indus Delta Submarine Canyon, lies to the south-west of the Kahr Creek mouth. The 20-fathom line here is less than 4 miles off shore. The Swatch thus affords a very useful sea mark for north bound shipping and its accurate delineation was taken up by Pakistan Navy Survey Ship "Zulfiquar" under the charge of Commander R. B. A. Hunt, O. B. E., R. A. N. under whom the writer worked, and from whose observations the ensuing data have been compiled.

Method of Observation

This Canyon which cuts across the continental shelf of the Indo-Pakistan Sub-Continent opposite the Indus Delta was sounded across by echo sounding lines running in an east-west direction and half a mile apart during the survey of the approaches to the Indus Delta in 1954.

A small cross section, 5 miles in length, was also examined on a scale of 1/25,000 to record the type of cross section of the Canyon at Latitude 23°27′ N.

The northern bank of the Canyon was delineated along its length of about 60 miles as far seaward as to where it merges with the edge of the continental shelf. At this junction, a reconnaissance cross section of soundings was also taken along its axis towards the sea.

The south bank of the Canyon entrance was not delineated nor was any attempt made to trace the Canyon further westward across the floor of the Arabian Sea.

Description

This Canyon cuts deeply into the continental shelf which here averages 60 miles in width, before dropping away to the floor of the Arabian Sea. The Canyon head lies in 20 fathoms, and is within 3 miles of the coast of the Indus Delta, directly opposite the mouth of one of the main distributaries of the Indus, the Kahr Creek. The coast of the Delta is of low partially flooded sand flats and mangrove swamps ; the firm land being nowhere more than a few feet high.

This portion of the coast has encroached seaward for upward of 5 miles since the last hydrographic survey in 1896. Firm land at the southern entrance to Kahr Creek now lies where a charted depth of 7 fathoms was shown on charts not corrected by the surveys in 1954.

The continental shelf through which this Canyon runs is somewhat peculiar, in that the average depth across the Kori Great Bank to the south east, is between 12 and 15 fathoms, while that of the shelf on its north western side is between 40 and 50 fathoms.

As far as could be ascertained, the mouth of the Canyon is bell shaped and some 10 miles in width, where it debouches on to the floor of the Arabian Sea without any marked fall.

Its average width is about 5 miles between the 100 fathom contour converging at its head. There is no indication by inshore soundings of any continuance beyond the 20 fathom line, but with the rapid encroachment of the land to seaward in this vicinity, any such indication is most unlikely with the tremendous amount of siltation occurring.

At the junction of its northern bank with the continental shelf a maximum depth of 625 fathoms with a width of 10 miles was obtained approximately 5 miles south of the merger.

The slopes along the sides, especially on the south, are regular, the northern slopes having several minor protrusions. The small deeply indented side valley branches off and runs for 2 miles northward, about 6 miles from its head on the northern side. Otherwise it is regular in shape, cutting across the shelf at right angles in a south—south-westerly direction with a gentle trend towards the west as it progresses seaward. Its average width is about 5 miles with a depth gradient of 1%. This gradient is regular with no water falls along its surveyed length. Judging by the soundings along the axis of its mouth, it grades steadily to the floor of the Arabian Sea.

The detailed cross section at latitude 23°27′N shows that the side slopes are regular and the bottom almost flat, this being indicated clearly by the echo trace.

There were no indications of any levies along its sides. The commencement of the slope on the southern side is more gradual than that on the north western bank.

Bottom samples in the Canyon up to a depth of 400 fathoms and on the side slopes were universally of a fine dark grey sandy mud, becoming slightly less fine in texture the farther to seaward.

At several places along the top of the edge of the westren slope, the bottom samples were of fine sand and small gravel, this being so at the position of the cross section examined at latitude 23°27′N. The Kori Great Bank to the south east is also of fine sand while the flats to the north-west are of mud of the same texture as the Canyon itself. In shore of the head of the Canyon the bottom is also the same.

The surface tidal streams appeared to run along the axis of the Canyon and were also slightly stronger than across the surrounding flats. There was usually at springs a slight tidal overfall indicating the edge of the continental shelf proper.

Surmise

The Canyon appears virtually the continuation of the Indus and thus an assumption was made that at some glacial age, when sea level was some 600 to 700 fathoms lower than now, this ancient river caused this ravine.

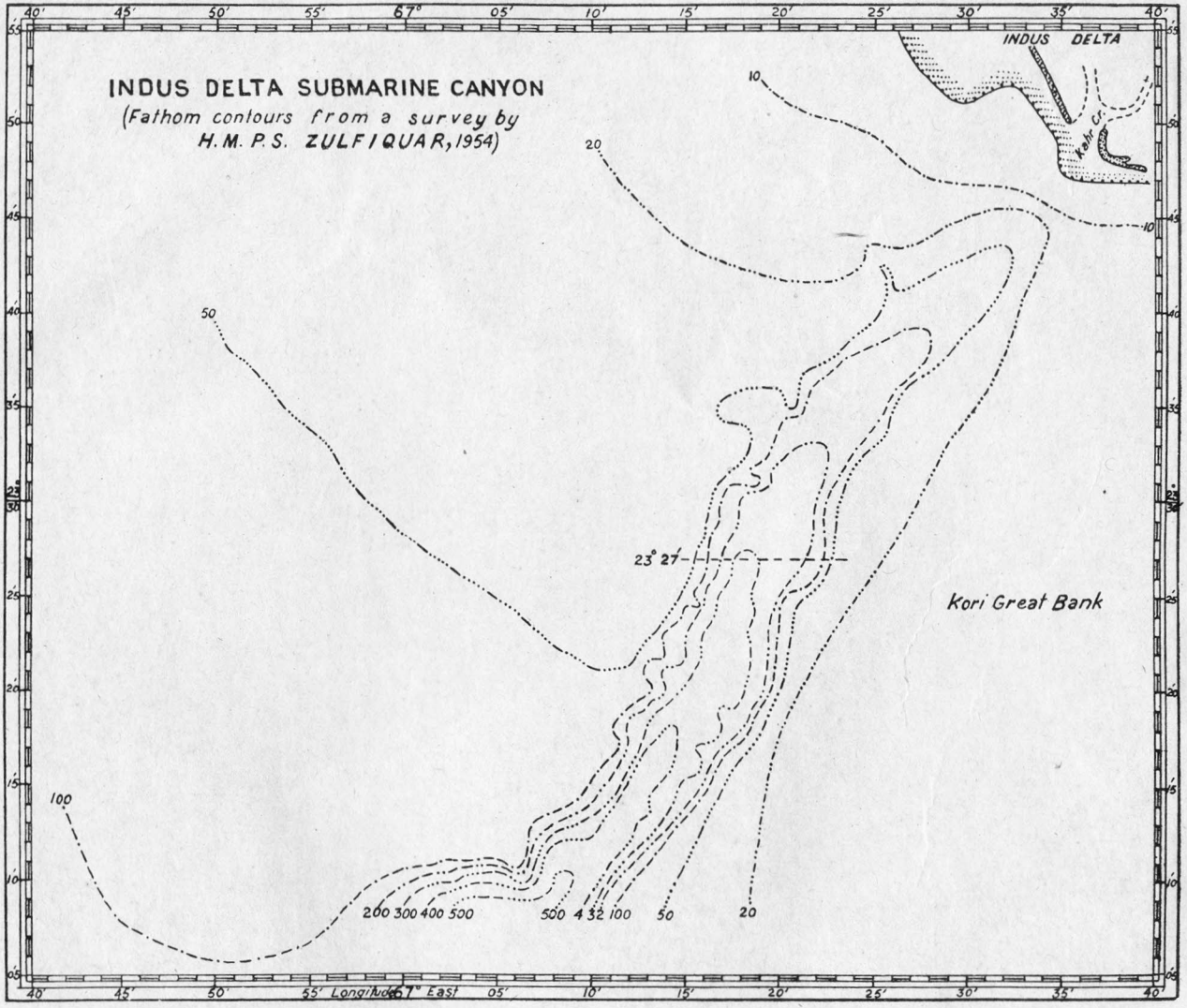
In view of Dr. Shepherds' theory such Canyons are formed by Sub-Aerial erosion. Professor Kuenen, Sir Edward Bullard and the majority of geologists and geophysicists considered the assumption of this enormous oscillation unacceptable.

Since the Canyon does not form a smooth continuation of the river, when viewed in longitudinal profile, Professor Kuenen was inclined to believing that it resulted from a separate submarine process. He also considered that the explanation of turbidity currents, formed mainly from sediments supplied by the Indus, seems to meet the case fairly well.

However, this Canyon is very similar to those off the East coast of United States, though its bottom is flatter.

The other submarine Canyon off the Ganges Delta in the Bay of Bengal, is almost identically situated. Although this has not been surveyed in such details, the main features appear to be similar. Inferences drawn from the features of one can be applied to the other. The compaction of silt occurring in the mud islands of Sandwip and Dakhin, causing sudden lowering of these island levels, can point towards what could also have happened some centuries ago. It is, therefore, assumed that "Density" or Turbidity currents at the mouth of these rivers have played an important part in the formation of these canyons.

Much research has been conducted in the field of Submarine Canyons notably by the Scripps Institute of the University of California, and as a result, theories formed previously are being revised. However deductions which could conclusively describe the causes and process through which these features came into being have not been finalised.


INDUS DELTA SUBMARINE CANYON
(Fathom contours from a survey by
H.M.P.S. ZULFIQUAR, 1954)
INDUS DELTA
Kohr Cr.
10
20
50
23° 27'
Kori Great Bank
100
200 300 400 500
500 432 100
50
20
40' 45' 50' 55' 67° 05' 10' 15' 20' 25' 30' 35' 40'
Longitude 67° East

AGRICULTURAL LAND USE SURVEY, NAWAN SHAHR (SOUTH), ABBOTTABAD

Report of the Annual Field Work, submitted by the M.A. (Final) Class 1957-58, *under the supervision of K. U. Kureishy and Miss M. K. Elahi, Department of Geography, University of the Panjab, Lahore.*

The total area covered in the present land use is 2,346 acres. It constitutes the 'revenue estate' of Nawan Shahr (south) *tahsil*, Abbottabad, district Hazara, N.W.F.P.

The method of investigation was based partly on field work, and partly on the study of 4 unpublished records of the Revenue Department *viz.*, Misl-i-hadiat, Jama Bandi, Khasra Girdawari and Lal Kitab. Misl-i-hadiat and Jama Bandi deal with the ownership of land, the former giving the details of ownership upto and including 1940, the year of last settlement, and the latter giving the changes which have taken place since then. For the purpose of the present land use, these two records are useful in so far as they give us an idea of sub-division and fragmentation of holdings. Khasra Girdawari gives details of farms relating to their position, area and products. Lal Kitab contains information about the usage to which the land is put taking the village (revenue estate) as a whole. It has two parts—the first gives the classification of land according to its uses, and the second gives the acreage under several crops, by harvests, Kharif and Rabi, and by kinds of land, for example *Chahi, Bari, Hotar, Rakkar Kalsi.*

The data available in the above mentioned reports, supplemented by field work, were recorded on cadastral map on a scale of 1″ to 200′, giving field boundaries. Figs. 1-3 are the result of this recording.

LOCATION OF NAWAN SHAHR (SOUTH)

The revenue estate is situated on the road to Thandiani, and off the road to Murree, nearly four miles east of Abbottabad, in the Rash or Orash plain at an average altitude of about 4,020 ft. above sea level.

PHYSIOGRAPHY OF THE RASH PLAIN

The Rash plain is a structural formation, surrounded by the sub-Himalayan ranges. The plain has a slightly undulating surface, dissected by numerous swift flowing streams. These streams drain into the tributaries of river Dor, which flows N. N. East to S. S. West off the settlement of Nawan Shahr, outside the surveyed area. These streams due to their steeper gradients in the foothill areas are utilised for running flour mills. There are also a number of streams in Rash plain area which supply water for irrigation to the surrounding

land. The hills overlooking the plain are almost barren. Local traditions assert that the slopes were once covered with predominantly coniferous trees, but reckless cutting of the trees and severe gully erosion seem to have led to the total destruction of vegetation and the removal of soil. The region gently slopes towards west. The water-table rises to the surface during rainy season, causing water-logging conditions in low areas. One such case is reported to be near the customs post of Nawan Shahr, where the crops either fail or low yields are obtained primarily due to water-logging. However, water logging, being restricted only to a very small number of extremely small low-lying areas, sparsely dispersed over the middle portion of the surveyed area, by no means invites serious attention. The surface is practically free from saline deposits. The explanation of the practical absence of saline deposits on the surface of the central low-lying area of the Rash plain with a generally high water-table, seems to lie in low temperatures as compared with those of the Indus plains. Low temperatures do not encourage capillary action leading to the saline surface deposits, resulting in the depletion of soil. The chemical analysis (given later in this report) of the soil examples collected gives no indication of salinity.

CULTIVATED LANDSCAPE

Most of the cultivated land of the revenue estate lies to its western side, while the eastern area is generally unfit for crop cultivation. Nearly in the centre of the cultivated area is the built-up area of Nawan Shahr with a modest market and Patwar Khana. The houses are mostly made of stone and mud with thatched roofs.

The field pattern of the land surveyed evokes interest and calls for some explanation. It was noted that the fields were remarkably elongated and their orientation changed from lateral (with reference to the direction of surrounding hills) in the higher land to transverse in the lower central part of the surveyed area. The field pattern seems to have been influenced by:

(*i*) The soil distribution.
(*ii*) Direction of water courses.
(*iii*) Direction of means of communication.

The alluvial soil of the area is generally fine grained in the lower central portions. It becomes gravelly, with increasing number and size of pebbles, towards the hills. Therefore, generally speaking, it is more fertile in the lower central portion of the area. The Rash plain is a basin in which the predominant direction of water course is towards the central area from the surrounding land. The main lines of communication in the surveyed area run almost transverse to the water courses. The highly elongated fields in the higher portions of the surveyed area are arranged roughly parallel to the contour lines, possibly because this orientation facilitates the even distribution of irrigation water from transverse streams among the fields in the higher surrounding portions of the area. The orientation is in confrmity with the predominant field pattern beyond the surveyed area, further up in the foot hills, where terraced cultivation is practised. This arrange-

ment of fields in the higher portions of the surveyed area also tends to maintain in one field the uniformity of soil. However, in this arrangement, the fields lower down contain more fertile soil than those higher up, towards the foot hills. But the difference in the quality of soil of two adjacent fields becomes imperceptible owing to the small width of the fields. The radically changed orientation of the fields towards the centre of the surveyed area gives access from the roads to the largest number of fields. Here, the texture of the soil is more uniform and distribution of water to fields away from the streams is easier.

CLIMATE

According to Ahmad's classification this region falls into II3 (*ii*), Sub-Humid Sub-Montane North,* where the annual rainfall is 20″ to 40″. The rainfall is less variable than in most other parts of West Pakistan. The summer monsoons breaks earlier (between 15th June and first July) and retreats later (between 1st and 15th of September). The rainy season associated is longer than in the rest of West Pakistan.

At Nawan Shahr rainfall is slightly higher than that of II3 (*ii*) of Ahmad's scheme. This is perhaps due to the physiographic opening towards Nathia Gali and Murree (17 and 36 miles respectively, where the annual rainfall is above 70″). The average rainfall is 49″ of which 29″ fall during summer, from May to September, when the *kharif* crops are growing, and 20″ in winter, from October to April, which is useful for *rabi* crops. November is the driest month in the year. The summer rainfall is well-distributed and is ample for the sowing and maturing of *kharif* harvest. Here, due to the altitude (4,020′) the evaporation is less as compared with the Indus plains. Hence less moisture is required for crops.

SOILS

Soil samples were collected from different fields and predominant soil was analysed both mechanically and chemically. The mechanical analysis of soil shows that it is coarse-grained, rough-textured, and has pebbly concretions which vary in size from a pea nut to a tennis ball. The porosity of the soil is high.

Chemical Composition of the Soil

Silica	...	70.42%
Alumina	...	9.66%
Ferric oxide	...	11.01%
Ferrous oxide	...	0.79%
Manganese dioxide	...	0.05%
Lime	...	2.61%
Magnesia	...	0.61%
Titania	...	0.02%
Potash	...	0.15%
Soda	...	0.06%
Loss on ignition	...	4.75%
Total	...	100.03%

*K. S. Ahmad, Climatic Regions of West Pakistan, *P.G.R.*, Vol. VI, No. 1, p. 18.

The classification of soil recognised by the Revenue Department is as follows :

Unirrigated soils.—Unirrigated soils comprise 93.6% of the total cultivated land, and include : (*i*) *Bari.* This term applies to the unirrigated but better manured soils. The tracts are located mostly around the village site. These are frequently manured by the night soil and cow-dung collected from the village. *Bari* tracts form 30.6% of the total cultivated area. (*ii*) *Baila.* It is a deep loamy soil free from stones and has an exceptional capacity of retaining moisture. This type of soil lies on the banks of streams and ravines. It some times yields two crops in a year, and often one of excellent quality. The area covered by this class of soil is 12.2% of the total cultivated land. (*iii*) *Maira.* It is a light soil composed of sand and clay, and is generally free from stones. It is not manured, and depends entirely on rainfall. It generally, though not always, yields one crop per year. This type of soil covers 39.5% of the total cultivated area of our revenue estate. (*iv*) *Rakkar kalsi.* It is generally formed in narrow terraced fields, out of the sides of the hills, or in undulating areas. The soil is often poor in mineral contents, is neither irrigated nor manured, and is generally ill-drained. The fields are generally difficult of access, and are ploughed with difficulty as these are narrow strips on slopes. In some cases they cannot be ploughed at all, but are prepared with the spade. The type of land forms 11.3% of the total cultivated area.

Irrigated Soils.—Irrigated soils comprise only 6.4% of the total cultivated area, and include : (*v*) *Bagh.* It is found in the immediate vicinity of the village, is highly manured and in this soil mostly vegetables are grown. It forms 1.8% of the total cultivated area. (*vi*) *Hotar.* It demands a constant and abundant irrigation characteristic of rice lands of the hill tracts. In Nawan Shahr (south) it occupies only 0.14% of the total cultivated area, and is, therefore, not shown on Fig. 2. Other irrigated soils, including *taradi, chahi* and *garir abi,* constitute 4.5% of the total cultivated area, out of which the last named soil forms 4.3%.

LAND CLASSIFICATION

The classfication of land under 'cultivated' and 'uncultivated' recognised by the Revenue Department and their sub-classification are illustrated in Fig. 1, and are described below:

I. Cultivated land.—The total area under cultivation, 800 acres, is 37.2% of the total area of Nawan Shahr (south). The cultivated area is mainly to the west of the revenue estate. 51 acres, that is, 6.4% of the total cultivated land is irrigated; out of it 0.12% is *Chahi* (well-irrigated), the rest being irrigated by streams. 749 acres of the cultivated land, that is, 93.6%, is *barani* (unirrigated, depending upon rainfall). The cultivated area comprises : (*a*) *Sown.* The area sown to agricultural commodities include single and double cropped areas. Double cropped area amounts to 35.1% of the total cultivated area. 53.6% of land sown is single cropped, 11.3% is fallow (after harvesting the land is left for some time to regain its fertility for the next crop). (*b*) *Vegetable gardens.* These are situated in the immediate vicinity of the

village site, are highly manured and form small portion of individual fields. These cover only 1.8% of the total cultivated land.

A comparative study of Figs. 1 & 2, respectively showing the classification of land and soil classification, seems to establish the following relationship :

(*i*) *Bari, bela, maira* and *rakkar kalsi* classes of soil are generally fit for cereals, while *garir abi* is of highly restricted utility.

(*ii*) Gardens are entirely restricted to *garir abi.*

(*iii*) The distribution of fallow land highly coincides with *taradi* soil. A small percentage of *taradi* soil is culturable waste, including *banjar qadim* and *banjar jadid.*

(*iv*) Double cropping is restricted to *bari, baila* and *maira* soils generally in the vicinity of the settlement, receiving greater attention of the cultivators. Smaller double cropped areas away from the settlement are generally near the roads.

(*c*) *Fallow.* According to the Settlement Report the fallow land is defined as one not sown for two harvests. It forms 11.3% of the total cultivated area. After harvesting one crop the land is left fallow for some time to recoup its fertility for the next crop.

II. Uncultivated Land.—It comprises : (*a*) Not Available. This includes built up area, graveyards, spring beds, steep slopes, roads and tracks. It covers about 6.2% of the total area. (*b*) Waste Lands. This category includes the border lands of the fields and grass lands. Grass lands or the *dhakkar* forms the major part of the uncultivated land in the west of the plain, claiming nearly 51.0% of the total area. (*c*) Culturable Waste. This type of land falls into two further sub-divisions, (*i*) *banjar qadim*, covering 5.6% of the total area, and (*ii*) *banjar jadid* (the land which has recently gone out of economic production of food grains), covering only 1.0% of the total area.

CROPS

The distribution of various crops is shown in Fig. 3. The agricultural scheme is remarkably simple. Two harvests, *rabi* and *kharif*, are raised. *Rabi* crop includes wheat, barley and fodder, while *kharif* crop includes maize and pulses. Maize is the major crop of the area.

Wheat.—The varieties commonly grown here are Ratta and Chitti Moni. The former is the bearded wheat with a low output. It is slow to mature and is liable to damage by the dry months of May and is hardly out of the ground in time, later to allow the sowing of maize. It will grow in any soil but its cultivation is mainly concentrated in the lands fringing the built up area. Its straw is used as a fodder for animals. The later is a beardless wheat variety which requires good soil. Its yield is higher than that of Ratta and it matures in time for maize to be grown in rotation with it.

The Department of Agriculture has recently distributed among the farmers small quantities of 8A, C591 and other improved seeds but these do not seem to have

made much headway in ousting the local varieties. Wheat grows best in single cropped lands. The land under wheat in Nawan Shahr is only 5.58% of the cropped land, which is very small.

Cultivators often grow wheat in the double cropped fields, but it is cut early, before the maize sowing, and is used as fodder.

Barley.—This crop is of little importance in the area and is generally sown in light and weak soils of low fertility. Its output per acre is a bit higher than that of wheat, but its bread is not so good as that of wheat. It, therefore, fetches low prices in the market. It matures three weeks earlier than wheat and is, thus, not liable to damage by the dry month of May. It covers a negligibly small area and is therefore not shown in Fig. 3.

Maize.—Maize occupies 88.68% of the cultivated land which is highest of all. It is the staple food of the local population and also provides fodder for the domestic animals. The yields vary greatly from field to field, following the local variations in soil fertility. Manure is some time applied to maize fields resulting in higher yields.

Pulses. - There is a considerable variety of pulses, the most common of them is 'horse grain' which is grown extensively on the poorer soil. The grain is ground with the maize or wheat to improve the taste of the bread or it is eaten separately as 'dal'. Moong and Mash are usually grown along with maize. Math, Methi, and Roan are coarse pulses which are grown sometimes with maize and sometimes alone. These latter named three kinds of pulses are normally fed to the cattle. The area under pulses is 26.34% of the total area under cultivation.

Bajra.—It is a small grained crop, not exacting in its water demand. It is a minor crop restricted only to the marginal lands of the cultivated area. It covers only a negligible area of Nawan Shahr and is thus not shown in Fig. 3.

Vegetables.—Vegetables and other crops of less importance are also sown in small patches, generally in small plots, adjacent to the house. The vegetables produced are used locally. These covers only a small fraction of the cultivated area, and are thus not shown in Fig. 3.

Rotation of Crops.—Rotation of crops (and manuring) is practised only on irrigated lands. The rest of the land is left fallow after harvesting one crop of maize or wheat to regain its fertility. In the double cropped area maize is often followed by wheat. In some cases maize is cut before its maturity, and is used as green fodder. Sometimes, maize is sown together with pulses in the same field.

Crop Failure.—A study of the agricultural record of the area for the period of 10 years, ending in 1956, reveals a high percentage of crop failure in large areas of the unirrigated land, while the same is extremely low in the irrigated land. Since unirrigated land accounts for 93.6 of the total cultivated area, crop failure is a serious problem in Nawan Shahr (south). The percentage figures of crops in the same type of unirrigated soils are variable from year to year. The highest failure, occasionally rising to 80 to 100%, is recorded in the *rakkar kalsi* soil. The second highest figure,

NAWAN SHAHR (SOUTH), ABBOTTABAD

Classification of Land

FEET 1000 500 0 1000 2000 3000 FEET

INDEX

Cultivated

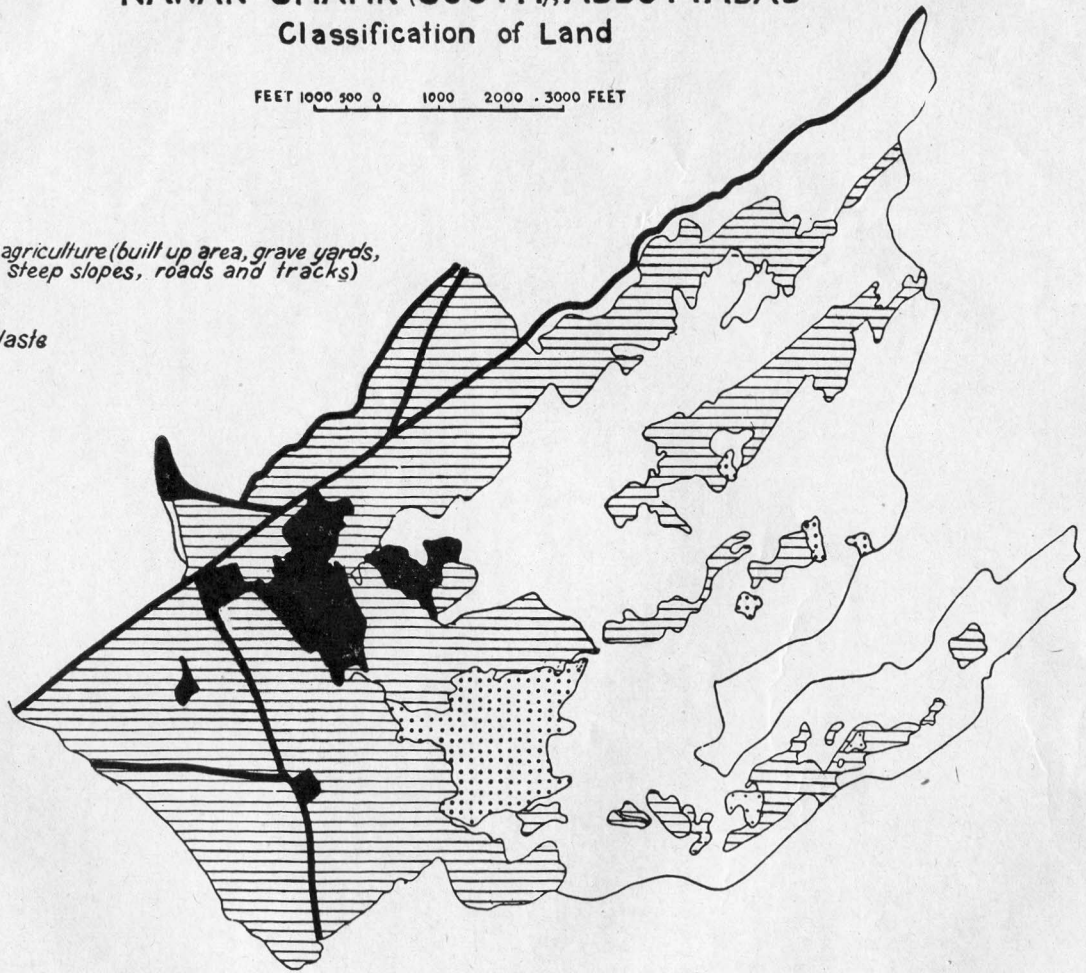
Not available to agriculture (built up area, grave yards, Spring beds, Steep slopes, roads and tracks)

Waste Lands

Banjar Qadim

Culturable Waste

Banjar Jadid



NAWAN SHAHR (SOUTH), ABBOTTABAD

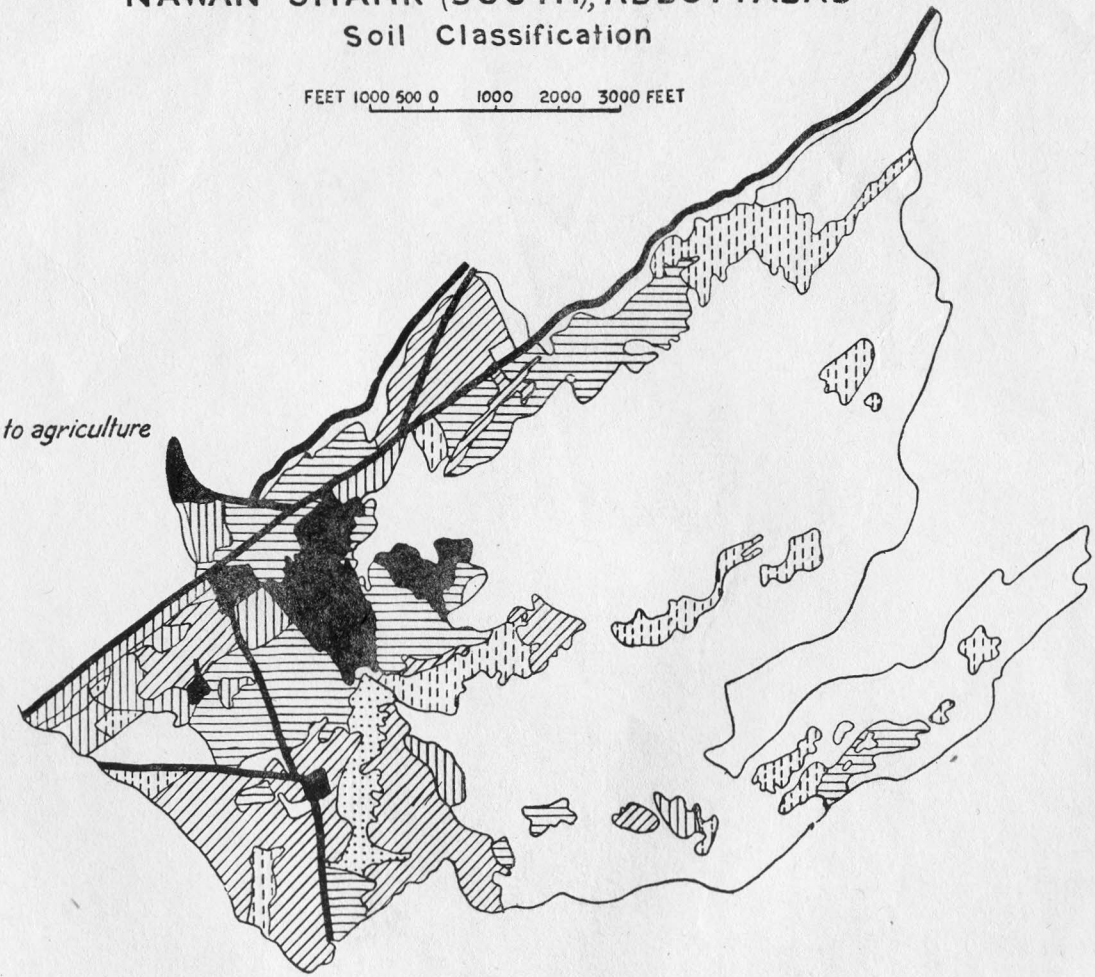
Soil Classification

FEET 1000 500 0 1000 2000 3000 FEET

INDEX

- Taradi
- Bari
- Baila
- Maira
- Rakkar Kalsi
- Garir Abi

Not available to agriculture



10-20%, of crop failure, are associated with the *maira* soil. The percentage of crop failure in the remaining unirrigated soils, *bari* and *baila*, is under 10%. The main causes of crop failure are discussed in the following paragraphs.

(*i*) Occurrence of drought, especially in the summer months, when the demand for water is relatively high due to the increased rate of evaporation. Most of the area is *barani* and, therefore, crops are highly susceptible to the vagaries of rainfall.

(*ii*) Occurrence of hail storm. The hail storms often do great damage to the standing crop and destroy a considerable percentage, sometimes up to a maximum of 50%.

(*iii*) Gully erosion. It is more active in *rakkar kalsi* lands, and largely accounts for the high percentage of crop failure in the area.

(*iv*) The continuous and unplanned farming reduces the fertility of the soil. After a certain period the productive capacity of the soil is so reduced as to result in crop failure.

CULTIVATING OCCUPANCY AND LAND HOLDINGS

The figures relating to cultivating occupancy and land holdings given below were arrived at as a result of 250 field enquiries.

Most of the agricultural land is either *khudkasht* or under tenancy. *khudkasht* is worked by the owner himself, sometimes with the assistance of labour and accounts for about 60% of the land under plough. Tenants are of two kinds: (*i*) Permanent and (*ii*) At will.

Land cultivated by permanent tenants, enjoying occupancy rights, accounts for about 20% of the total area under plough. The remaining land, about 20% of the total under plough, is worked by tenants at will, who have a tendency to exacting as much from the land as is possible without paying heed to its future depletion, because they are not sure as to whether they will till the same field over the coming years.

The average size of agricultural holdings in the area is as low as ½ acre. Field enquiries revealed that a large percentage of holdings in the revenue estate under study are uneconomical. However, the number of enquiries made was not large enough to establish an authenticated and precise percentage of the uneconomic holdings. An average cultivator supports a family of 5 to 8 members. Therefore owing to the uneconomic nature of a large percentage of holdings, the cultivators generally have to supplement their income by employing themselves in the slack season in the secondary professions, for example, domestic service in Abbottabad town. The small size of average holdings, resulting in the poverty of the farmers, largely explains the agricultural backwardness of the area.

GEOGRAPHICAL RECORD

West Pakistan Land Reforms

The land reforms were announced by the President of Pakistan on January 24, 1959, which would go a long way towards "breaking up the present concentration of landed wealth in the hands of some 6,000 landlords throughout West Pakistan" and "creating an economically viable, socially free and politically stable and progressive society".[1] These reforms are the result of the recommendation of the Land Reforms Commission set up by an order of the President, dated the 31st October, 1958, asking the Commission to "consider problems relating to the ownership and tenancy of agricultural land, and to recommend measures for ensuring better production and social justice as well as security of tenure for those engaged in clutivation".[2]

Classification of Different Kinds of Proprietary Rights.—The proprietary (and tenancy) rights, as these formerly existed, unmodified by present reforms, might vest in an individual or in a village community as a whole and, subject to the lien of the State on the produce of the land as a first charge, such individual or community is said to enjoy ownership. The ownership right is, however, not always 'complete' or 'undivided'. As a matter of historical accident, or resulting from the policies pursued by the various Governments at the time the land was first settled, or under economic pressure the individual who occupies the land or has engaged for the payment of the land revenue may only be an inferior owner or *adna malik* paying certain dues as a *quit* rent to another person called the superior owner or *ala malik*. The *ala malik* has no right to interfere in the management of the cultivated holding but he may possess vast rights over the village wastes (*shamilats* or commons). Again, the so-called owner who pays the land revenue may have no right to cultivate the land but merely to receive a rent from another person who has acquired a permanent, heritable, and in some cases, under certain conditions, transferable right of cultivation. Such a cultivator is called an occupancy tenant. It will be noticed that although a tenant, the occupancy tenant enjoys some of the characteristics of the proprietary right.

Broadly speaking the proprietary right may, therefore, be divided into :

(1) Undivided ownership ; and

(2) Divided ownership.

The undivided ownership may be communal in character; for example, the ownership by a villag community jointly of an estate in which there are no superior proprietors or occupancy tenants and where the community as such is responsible for the payment of the land revenue ; or it may be non-communal, as for example, in the

1. Extracts from the President's speech of 24th Jan., 1959.
2. *Report of the Land Reforms Commission for West Pakistan*, Jan., 1959, "*Introductory*".

milkyat maqbooza ownership where each holding constitutes a complete unit by itself of which no part is either subject to common rights or carries with it any right to the waste lands still held in common and whose owner alone is responsible for the payment of its revenue. The divided ownership can similarly be categorised into (*a*) superior owner or *ala malik* (*b*) inferior owner or *adna malik*, each one of which can again be communal or non-communal, and (*c*) occupancy tenant.

A tenant under the Revenue Law is a person who holds land under another person, and but for a special contract would be liable to pay rent for that land to that other person and includes his predecessor and successor in interest. Tenants fall into two main categories : (1) occupancy tenants and (2) non-occupancy tenants or tenants-at-will. An occupancy tenant has a more or less permanent, heritable and, on the fulfilment of certain conditions, transferable right to occupy the land for so long as he pays the rent fixed by authority. A non-occupancy tenant or a tenant-at-will is a tenant from year to year. His rent is determined by an agreement, whether expressed or implied, but generally implied and customary, between himself and the landlord. He is liable to ejectment, as his name implies, at the will of the landlord.

Besides these two classes of tenants there may be tenants for fixed terms exceeding one year under a contract or decree or orders of a competent authority. There is yet another class of people dependent on land for a livelihood. It is the casual agricultural worker whose number, because of the pressure of population and lack of alternative avenues of employment, is multiplying very fast.

In common with most of the under-developed countries of the world, tenancy is a dominant feature of our land tenure system. Exact statistics for the whole of West Pakistan are not forthcoming, but it is believed that over 50% of the cultivated land is held in tenancy (50% in the former North-West Frontier Province, 56% in the former Punjab and 80% in the former Sind, by tenants who have no permanent rights whatsoever in land).*

Before the present reforms, ownership of land was unequitably distributed to the detriment of agricultural production. Reliable statistics for West Pakistan as a whole are not available but according to the data compiled by the National Planning Board (now Planning Commission), while at one end of the scale 3.3 million people (65% of the owners) owned about 7.4 million acres of land (15%) in holdings of less than 5 acres each, at the other end of the scale a little more than 6,000 people (0.1%) owned as much as 7.5 million acres (a little over 15%) in properties of more than 500 acres each.[1]

Major Decisions.—According to the present reforms a ceiling has been fixed for agricultural holdings at 500 acres of irrigated or 1,000 acres of unirrigated lands. Existing landowners will, however, be allowed to retain such additional areas as well to which they would be entitled had the ceiling on ownership been fixed as equivalent to 36,000 'produce index units' allowable in the case of refugees. They will also be allowed to retain out of their present holdings such additional area not exceeding

1. *Ibid.*, pp. 1—8.

150 acres as may be under an orchard, so long as it is maintained as an orchard provided : (*i*) the area under the orchard is in compact blocks and not less than 10 acres each, and (*ii*) it has been shown as area under an orchard in the revenue records of 'rabi' 1956-57. The land over and above the ceiling limit thus fixed in each case will be resumed by the Government for re-distribution to tenants and other deserving claimants. In order to avoid displacement of existing tenants and disruption of production, tenants already cultivating the resumed areas will be given the option to buy them on instalments spread over 25 years. The landlords will be paid compensation in the form of interest-bearing bonds redeemable in 25 years.

Occupancy tenants shall be converted into full owners throughout West Pakistan and the tenants in congested areas, as far as possible, shall be accommodated in the programme for the colonisation of State lands. The tenants everywhere will, thus, have security of tenure. In the event of ejectment according to the process of law, they will be entitled to fair compensation for improvement of land and disturbance of possession. An embargo will be placed on the enhancement of rents, and illegal exactions in the shape of fees or free labour or services from tenants will be eliminated. In order to prevent progressive fragmentation of holdings, division of holdings below a certain economic or subsistence level will be forbidden and joint management of such holdings will be facilitated by law. Immediate steps will also be taken to introduce a provincewise scheme for the compulsory consolidation of fragmented holdings.

All *jagirs*[1] will be resumed by the Government without payment of eompensation and other intermediary interests will be abolished.

K. U. K.

Bhambore excavations

The ruined site of the settlement of Bhambore,[2] about 40 miles east of Karachi on the road to Hyderabad and about 3 miles west of the village of Gharo, has been for long attracting the attention of the archaeologist, the historian and the urban geographer. The recent large-scale excavations of the site by the Department of Archaeology, Government of Pakistan, have greatly increased the interest in the site. These excavations were carried on in March-April, 1958, resumed in October, 1958, and are in progress at the moment. Earlier, the site was recorded and explored (and in cases excavated in parts), among others, by A. Cunningham,[3] H. Cousens,[4] N. G. Majumdar,[5] and L. Alcock.[6]

1. The grant of a *jagir* in the past involved the transfer by Government to an individual of the State's right to collect and appropriate a share of the produce of land. In some cases the transfer of this right was also accompanied by the transfer of the proprietary rights in land to the holder of a *jagir* (*Report of the Land Reforms Commission, Ibid.*, p. 5).

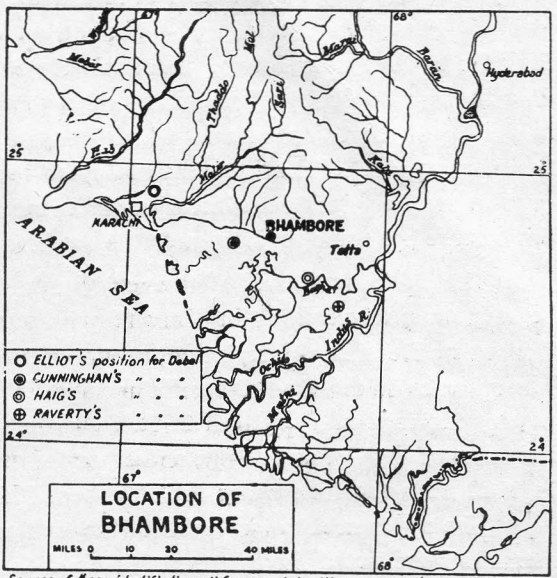
2. The name has differently been spelt by several writers, for example as Bhambor, Bhambora, Bhambur, Bhambura, Bhambhura and Bhambharawa.

3. A. Cunningham, *Ancient Geography of India*, pp. 294-95.

4. H. Cousens, *The Antiquities of Sind*, Calcutta, 1929, pp. 80-81.

5. & 6. Quoted in the information recently released to the Press by F. A. Khan, Director of Archaeology, Government of Pakistan.

Previously, the main interest in the site was because of its controversial identification with Debal, the famous port which fell to the Arab General, Muhammad Bin Qasim in 712 A.D. "Some writers have supposed these ruins to be those of the ancient delta city of Debal or Deval."[1] Wheeler considers Bhambore to be the site of Debal.[2] Others, including Elliot and Dawson, Cunningham, Haig, Raverty, Cousens, Majumdar and Alcock[3] failed to find evidence to identify it with Debal. The evidence recorded so far as a result of the present excavations, and its interpretation, are not conclusive upto the moment either to accept or reject the identification. Regarding the antiquity of Bhambore Cousens expressed the opinion that "its position, and the course of the river (Indus) at that time, so far as we are able to locate it, make it probable that there was a port in this position at the time of Alexander's expedition into India" although "there is nothing now on the ground earlier than the Arab invasion"[4]. The present excavations have confirmed this antiquity of Bhambore.



Source of these identifications: H.Cousens, Antiquities of Sind, Calcutta, 1929, Plate CIII.

The ruins are recorded to have been located on an eminence about 30 ft. high[5] above the ground level, on the northern bank of the Gharo Creek of the Arabian Sea. The eminence is the extreme end of a low range of hillocks running seaward. This site is regarded to have been ideal for the location of a port of importance in the past, when it is considered to have been well-connected with the interior of the country, through the Gharo Creek, which represents a former main delta-channel[6] The ruins are regarded to be of a "considerable" settlement, and are divided into two parts, (*i*) the area interpreted to be that of the citadel, measuring over 2,000 ft. east-west and about 1,000 ft. north-south, and (*ii*) the outer quarters extending over a "large area"[7] round the ancient tank on the

1. H. Cousens, *op. cit.*, p. 80.
2. R. E. M. Wheeler, *Five Thousand Years of Pakistan*, London, 1950, p. 62.
3. For the location of Debal by Elliot, Cunningham, Haig and Raverty see the inset map; for Cousens' views see *op. cit.*, pp. 80-81; for Majumdar and Alcock see F. A. Khan, *op. cit.*
4. H. Cousens, *op. cit.*, p. 81.
5. R. E. M. Wheeler, *op. cit.*, p. 62.
6. R. E. M. Wheeler, *op. cit.*, p. 62.
7. F. A. Khan, *op. cit.*,

northern and easetrn side. "It is said that other mounds lie on the southern side of the Creek."[1]

The information about the settlement, resulting mostly from the present excavations, is given in the following paragraphs, and is based almost entirely on the press release by the Director of Archaeology.

Origin of the Settlement.—The origin of the settlement, as revealed by the finds from the lower levels, unmistakably dates back to the pre-Muslim period. The finds include cultural material strongly suggestive of the origin of the settlement in the Scytho-Parthian[2] period, which extended from the first century B.C. to the first century A.D. The discovery of Scytho-Parthian cultural material at Bhambore opens a new chapter in the history of Pakistan as this is the first time that evidence of this culture has come to light near the Arabian sea coast.

The cultural material of the non-Muslim origin includes fragments of pottery bearing short inscriptions in Dev Nagri characters, a bone piece engraved with an incomplete Dev Nagri inscription, a terra-cotta female figure and a few human figures. The evidence of the Scytho-Parthian origin is mainly furnished by the red burnished pottery obtained at a depth of 25 ft. from the surface, unmistakably recognised as the imitation of the Greek pottery, and some forms of it being similar to those unearthed in 1912 from the 1st century B.C. levels of Bhir Mound (Taxila).

The upper occupation levels of the settlement are of the Muslim period, which seems to have lasted here from 8th to 13th century A.D. The evidence of the Muslim occupation comes, among other things, from the unearthed coins, belonging to the Umayyad period (two discovered copper coins are of the 10th Umayyad caliph, Hashim bin Abdul Malik, who ruled from 724 to 743 A.D.) and the Abbaside period (gold coins discovered are of the ninth Abbaside caliph, Abu Jaffer Harun al Wasiq Billah, who ruled from 842 to 847 A.D.). Other evidence comes from a type of pottery made in Syria during Umayyad times and glazed pottery vessels showing Persian influence. The pottery discovered from the upper most levels of Muslim period closely resembles the Persian material of the 10th-13th centuries A.D.

Layout of the Settlement and Important Structures.—From the progress so far made it can be safely said that the Bhambore site represents the remains of a city in no way less important than the famous port of Debal. The excavations have already laid bare the remains of a big port establishment, with finds of distinct defensive system, town planning and with details of architecture. It is evident that the city was well-planned with lanes and blocks of houses with stone founda-

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1. R. E. M. Wheeler, *op. cit.*, p. 62.

2. The Scythians, also known as Sakas, who came from Persia overran in the 1st century B.C. all the Greek principalities including southern Afghanistan and Taxila though they retained the Greek system of administration. They were replaced in the 1st century A.D. by the Parthians, whose empire embraced southern parts of Afghanistan; the fertile and green valleys of Peshawar, Swat and Dir, Punjab, Sind and Seistan. The Scytho-Parthians, who appeared to have adopted Buddhism as their religion were strikingly Hellenistic in culture.

tions and mud-brick super-structures arranged around open courtyards which contained stone lines, water-wells and soak pits. Among the important structural remains uncovered are the city defences and embankment, three gateways, anchorage and a large sized public building with a round corner and a large stone built well.

The clearance of the outer facing of the fortification wall has revealed three main periods of defensive system in the history of settlement. The original fortification wall girdling round the citadel, characterised by its massive solidity was built with large and heavy semi-dressed and undressed limestone blocks set in mudmortar. It is strengthened by semi-circular towers at irregular intervals. Its existing height is about 19 feet. The second fortification wall was also built on the same plan but on a reduced scale at the back of the original wall. It is less massive and solid in character and has two faces set with smaller stone blocks in mud-martar; the core being filled with hard and compact gritty material. At places this later period wall was pierced through by narrow lanes; and houses were built against it which must have reduced its defensive character. The third or last period defence wall is characterised by its weak and shoddy character; it does not appear to have any tower.

The excavation of the exterior of the fortification wall has also brought to light the stone built embankment which lies at the foot of the early period defence wall and around the artificial lake, situated in the north-east, immediately outside the citadel and the city. This embankment appears to have served as the perimeter wall of the outer city. There are traces of off-sets and landing stages which at the water front could have served as the bathing Ghat.

Overlooking the eastern part of the lower city lies a gateway of the citadel. On its north a flight of badly preserved steps lead to the lake water. In the north-eastern corner lies another gateway. Its opening is 10 feet wide. In later times its entrance was blocked up. The front of this gateway is paved with semidressed stone slabs. At the foot of the gateway and the stone paved floor lies the stone faced embankment pierced by a well preserved staircase with 17 treads descending down the lake bed; the average width of the treads being one foot and 3 inches. The eighth step is broader—2 feet and 10 inches. The stairs are built of dressed limestone blocks; it shows much wear and tear.

The most interesting structural remain in the southern part of the citadel is an imposing gateway between semicircular towers. Its opening is 8 feet wide. Its entrance hall measures 26½ feet by 14 feet. The stairs of this gateway leads down to the present creek, which was once a branch of the Indus.

The building uncovered in front of the southern gate has solid and deep stone built foundations. The exact purpose of this building cannot be determined at this stage, but its southern face indicates that it might have been used for berthing small country craft, for a few round stones set in that face like the boulders indicate their use for tying cargo ladden craft.

The citadel defences, gates and residential buildings excavated in the north-eastern part include the remains of a large building built in rough and dressed limestone blocks. It appears to be a public building as it contains a large stone lined well. A flight of steps connects it with the street level.

K. U. K.

Symposium on salinity in the arid zones

The Symposium was held in Teheran from 11th to 15th October, 1958. It was jointly sponsored by Unesco and the Government of Iran. This symposium was sixth of the series planned to discuss the various problems involved in the development of arid zones. The previous five symposia organized by Unesco were:—

1. Arid Zone Hydrology, held at Ankara in 1952,
2. Arid Zone Plant Ecology, held at Montepellier in 1953,
3. Wind and Solar Energy, held at New Delhi in 1954,
4. Arid Zone Climatology and Micro-climatology, held at Canberra in 1956,
5. Soil Erosion in the Arid and Semi-Arid Zones, held at Karachi in 1957.

At the Teheran Symposium on Salinity in the Arid Zone, the problem was discussed under four heads:—

1. Hydrology and Salinity. Papers in this section dealt with the chemical composition of waters, the origin of salinity and regulation of hydrological cycle in order to check the process of salinization.
2. Physiology of plants and animals using saline water. Problems such as the toxic resistence of plants, plant selection and physiology of plants and animals consuming saline water were discussed.
3. Use of saline water for Irrigational purposes. Papers in this section dealt with such problems as irrigational suitability of brackish waters, drainage and washing of saline soils and the evolution of such plant species as would be more tolerant of salinity.
4. Desalinization. Problems relating to demineralization of saline waters were discussed under this section.

The symposium was attended by more than 75 scientists from several parts of the world. In all, 56 contributions were made on the four subjects outlined above.

Dr. Kazi S. Ahmad, Professor of Geography, University of the Panjab represented the I. G. U. and International Council of Scientific Unions at the Symposium.

M. L. K.