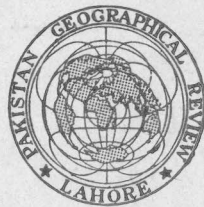


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*The editors assume no responsibility for
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CHANGES IN THE LAND USE PATTERN OF THE UPPER INDUS BASIN DURING THE BRITISH PERIOD*

RASHID A. MALIK†

IN the Upper Indus Basin, where rainfall is inadequate and erratic, irrigation has been the vehicle of economic and social development from early times. However, the elaborate and extensive irrigation system that now exist are largely the product of the British period. From 1859 to 1947, the British government completed nine irrigation projects, involving irrigation and colonization of twelve million acres of previously unproductive land. These projects are exemplary of changing concepts and procedures in regional planning and development of dry lands. Associated with regional social and cultural needs, the changing irrigation techniques have profoundly influenced the nature and form of the areal pattern of land use and settlement in the Upper Indus Basin. The introduction of large perennial irrigation systems by the British has meant the extension of agricultural land use both horizontally and vertically. Irrigation expansion has acted as an important agent of change in the areal distribution of population and the intra-regional character of settlements. This paper is an attempt to assess the important areal changes that have occurred in the pattern of water utilization, agricultural land use and urbanization of the study area as a result of the implementation of irrigation projects during the British period.

Pattern of Water Utilization

According to the census data for the year 1891, the total cultivated area in the Upper Indus Basin was 6,320,002 acres.¹ Of this, 3,593,490 acres, or 56 per cent of the total cultivated area, were already irrigated. By 1920-21, the acreage under production had increased to 10,047,261 acres, over 64 per cent of which was under irrigation. In 1945-46, of the total cultivated acreage of 13,539,000 acres, 80 per cent was cultivated through irrigation.

The role that irrigation has played in agricultural development, however, has varied greatly in time and place. While in the humid northeastern districts dry farming has been extensive from early times, the districts lying in the semi-arid and arid zones have needed irrigation. From Figure 1, it will be seen that the percentage of irrigated area to the total cultivated area for the year 1890-91 increases from northeast to southwest in inverse relationship to the distribution of rainfall. In the districts of Sialkot, Gujrat and Sargodha, where precipitation is relatively sufficient, dry farming was extensively practised for growing *rabi* crops, while for summer crops well irrigation was necessary during the dry

*This article is derived from the research done by the author in regard to his doctoral dissertation submitted to the Indiana University, Bloomington, Indiana in 1963.

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season. In the districts where intensive cultivation was common, well irrigation supported cultivation from 21 per cent of the land, as in Gujrat district, to about half as much, as in both Sialkot and Sargodha districts.

In the central part of the basin, comprising Gujranwala, Lahore, Jhang and Montgomery districts, the dependence of agriculture on irrigation becomes more pronounced, ranging from 64 per cent in the case of Gujranwala district to 77.6 in the case of Jhang district.² Irrigation in these districts was largely confined to riverine and *bet* lands drawing water mainly from wells but also from inundation canals. Dry farming on roughly one-fourth of the cultivated land in the early years of British control was apparently undertaken under highly speculative rainfall conditions. In the districts of Multan and Muzaffargarh, over 80 per cent of the total cultivated land was under irrigation. In these districts with their dry climate there was little dry farming, and a large proportion of the cultivated land was irrigated from a widespread network of inundation canals. Mianwali district, where neither well nor canal irrigation were yet developed to any significant extent, showed the least irrigated land.

In the year 1920-21, after the major irrigation works had been completed in the basin, significant areal changes occurred in the agricultural land use pattern. Except for Mianwali district, which still awaited irrigation development, and the districts of Multan and Muzaffargarh, which were already highly irrigated, the other districts in the basin made large gains in irrigated area. The largest percentage increases were attained in the central districts, where canal irrigation development had been largely undertaken. From Figure 1, it can be seen that in the districts of Sargodha and Gujranwala only about 10 per cent of the total cropped land was unirrigated, while in the districts of Lyallpur, Montgomery and Sheikhpura almost the whole of the cropped land was irrigated. Of the northeastern districts, Lahore and Sialkot showed an increase of only 10 per cent, while Gujrat showed a sharp rise of 39 per cent in irrigated acreage.³ The only districts which showed little percentage increase in irrigated area were Mianwali, Muzaffargarh and Multan, where no new irrigation works were yet undertaken. In any event, it will have been noticed that all of the districts in the study area had become almost wholly dependent on irrigation. Of the twelve districts in the study area, over 90 per cent of the total cropped area was under irrigation in six districts; in three the irrigated land varied from 75 to 85 per cent of the total land under production; while the northeastern humid belt averaged 60 per cent. The only district which had a low percentage was Mianwali, which lay in the arid Sind Sagar Doab and awaited irrigation development up until the partition of the subcontinent.

Well Irrigation vs. Canal Irrigation

Until the beginning of the twentieth century, underground wells were the major means of irrigation in the basin. However, with the expansion of canal irrigation, well irrigation began to decline in importance. In the year 1890-91, before any large irrigation project was completed, of the total cultivated land in the basin 3,593,849 acres or 57 per cent were irrigated, 2,162,658 acres or 37 per cent by wells and 1,353,490 acres or 22

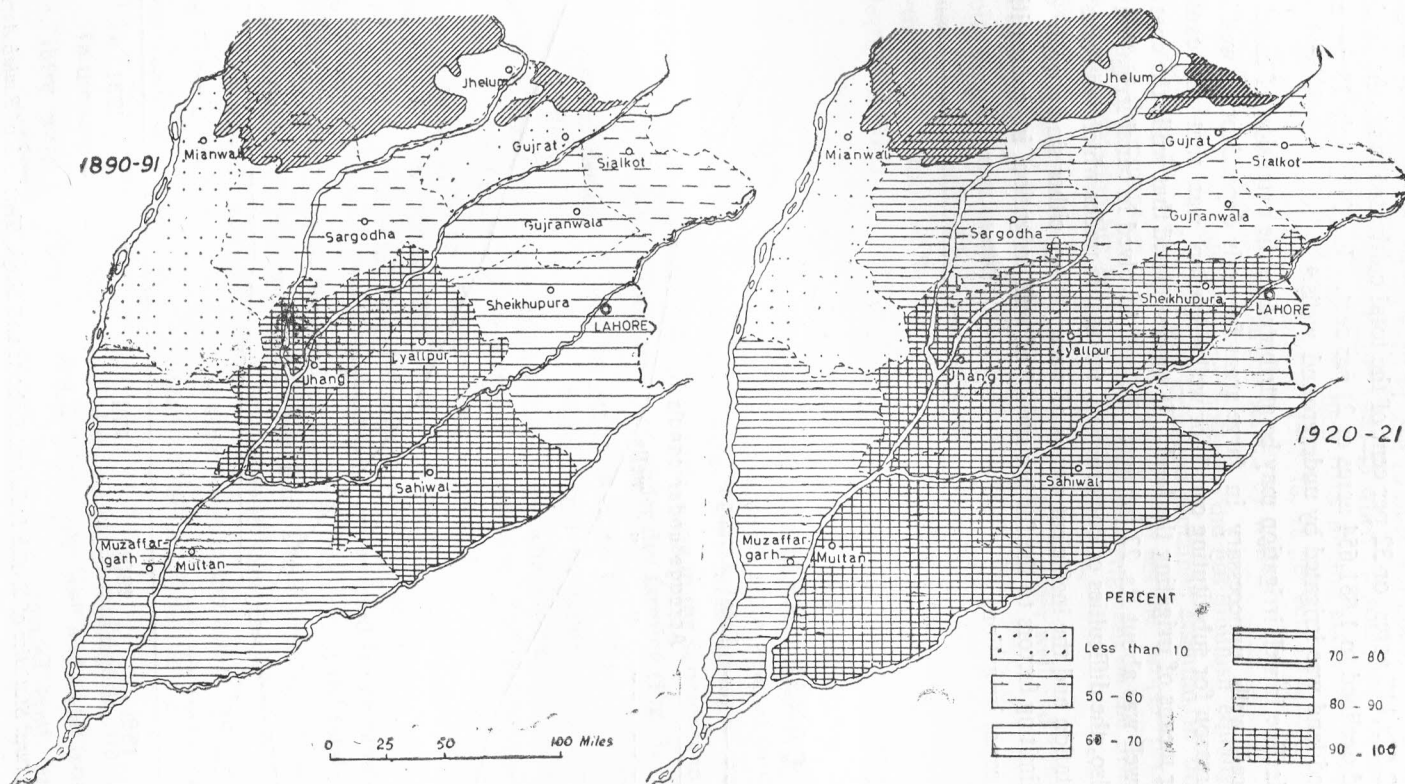
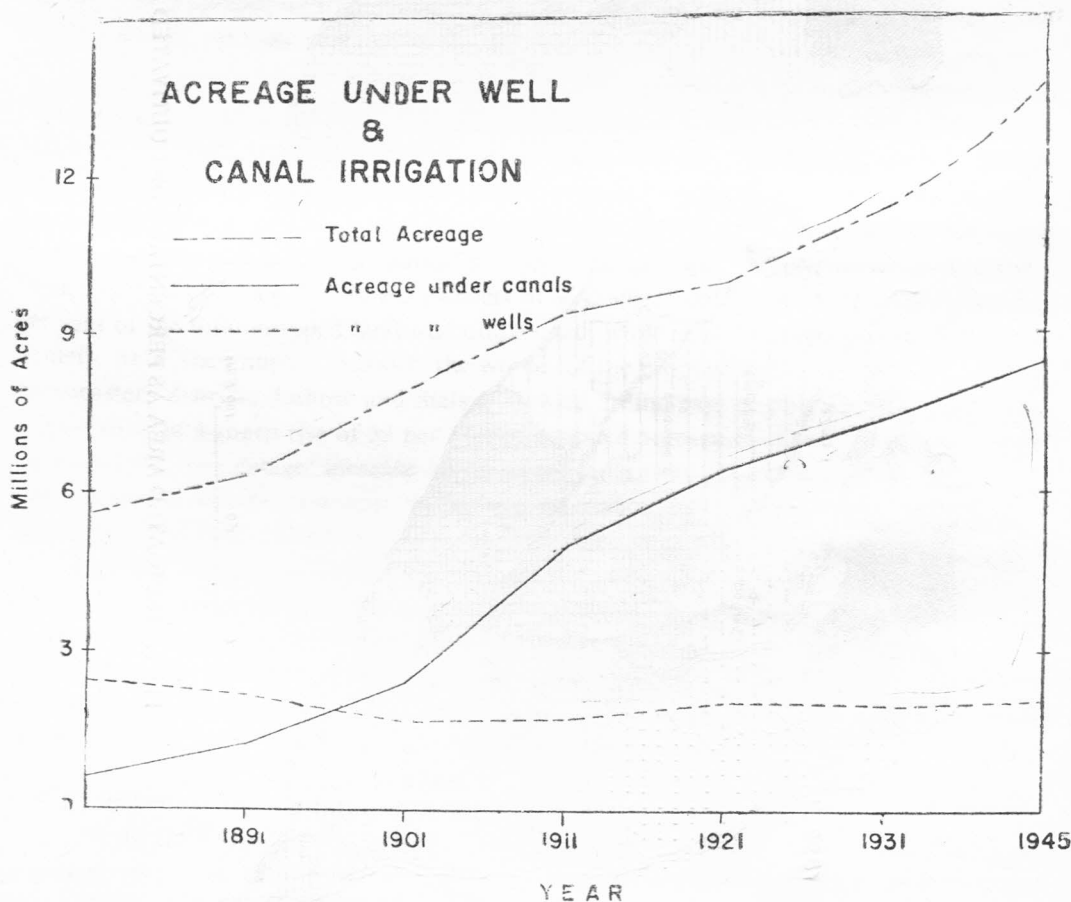


Fig. 1. IRRIGATED AREA AS PERCENTAGE OF CULTIVATED AREA. (1891—1921)

per cent by canals. Only a decade later, while acreage under canal irrigation had increased to 2,529,117 acres, or 32 per cent of the total cultivated land, the land irrigation by wells had declined to 1,681,654 acres or 21 per cent. In 1911, only 18 per cent of the total cultivated land was irrigated by underground wells.⁴

This decline in well irrigation may be attributed to the extension of canal irrigation which rendered wells unnecessary in large areas formerly dependent on well irrigation. The primary reason for substituting canal for well irrigation was that the canals were a much cheaper means of irrigating the land. It was estimated that while the cost of irrigation from a well was about Rs. 22 per acre, the cost involved in canal irrigation was only Rs. 3.8.⁵ Also, the difficulties of construction, the tenure under which land was held, the land fragmentation and the inefficient means of water lifting, either singly or in combination, proved limiting factors to the further spread of well irrigation in competition with expansion of canal irrigation.



Sources : *Agricultural Statistics of British India* and Roberts and Singh, *Textbook of Punjab Agriculture*.

Fig. 2

Acreage under canal irrigation showed a rapid increase from 1.3 million acres in 1890-91 to nearly 5 million acres in 1910-11 and to over 6.4 million acres in 1921 (Fig. 2). The rate of increase was maintained until 1945-46 when the total area under cultivation in the basin stood at 13.5 million acres, of which 10.8 million acres or 80 per cent were irrigated. Of the total irrigated land in 1945-46, 78 per cent was irrigated from canals and the remaining 22 per cent was largely served by wells.⁶

The importance of well irrigation, however, did not diminish equally in all parts of the basin. While in some districts well irrigation remained essential, in others it greatly declined due to the expansion of canal irrigation. To get the proper perspective, therefore, the regional relationship between canal and well irrigation on the district level may prove instructive.

From Figure 3, showing the proportionate land under well and canal irrigation as of the total cropped area in each district for the years 1890, 1905, and 1920, the relative significance of each method becomes apparent. It will be noted that well irrigation in the northeastern districts of Sialkot, Gujranwala, Gujrat and Lahore has always occupied an important position. As late as 1905, virtually all of the irrigated land in Sialkot and Gujrat was under wells, while Gujranwala and Lahore had 44 and 28 per cent under well irrigation. In 1920, while Sialkot still had 90 per cent of its irrigated land under well irrigation, in the remaining districts it varied from 30 per cent (Gujranwala) to 25 per cent (Lahore). It may be pointed out that irrigation, either from wells or canals, in the northeastern districts was of supplementary nature and large acreages were dry farmed. Sialkot, Gujrat and Gujranwala districts in 1920, lying in the submontane humid belt, had as much as half of their total cultivated land under dry farming (Fig. 3).

The greatest decline in well irrigation was in the central districts of Lyallpur, Montgomery, Jhang and Sargodha, where canal irrigation was extensively developed. The district of Lyallpur represents an extreme case where canal irrigation attained great significance. Where there was virtually no irrigation in 1890, the land under canal irrigation rose from 1,158,964 to 1,514,447 acres between 1905 and 1920. This phenomenal increase was due to the completion of the Lower Chenab Project in the early twentieth century. In Jhang the entire irrigated area in 1890 was served by wells, while in 1920 nearly 70 per cent of the total irrigated land was watered from canals. In the case of Montgomery district, canals provided water for 40 per cent of the total irrigated area, but after the extension of the Upper and Lower Bari Doab canals, the percentage rose to about 80 in 1920. The situation was similar in Sargodha where well irrigation in 1890 served 78 per cent of the total irrigated area, while it declined to 14 per cent in 1920, a change which can largely be attributed to irrigation of a large area by the Upper Jhelum and Upper Bari Doab canals.

In the southwestern districts of Multan and Muzaffargarh, unlike the rest of the basin, there were increases in acreage both under well and canal irrigation. In 1890, Multan had 494,898 acres, or 78 per cent of the total irrigated land, under canal irrigation, while 124,226 acres of 22 per cent were served from wells. In 1920, the respective

acres under both irrigation types were 820,981 (80 per cent) and 204,850 (20 per cent). In the case of Muzaffargarh, of the total irrigated land in 1890, canals served 284,861 acres (80 per cent) and wells irrigated 59,467 acres (18 per cent), while respective acreages for the year 1920 were 329,915 acres (68 per cent) under canals and 150,574 acres (30 per cent) under wells. The reason for the continuing importance of well irrigation in these two districts was that most of the canals irrigating this region were of the inundation type, in which case summer crops had to be irrigated from wells. Thus, an increase

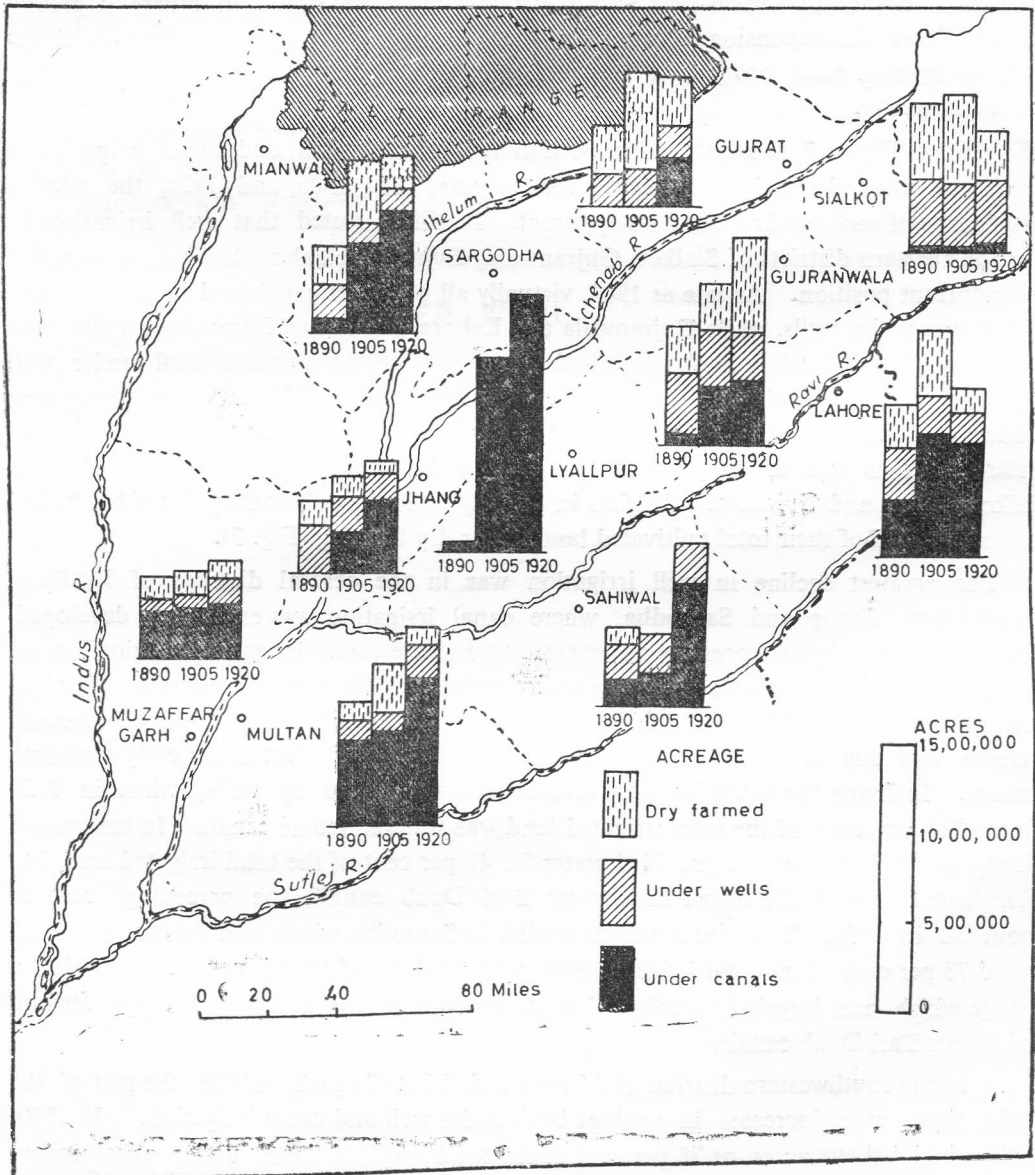


Fig. 3. WELL AND CANAL IRRIGATION. (1890—1920)

in cannal irrigated acreage created a greater need for supplemental water use for summer crops, which led to corresponding increases in well irrigation.

CHANGES IN AGRICULTURAL LAND USE

Partly subtropical and partly warm temperate in climate, the only limiting factor in the agricultural growth of the basin in the past was the unavailability of water. The introduction of perennial irrigation systems converted the basin from a monsoon semi-oasis into a perennial monsoon region. The technological advance meant not only an areal extension of the regional agricultural base but also an increase in the range of crops that could be grown.

However, the extended and varied crop complex that resulted from expansion of perennial irrigation did not mean the introduction of new crops as much as the areal changes that occurred in the relative importance and growth of the crops already in production. In the Upper Indus Basin, where water needs for the *kharif* (summer) crops during the dry months of April, May and June were great, agricultural possibilities for their growth were seriously limited. Formerly, *kharif* crops were precariously grown in the flood plains or around underground wells, while in the *doab* upland where no such possibilities existed winter crops were mainly grown. Thus, the extension of perennial irrigation into the *doab* areas not only insured irrigation for the *rabi* (winter) crops, but also greatly increased the areas that could be cultivated under *kharif* crops.

The significance of the new crop complex that emerged as a result of irrigation development was the increase in the relative proportions and values of the *kharif* crops. The increased acreages under *kharif* crops, particularly cotton and rice, introduced commercial agriculture, hitherto unknown in the basin. From Table 1, it will be realized that both the *rabi* and *kharif* crops showed a continued increase in acreage after the year 1905. However, the significance of the change is that acreage increase under *kharif* crops was proportionately greater than the acreage increase under *rabi* crops. In 1905-06, before the major canal irrigation projects were completed, the acreage under *rabi* crops was 5,596,998 acres or 75 per cent of the total cropped area, while 1,781,992 acres or 25 per cent of the total cultivated land was under *kharif* crops. In 1946-47, the year when the British period ended, the acreage under *rabi* crops, although increased by over three million acres, had dropped proportionately from 75 per cent in 1905 to 60 per cent of the total cropped area. The *kharif* crops, on the other hand, had a much greater relative increase, four times as much as 1905. Thus, within a period of only forty years, the acreage under *kharif* crops had increased from 1,781,992 (35 per cent) to 5,594,000 acres, which constituted 40 per cent of the total land under cultivation.

RABI CROPS

Rabi crops, primarily wheat, gram and barley, have always occupied first position in total acreage. In 1905, a total of 5,596,998 acres or 75 per cent of the total cropped land was under *rabi* crops, of which wheat occupied 59 per cent (Table 1 and Fig. 4), leaving 12.7 per cent under gram and 4.3 per cent under barley. In 1946, the acreage

under *rabi* crops rose to 8,619,000 acres or 60 per cent of the total cultivated land, being an increase of 40 per cent in four decades. At this time, of the total land under cultivation wheat occupied 47 per cent, while gram and barley occupied 11.8 per cent and 1.5 per cent respectively. This shows that although the combined acreage under *rabi* crops had risen by over 3 million acres, their relative position in the total crop complex had declined, meaning thereby a relative increase in area under *kharif* crops.

TABLE 1.—*Acreages Under Rabi and Kharif Crops, 1905-1946**

Year	<i>Rabi</i> Crops	Per Cent of the Total	<i>Kharif</i> Crops	Per Cent of the Total	Total Acreage
1905-06	5,596,998	75	1,781,992	25	7,378,990
1915-16	5,890,971	70	2,465,449	30	8,356,420
1920-21	5,377,687	63	3,053,353	37	8,431,040
1946-47	8,619,000	60	5,594,000	40	14,213,000

*Source : India, Statistical Department, *Agricultural Statistics of British India*.

Among the *rabi* crops, wheat and gram have shown an increase in acreage since 1905. While acreages under wheat and gram increased respectively from 4,333,936 and 942,189 acres in 1905 to 6,731,000 and 1,680,000 acres in 1946, the area cropped under barley dropped from 323,273 to 208,000 acres (Fig. 4). The percentage figures for land under each major *rabi* crop illustrate the general change that occurred due to irrigation development in the period under review. In 1905, combined acreage under wheat and gram occupied 94 per cent of the land under *rabi* crops, of which 77 per cent was under wheat alone. Barley, although confined to unirrigated marginal land was relatively important at the time and occupied about 6 per cent of the total *rabi* cropland. In the year 1946, nearly 98 per cent of the total *rabi* cropland was under wheat and gram, of which wheat occupied 78 per cent, leaving 19 per cent for gram and 2 per cent for barley. From these figures, it becomes clear that the hardier crop barley, which could be grown relatively more satisfactorily under arid environmental conditions, lost ground to more remunerative crops such as wheat and gram, which could now be grown under irrigation from the new canal systems.

Wheat.—Of the *rabi* crops, wheat is of particular significance in the basin. From early times, it has occupied a supreme position in the agricultural organization of the region. But the fact that wheat changed its role from that of the staple food crop of the subsistence farmer to one of the great commercial crops may be attributed to irrigation development. Within forty years from 1905 to 1946, the acreage under wheat increased from 4,333,936 to 6,731,000 acres, an increase of about 65 per cent (Fig. 4). This increase in wheat production was far greater than regional needs ; and, therefore, large wheat surpluses were available for disposal elsewhere. The importance of wheat as a commercial crop can be estimated from the fact that in the year 1900-01, of a total of 2,623,094 tons of wheat produced in the basin, 625,826 tons or 24 per cent was available for export. Of

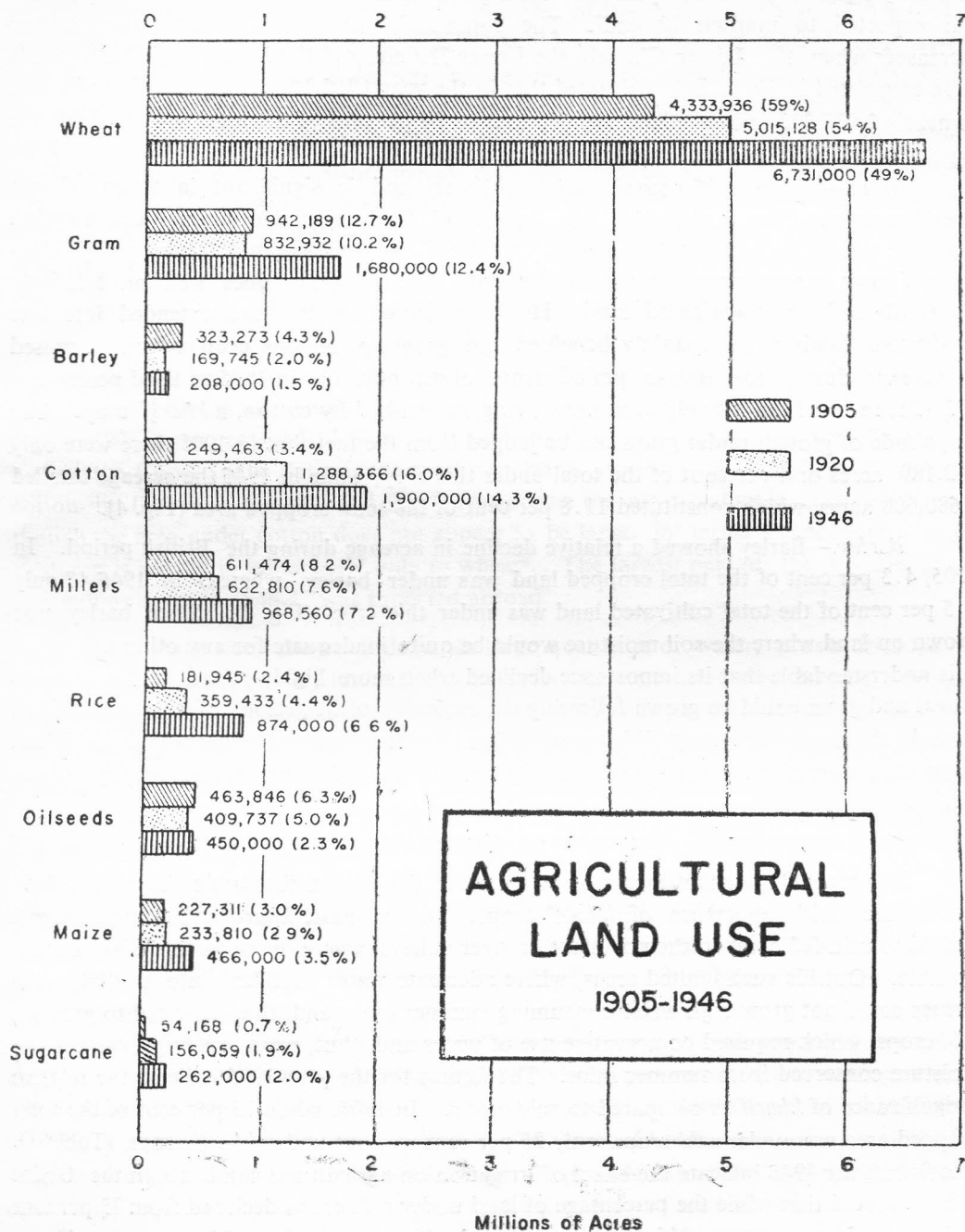


Fig. 4

this, only 8 per cent was transported to other parts of the subcontinent, while 16 per cent was exported to markets abroad⁷. The commercial prospects of this crop further increased when the Lower Chenab, the Lower Jhelum and the Lower Bari Doab canals were completed in 1915. It is estimated that in the year 1916-17, out of a total production of nearly 2,937,212 tons of wheat 996,660 tons or 34 per cent of the total was available for export, of which 29 per cent was exported overseas⁸.

Gram.—Gram is the second major *rabi* crop and is significant in terms of two considerations. First, it provides not only food for human and animal consumption but also serves as a leguminous crop. It, therefore, assists in maintaining soil productivity if sown in rotation with cotton and wheat. Second, gram does well on relatively less fertile and even unirrigated land. However, irrigation facilities extended into less productive lands have certainly benefited the growing of this crop which increased in acreage during the British period from ninth position in 1895 to third position in 1920-21, the position it holds even now, being out-ranked by cotton, a *kharif* crop. The magnitude of growth under gram can be judged from the fact that in 1905 there were only 942,189 acres or 4 per cent of the total under this crop, while in 1946 the acreage totalled 1,680,000 acres, which constituted 11.8 per cent of the total cropped area (Fig. 4).

Barley.—Barley showed a relative decline in acreage during the British period. In 1905, 4.3 per cent of the total cropped land was under barley, whereas in 1946-47 only 1.5 per cent of the total cultivated land was under this crop (Fig. 4). Since barley was grown on land where the soil moisture would be quite inadequate for any other *rabi* crop, it is understandable that its importance declined when more highly-prized crops such as wheat and gram could be grown following the extension of irrigation. During the British period, therefore, not only did the expansion of acreage under barley end ; but, in fact, large areas were given over to gram, thereby causing a net decline in the acreage under barley.

SUMMER OR KHARIF CROPS

The great change that extension of irrigation farming in the basin brought about was the increased importance of *kharif* crops. In the past, *kharif* crops were largely limited to rain-fed areas in the northeast or river valleys where inundation irrigation was possible. Outside such limited areas, where adequate water supplies were available, the farmer could not grow high water consuming summer crops and, thus, reverted to growing *rabi* crops, which required conservative use of water and, thus, were easily grown on soil moisture conserved from summer rains. The figures for the year 1905 indicate the relative insignificance of *kharif* as compared to *rabi* crops. In 1905, while 75 per cent of the total cropped area was under *rabi* crops, only 25 per cent was put under *kharif* crops, (Table 1). The figures for 1946 indicate the effect of irrigation on agricultural land use in the basin. It is estimated that while the percentage of land under *rabi* crops declined from 75 per cent in 1905 to 60 per cent in 1946, the figures for *kharif* crops rose from 25 per cent to 40 per cent in the same period (Table 1).

Cotton.—Cotton is the most important *kharif* crop both in area and value and illustrates the most important change in the agricultural land use of the basin. In 1905,

it occupied sixth position in the total crop complex of the basin, while in 1920 it ranked second to wheat in both acreage and value. Within a short span of fifteen years, cotton was converted from an inferior *desi* variety used mainly by village weavers to a significant cash crop which competed favourably in the world market. The significant role that cotton has played may be attributed to the extension of irrigation in the region, where fertile soil and a hot, dry climate provided excellent conditions for cotton cultivation. The fact that about 90 per cent of the land under cotton is normally irrigated ascertains the belief that great increases in cotton could not have been made without irrigation extension in the basin.

As late as 1905, there were only 249,463 acres or 3.4 per cent of the total cropped land grown under cotton (Fig. 4). In 1920-21, cotton occupied 1,288,366 acres or 16 per cent of the total land, over a five-fold increase within these fifteen years. The increased importance of cotton as a *kharif* crop illustrated by the fact that of the total *kharif* crop land in 1905 cotton covered 13.9 per cent while by 1920 it had increased to 42 per cent. Today, the Upper Indus Basin is the most important producer of American varieties of cotton in the subcontinent, and they have become the most valuable cash crop. Although the area under cotton does not appear to be large, in terms of economic value this crop is second in importance only to wheat⁹. The largest part of the produce from two million acres in 1946-47 was exported abroad.

Rice.—Since rice cultivation demands large quantities of water, possibilities for its expansion have been severely limited. Land under rice cultivation was largely confined to submontane districts and narrow bottom lands in the valleys where flood irrigation was possible. However, canal irrigation made rice growing possible in the drier *doab* uplands, which now are large producers of surplus rice. Of the total area under rice, over 82 per cent is estimated to be irrigated artificially, and the rest is unirrigated¹⁰. The close relationship that exists between the extension of irrigation and the increase in rice acreage can be judged from the fact that an acreage of 181,945 acres, which constituted 2.4 per cent of the total crop land in 1905, was increased to 874,000 acres (6.6 per cent) in 1946, an increase of 500 per cent. The fact that in 1944 approximately 150,000 tons of rice were exported from the basin shows that it has become an important cash crop for the farmer.

Other Kharif Crops.—Both sugar cane and maize have shown a marked improvement in terms of acreage and percentage of the total cropped area. While acreage under maize increased from 227,311 acres in 1905 (3.0 per cent) to 466,000 acres (3.5 per cent) in 1946, acreage under sugar cane showed a rise from 54,168 acres (0.7 per cent) to 262,000 acres (2.0 per cent) during the same period (Fig. 4). Since the cultivation of sugar cane maize requires large quantities of water, the provision of artificial irrigation supplies was necessary. Therefore, the spread of irrigation canals made possible the expansion of area under both maize and sugar cane. However, sugar cane, being a more remunerative cash crop, showed the more rapid increase. Within a period of only 40 years, sugar cane acreage increased 500 per cent, whereas maize acreage only doubled.

Millets and oilseeds are the only *kharif* crops which showed a relative decline in importance. While acreage under millets increased from 611,474 acres in 1905 to 968,560 acres in 1946, acreage under oilseeds actually declined. In 1905, the total area in the basin under oilseeds was estimated to be 463,846 acres while in 1946 it had dropped to 450,000 acres. In 1905, millets occupied 8.2 per cent of the total land and was third in order of importance after wheat and gram. In 1946, acreage under millets declined to 7.2 per cent and became fourth in order of importance ; cotton superseding it in acreage, while rice almost equalled it (Fig. 4). The relative decline in the case of oilseeds was even more drastic. In 1905, oilseeds covered nearly 6.3 per cent of the total land and were fourth in acreage, while they declined in 1946 to 3.3 per cent and seventh position.

INTRA-REGIONAL ELEMENTS OF THE CROP COMPLEX

The change in the regional crop complex, however, did not occur uniformly within the basin. In fact, there were large areas where change in agricultural land use was minimal and insignificant, while in others it was of extraordinary magnitude and great significance. The amount of change depended on the local physical and social conditions and the level of irrigation development in the area. Figure 5, showing the crop complex of each district for the year 1905, has been selected to give an impression of the indigenous crop complex as it existed before British irrigation development¹¹.

Examination of Figure 5 reveals that in almost all districts three-fourths or more of the cultivated land in 1905 was under *rabi* crops, with wheat in most cases occupying over 80 per cent. However, the amount of land under *rabi* crops in the submontane districts of Sialkot, Gujrat and Sargodha and the southwestern districts of Multan and Muzaffargarh was proportionately less. The larger acreage under *kharif* crops in the submontane districts may be explained by the fact that these are relatively humid and have a high water table, which permits well irrigation during the dry season. An inundation system supplemented by well irrigation in the districts of Multan and Muzaffargarh explains the higher acreage under *kharif* crops there. In the districts of Sialkot, Gujrat and Sargodha, from 27 to 37 per cent of the total land was under *kharif* crops, while in the districts of Multan and Muzaffargarh 37 and 24 per cent was occupied by *kharif* crops. It may be noted that although cotton was grown also in the submontane districts, it was relatively more important in the southwest. Multan with 11.2 per cent of its total land under cotton was the largest producer at that time.

The pattern of the crop complex in the central districts, which later became the canal colony districts, was quite different. The increased aridity and low water table did not permit, under the techniques of irrigation then existing, the cultivation of *kharif* crops. In the district of Montgomery, only 11.6 per cent of the total cultivated land was under *kharif* crops. The percentage of 22 per cent under *kharif* crops in the case of Lyallpur was because of the construction of the Lower Chenab Canal, which already had irrigated large areas in this district. Of the *rabi* crops grown in these districts, wheat and gram were by far the most important, covering in most cases over 75 per cent of the total culti-

vated land (Fig. 5). Millets were important among the summer crops. Cotton in the central districts was virtually non-existent at the time.

The changes that occurred in the intra-regional crop complex as a result of the completion of the irrigation projects in the Rechna, Bari, and Jech *doabs*, are illustrated in Figure 6. It will be noted that in 1946-47 the relative role of *rabi* crops had sharply declined in all the districts of the basin. The change from *rabi* to *kharif* crops was most striking in the canal colony districts of Montgomery, Lyallpur and Multan where *kharif*

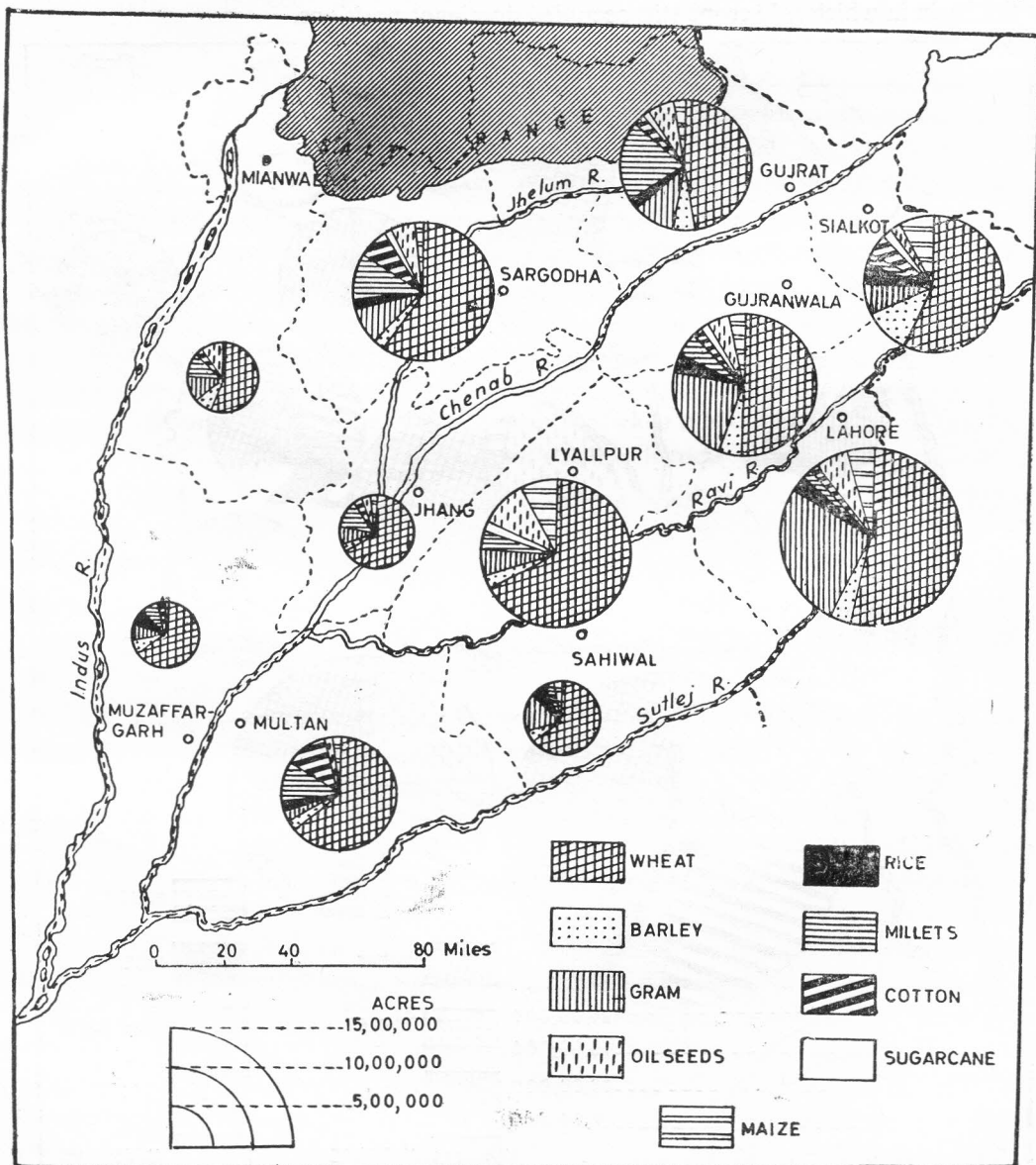


Fig. 5. AGRICULTURAL LAND USE. (1905-06)

An examination of Figure 6 shows that acreage under cotton, oilseeds and rice underwent the greatest change in the canal colony districts where they now formed important elements of the *kharif* crop complex. In the case of Montgomery and Lyallpur the change in cotton acreage was the most spectacular. From virtually no acreage under cotton in 1905, Montgomery and Lyallpur emerged as major producer in 1946. Both Montgomery and Lyallpur had 20 per cent of their total cultivated land under cotton in 1945. Percentage of total land under cotton in Multan increased from 11 per cent in 1905 to nearly 23 per cent in 1946, making Multan the largest producer of cotton in the basin.

Oilseeds, constituting largely rapeseed and mustard, are the other *kharif* crop which has rapidly increased since the extension of irrigation farming in the basin. Before 1905, oilseeds occupied relatively small acreages limited mainly to the northeastern districts of Gujrat, Sargodha, Lahore and Gujranwala, with an average of six per cent of the total crop land (Fig. 6). In the central districts until the beginning of the twentieth century there was practically no land cultivated under oilseeds. Whatever acreage there was, was of a subsistence nature and the crop was consumed locally. But with the spread of irrigation farming in the basin, oilseeds became an important summer cash crop to the farmers. The increases in acreage under oilseeds was particularly significant in the canal colonies where they have been grown under canal irrigation. Multan district had 25.6 per cent of its cultivated land under oilseeds in 1946, while it had only 3.6 per cent in 1905. Lyallpur and Montgomery are the other canal colony districts which made phenomenal increases in acreage under oilseeds. While the percentage of land under oilseeds in Lyallpur increased from 11 per cent¹² in 1905 to 22 per cent in 1946, the respective percentage figures for Montgomery were 1.2 per cent and 21 per cent.

Although the cultivation of rice has increased in all the canal colony districts, its increase was particularly significant in the districts of Gujranwala, Sheikhpura and Lahore¹³. The combined acreage in all these three districts in 1905 amounted to 58,636 acres, which was largely confined to the flood plains. In 1946, there were 229,276 acres in Gujranwala district alone, constituting 25 per cent of the district total. Sheikhpura, the second largest producer in the basin, had 20 per cent of its total cropped land under rice in 1946.

PATTERN OF POPULATION CHANGE

According to the Census Reports of 1881, the population of the Upper Indus Basin totalled 5,389,466 persons, which constituted 24 per cent of the total population of the former British province of the Punjab¹⁴. The region, as enclosed in the study area, however, contained 43,532 square miles or 30 per cent of the total area of the former Punjab province, indicating relatively less pressure of population on land. In 1891, the population of the basin had increased to 6,489,039, an addition of over one million people within a decade. From Fig. 7, it can be seen that the curve of population from 1881 to 1941 shows a slight leveling after 1891, indicating a drop in the rate of growth. This

trend was continued until 1921, after which the curve makes a steep turn upwards, showing a sharp increase in population growth between 1921 and 1941. The change in the rate of growth can be judged from the fact that during the three decades between 1891 and 1921, the population of the basin increased from 6,489,039 to 8,914,808, an increase of 38 per cent. During the twenty years between 1921 and 1941, the population increased to 13,055,508, meaning an increase of 46 per cent. In other words, the population during the two decades between 1921 and 1941 increased at a rate nearly twice as great as during the thirty years between 1891 and 1921.

At first, it seems surprising that the rate of population growth should have been slower in the period from 1891 to 1921, during which the largest irrigation and colonization schemes were completed. Considering that the colonization schemes undertaken between 1891 and 1921 immigrated nearly a million colonists into the canal colonies, the majority of whom came from the overpopulated northeastern and eastern districts outside the study area, the slower rate of growth seems all the more surprising. In spite of this net increase, the rate of population growth was not as great as either before or after the irrigation-colonization projects were undertaken (Fig. 7).

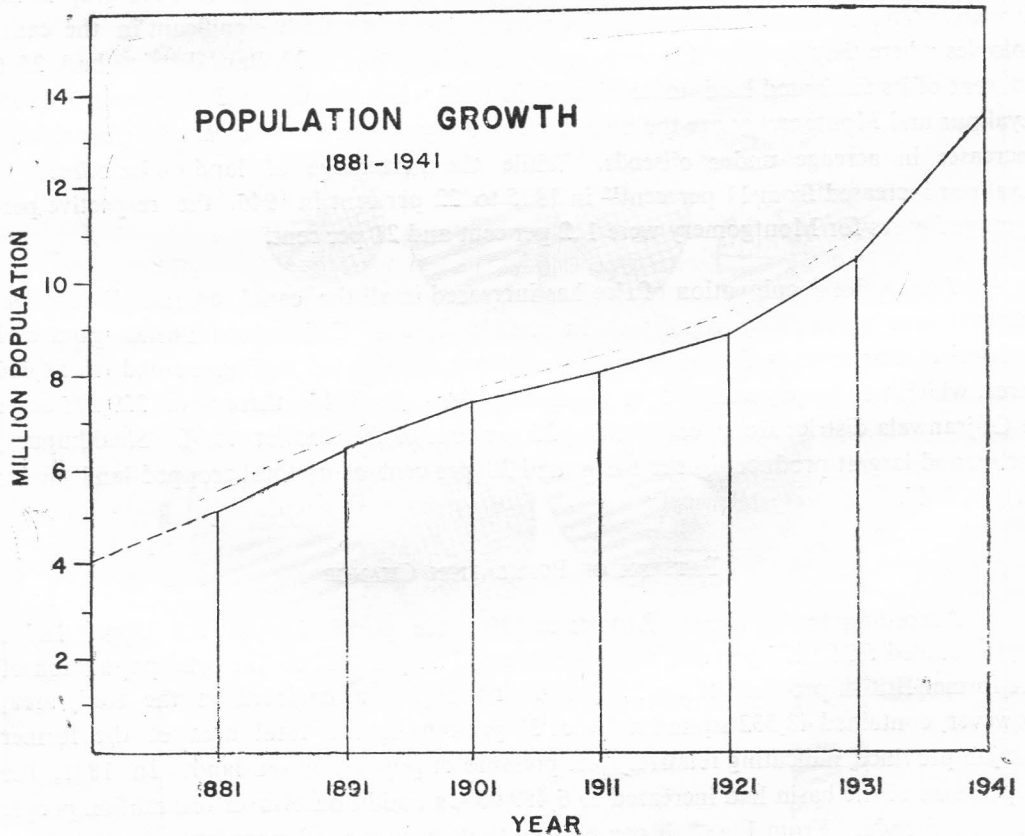


Fig. 7

Disease, sharply increasing the mortality rate, was the major reason for the decreased growth rate in the basin during the reclamation era between 1891 and 1921. It is estimated that a total of 6,528,981 deaths in the former Punjab province were caused by plague and fever during the decade 1901-11¹⁵. Losses of 38,762 and 107,109 during the same period were from cholera and smallpox respectively. This abnormal mortality rate took a heavy toll of life and considerably lessened the effect of irrigation-colonization on the rate of population growth. On the other hand, the phenomenal rate of population growth that was experienced during the twenty years from 1921 to 1941 may be attributed to the better agricultural opportunities and health conditions that the irrigation-colonization program was able to provide.

There is little doubt that the rate of population growth would have been even greater if it had not been for the high death rate caused by the influenza epidemic of 1918. It is estimated that the number of deaths due to this disease was in the vicinity of a million, of this number the deaths in the reproductive ages (aged 15-40) were 417,699 (205,399 males and 212,300 females).¹⁶ Despite all this, the Upper Indus Basin showed a phenomenal increase in population in the years between 1921 and 1941. First of all, the rapid rate of immigration, which continued until 1931, brought about a net increase in population. This resident population, with the better agricultural and economic conditions which irrigation extension made possible, showed great recuperative power; thereby greatly increasing its birth rate. On the other hand, the better health and sanitation conditions that the new canal colonies provided tended to decrease the death rate in the basin. In 1919, the death rate, which had already fallen to 28.3 per thousand, had further declined to 22 per thousand in 1922, the lowest rate on record since 1877.¹⁷ The net increase due to immigration into the basin from the adjoining districts in the northeast and a large excess of birth over deaths in the canal irrigated colonies had largely contributed to the phenomenal population explosion in the twenties and thirties.

Intra-regional Pattern of Population Growth

The indigenous pattern of population distribution, before British occupation of the basin, was strictly hydrographic in nature, in which population was largely confined to the humid submontane districts or riverine areas. The submontane districts, where over two-thirds of the population was located, were, however, by far the major centers of concentration. Away from the northeastern belt, the *doab* lands were largely empty; and the population that existed was confined to the narrow *bet* lands in the flood plains.

The extent to which the population was concentrated in the northeastern humid districts can be estimated from the fact that of the twelve districts located in the basin, four districts—Sialkot, Gujrat, Lahore and Gujrawala—in 1881 supported 3,593,165 persons, which constituted 67 per cent of the total population. On the other hand, the combined area of these four districts, which totaled 6,445 square miles, was only 20 per cent of the study area. On the remaining 80 per cent of the land, lying to the west and southwest of the submontane districts, the other 33 per cent of the population was distributed.

Population Changes (1891-1941)

The most significant change in the demographic pattern of the basin after 1891 was the reversal of the order of regional population growth. The population in the Upper Indus Basin until 1891 was concentrated in the northeastern districts and was increasing there relatively more rapidly than in the central and western districts. But with the opening of the Lower Chenab Canal in the Rechna Doab in 1899, a great impetus to population spread and growth was given to the central districts. The combined effects of the Lower Chenab Canal and other irrigation projects undertaken in the central basin was that while the rate of population growth was rapidly increasing in the central canal colony districts, it was tending to decline in the northeastern districts (Fig. 8). These two opposite tendencies that began after the year 1891 were directed naturally towards equalizing the distribution of population in the basin.

During the thirty years between 1891 and 1921, the population of the basin increased from 6.5 million to 8.9 million, an overall increase of 34 per cent. The largest increases, however, were made in the canal irrigated districts of the central basin, while the rate of population growth sharply declined in the northeastern districts. As a matter of fact, both Sialkot and Gujranwala showed a net decrease of 9 and 3.3 per cent in the thirty years between 1891 and 1921 (Table 2). The districts of Gujrat and Lahore in the same period showed an increase of only 2.3 and 24 per cent respectively, which were indeed very small increases.

The district of Lyallpur is the most striking illustration of the population change in the canal colony districts. Until 1891, the population in this district was only 46,926 and had actually declined from 53,832 in 1881. By 1901, the population figures had increased to 576,939, showing an increase of 1,129 per cent over the previous decade. The reason for this phenomenal growth was the completion of the Lower Chenab Canal in 1899 and the colonization program which was responsible for the immigration of over half a million colonists from the overpopulated districts in the northeast¹⁸. The rate of increase in Lyallpur district, although not as high as during the colonization of the area, remained nonetheless the highest in the basin. According to the Census of 1921, the population of the district totaled nearly a million, an increase of 60 per cent over the year 1901.

The completion of the Lower Jhelum and Lower Bari Doab canals in 1915 brought a rapid population increase in the districts lying in the Jech and Bari *doabs*. The largest part of the increase was concentrated in the districts of Montgomery and Sargodha. The population of Montgomery increased from 429,674 in 1901 to 685,690 in 1921, an increase of over 50 per cent. Sargodha, next in order of increase, showed an increase of about 44 per cent in the same period (Table 2). It is to be noted that in the period between 1891 and 1921, the population in the three canal colony districts of Lyallpur, Montgomery and Sargodha was growing at a rate much faster than either the northeastern or southwestern districts of the basin.

During the two decades between 1921 and 1941, the population of the basin increased at an unprecedented rate. The decade of 1921-31 showed an increase from

TABLE 2.—Population Changes in the Upper Indus Basin, 1891-1941

District	1891	% Change 1881- 1891	1901	% Change 1891- 1901	1911	% Change 1901- 1911	1921	% Change 1911- 1921	1931	% Change 1921- 1931	1941	% Change 1931- 1941
Lahore	898,790	+17.1	1,003,862	+ 11.7	999,521	— .4	1,129,839	+13.0	1,378,570	+22.0	1,695,375	+22.9
Sialkot	961,600	+ 9.2	933,205	— 3.0	871,867	— 6.6	877,867	+ .7	979,617	+11.9	1,190,497	+21.5
Gujranwala	661,223	+14.1	739,546	+ 11.8	605,582	— 18.1	623,581	+ 3.0	736,138	+18.1	912,234	+23.9
Sheikhupura	401,451	+14.6	523,522	+ 30.4	540,574	+ 1.8	634,584	+19.9	696,732	+ 9.8	852,508	+22.4
Gujrat	806,382	+10.9	792,159	— 1.8	787,999	— .5	824,046	+ 4.6	922,427	+11.9	1,104,952	+19.8
Sargodha	478 289	+24.7	488,149	+ 2.1	645,001	+ 32.1	719,918	+11.6	821,490	+14.1	998,921	+21.6
Mianwali	287,026	+ 9.4	301,910	+ 5.2	341,377	+ 13.1	358,205	+ 4.9	411,539	+14.9	506,321	+23.0
Montgomery	416,559	+19.6	429,674	+ 3.1	481,965	+ 12.2	685,690	+42.3	999,772	+45.8	1,329,103	+32.9
Lyallpur	46,926	—12.8	576,939	+1,129.5	824,470	+ 43.9	957,881	+15.5	1,151,351	+20.5	1,396 305	+19.7
Jhang	402,341	+ 3.0	426,225	+ 5.9	524,803	+ 23.1	570,559	+ 8.7	664,833	+16.5	821,631	+23.6
Multan	634,538	+14.2	709,297	+ 11.8	813,357	+ 14.7	889,328	+ 9.3	1,174,900	+31.9	1,484,333	+28.0
Muzaffargarh	493,914	+11.9	527,681	+ 6.8	569,461	+ 7.9	568,478	— .2	591,375	+ 4.0	712,849	+20.5
Total	6,489,039		7,454,217		8,105,760		8,914,808		10,528,774		13,005 508	

1. Source: *Census of India, The Punjab*, 1891, 1901, 1911, 1921, 1931, 1941.

8,914,808 to 10,528,774, an increase of 18 per cent. As usual, the largest increases in population occurred in districts where irrigation had been extended. In Montgomery, the population increased by 45 per cent, while in Multan an increase of nearly 32 per cent was recorded. The rapid increase in these two districts was due to the completion of the Sutlej Valley Project in 1926.

According to the 1941 census figures, the population of the Upper Indus Basin increased from 10,528,774 in 1931 to 13,005,508 in 1941, an increase of 23.3 per cent over the previous decade, the largest increase in any one decade made thus far. The significant aspect of this increase was that population grew nearly as rapidly in the canal irrigated districts as in the northeastern submontane districts. Previously, irrigation extension and colonization schemes had meant a far more rapid rate of increase in the canal colony districts than in the humid northeastern districts, wherefrom the bulk of the migrants came. During the decade 1931-1941, however, the population in each district began to rapidly increase at a fairly uniform rate of 20 to 30 per cent, the average increase rate for the basin as a whole being 23 per cent¹⁹.

The rapid increase in the remaining districts tends to show that while the shift of population from the crowded northeastern districts to the canal colony districts brought about phenomenal increases in population there, it created additional room for the population which remained behind. Consequently, after a relatively short period, the effects of the decrease in population in the already settled areas were erased when the population grew at an even faster rate due to better economic conditions, thereby bringing about a greater overall increase in the rate of population growth in the basin.

Changes in Population Density

It will be remembered from the preceding discussion that the British irrigation program was intended to reduce the pressure of population on land in the northeastern districts. From Table 3, showing the population densities on the district level, one can judge the extent to which irrigation expansion has been successful in reducing the population pressure in the northeastern districts by shifting population into the central districts. Table 3 shows that until 1891 the population densities in the northeastern districts, which were already overpopulated, were increasing at a rate greater than elsewhere in the basin. In the four northeastern districts, the average population density of 357 in 1881 increased to 400 in 1891, while in the six canal colony districts it only increased from 88 to 101.

During the decade of 1891-1901, great shifts in population occurred when colonization of the Lower Rechna Doab was undertaken. The movement of large numbers of people from the overpopulated districts in the northeast to empty *doab* areas in the central districts meant rapid changes in population densities. According to the 1901 census, the densities for Sialkot and Gujrat declined from 610 and 359 in 1891 to 592 and 352 respectively²⁰ (Table 3). On the other hand, Lyallpur district, where the Lower Chenab Project was launched, showed the largest increase. The average density of this district rose from 15 per square mile in 1881 to 184 in 1901. In the remaining districts

of the central and southwestern basin, average district densities nowhere exceeded 124 per square mile (Figure 9).

TABLE 3. *Density of Population (Per Square Mile)*

Districts	1881	1891	1901	1911	1921	1931	1941
UPPER INDUS BASIN	174	196	221	229	249	293	358
N. E. Districts	357	400	412	387	406	469	572
Lahore	294	344	384	382	432	527	653
Gujranwala	251	287	321	262	270	319	395
Sialkot	559	610	592	553	557	622	755
Gujrat	323	359	352	351	367	410	488
Canal Colony Districts	88	101	142	172	200	244	300
Sheikhupura	152	174	227	235	253	303	370
Montgomery	79	94	97	109	155	225	316
Sargodha	80	100	102	135	150	172	209
Lyallpur	17	15	184	264	323	363	396
Jhang	113	117	124	152	166	193	241
Multan	95	109	122	140	155	202	263
Western Districts	64	72	75	83	84	91	111
Mianwali	48	53	55	63	66	76	94
Muzaffargarh	79	88	94	102	101	105	127

Source: *Census of India, The Punjab*, 1881, 1891, 1901, 1911, 1921, 1931, 1941.

During the two decades that lapsed between 1901 and 1921, irrigation expansion continued to successfully reduce the pressure of population in the northeastern districts. It will be noted from Table 3 that during the decade 1901-11 all of the northeastern districts showed a rapid decrease in population density. The greatest decline occurred in the districts of Sialkot and Gujranwala. From 592 in Sialkot and 321 in Gujranwala, their densities declined to 553 and 262 respectively. At the same time, densities rose rapidly in the canal colony districts. The greatest increase occurred in the districts of Lyallpur, Montgomery, Sargodha and Jhang. Lyallpur, with a density of 323 in 1921, was the most densely populated canal colony district, followed by Sargodha and Montgomery, which had respective densities of 166 and 155. Rapid increases in density also occurred in the case of Jhang and Multan districts. Mianwali and Muzaffargarh were the only districts where irrigation as yet was not developed, and the population densities remained very low.

From the map showing the density pattern as it existed in 1941, it becomes evident that irrigation expansion had fairly equalized the distribution of population in the basin. Comparison with the density map for 1901 shows that the largest increases in population density occurred in the districts of the Rechna, Aari and Jech *doabs* where most of the irrigation projects were implemented. The Sind Sagar Doab, which was largely undeveloped, had still very low population densities. Lyallpur, Montgomery and Sheikhu-

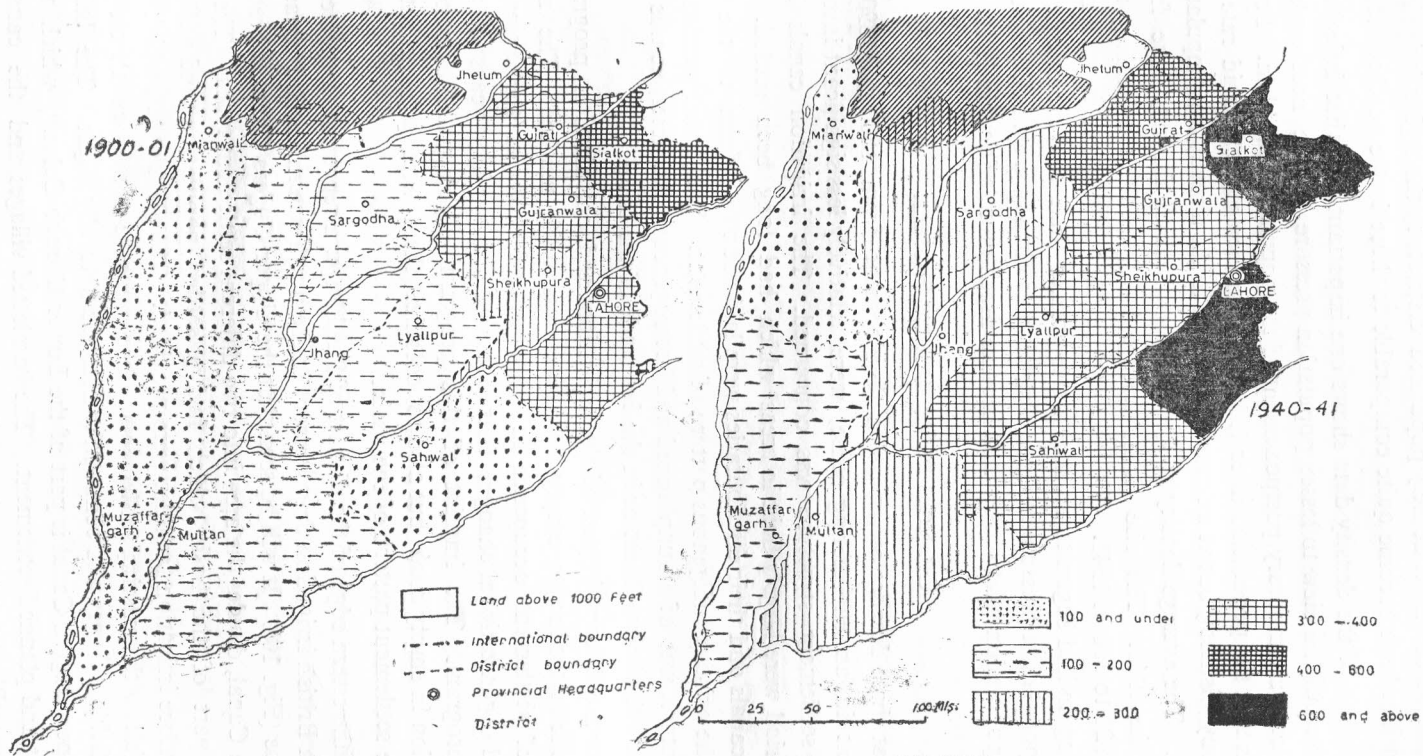


Fig. 9. POPULATION DENSITY. (1901-1941)

pura stand out as the most densely populated districts in the region irrigated by canals, and their densities have become quite comparable to those in the northeastern districts.

An analysis of the density data shows one important fact, that irrigation development undertaken with a view to lessen population pressure in the northeastern districts proved to be only a temporary postponement of the population problem. From Table 3 it may be seen that the population after 1921 began to increase at a rapid rate not only in the canal colony districts, but at an ever higher rate in the already overpopulated northeastern districts. The average density of the four northeastern districts rose from 406 in 1921 to 572 in 1941. The rise in the average density of the canal colony districts was from 200 in 1921 to 300 in 1941. This means that the population in the northeastern districts once again had begun to grow at a rate greater than the canal colonies. Considering that population pressure in these districts was already great in 1891, it is evident that the land-population relationship had become much more critical in 1941.

CHANGES IN SETTLEMENT PATTERN

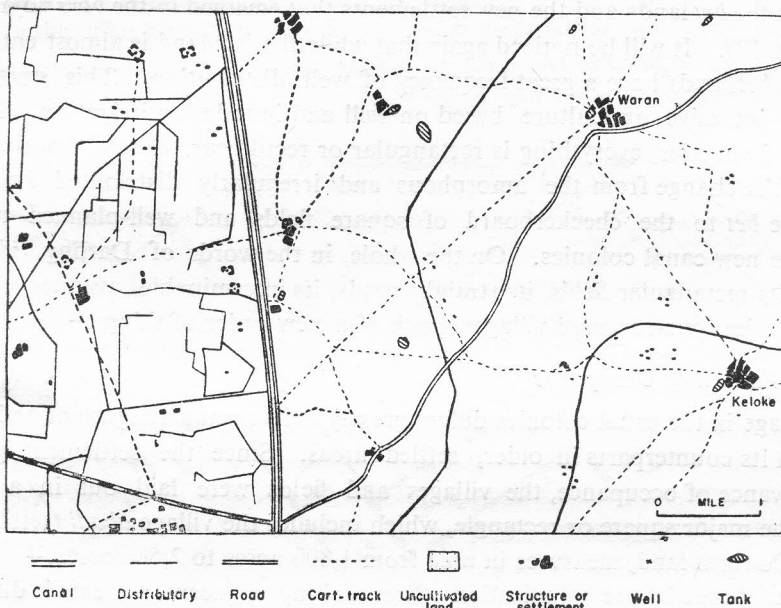
The first three decades of irrigation development from 1860 to 1890, although very significant in an engineering sense, were relatively less significant insofar as their impact on the settlement structure was concerned. The irrigation canals constructed during this period were largely built in areas which had long been settled. Therefore, the irrigation canals and their distributaries were laid out to conform to the needs and exigencies of the existing indigenous pattern of settlement. The canal pattern, being of consequent nature, was of an unplanned and heterogeneous character, as was the case in other settlements to the northeast or in the *bet* lands of the basin.

However the cultural impact of the irrigation and colonization program undertaken later in the unproductive, empty *bar* areas was quite marked. The nature and arrangement of settlement occupance in these upland *doabs* is the expression of the conceptual and organizational changes that occurred during fifty years of a planned colonization program. The imprint of this program, which undertook not only to provide irrigation in empty *doabs* but also to colonize them with pioneer settlers, was marked on the settlement pattern of the basin.

The southwestern edge of the district of Sheikhupura represents settlement patterns associated with British irrigation development in the northeastern settled areas and the empty *bar* areas (Fig. 10). It will be seen that the Upper Gugera Canal, a branch of the Lower Chenab Canal, divides the area into two different settlement types. The area east of the canal is part of the basin which had a settled population and well organized communities before irrigation facilities were provided. Thus, the canals which were built were made to follow the existing settlements. The influence of such canals on the existing pattern of fields, villages and communication was naturally slight. The land on the west of the Upper Gugera Canal is part of the Lower Chenab Colony, which underwent predevelopment and planned settlement. The hamletted villages and the canals, which conform to a rectilinear pattern, stand in clear contrast to the irregularly laid out

SETTLEMENT PATTERNS OLD AND NEW

Occupance Pattern in the Old and New Settled Areas,
Rechna Doab Upland in the Sheikhupura District, about
10 miles northwest of Sheikhupura. Survey of Pakistan 44 E/13



Occupance Pattern in the Bet and Bar Lands, Lyallpur District,
70 miles southwest of Lahore. Survey of Pakistan 44-E/8

Fig. 10

agglomerated villages and canals in the old, settled areas. The predominance of wells in the old, settled areas reflects the practice of well irrigation before perennial canals were extended into the area. In the new canal colony, on the other hand, the wells are few and far apart.

That part of Lyallpur district along the Ravi illustrates the contrast between the old settlements in the *bet* lands and the new settlements that emerged in the *bars* adjacent to the *bet* lands (Fig. 10). It will be noticed again that while the *bar* land is almost entirely canal irrigated, the *bet* lands have a great frequency of well distribution. This suggests good soil and an intensive agriculture based on well and inundation irrigation. In the new canal irrigated colonies, everything is rectangular or rectilinear. From the air, one can easily notice the change from the amorphous and irregularly distributed agglomerated villages in the *bet* to the checkerboard of square fields and well-planned rectangular villages in the new canal colonies. On the whole, in the words of Darling, "The canal colony with its rectangular fields, its straight roads, its interminable avenues of shisham trees, and its trim four-cornered villages speak of a new order of things."²¹

Intra-village Pattern of Occupance

A village in the canal colonies differs greatly in its areal arrangement and geometric pattern from its counterparts in older, settled areas. Since the settlement plans were drawn in advance of occupance, the villages and fields were laid out in a rectilinear fashion. The major square or rectangle, which includes the village *abadi* (settlement) and the associated farm land, measures in area from 1,800 acres to 2,500 acres.²² It was outlined and numbered by the colonization officer and lay adjacent to canal distributaries and roads. The *abadi* is located generally in the middle of this major square, around which land belonging to residents of the village is outlined in other squares.

Figure 11 gives an idea as to how a new village in the canal colony of Lyallpur district compares with a village in the older, irrigated district of Multan. The Chak No. 71 G. G., the number of the new village, is composed of roughly 80 squares (*murabbas*), each of which belongs to a family resident in the *abadi*. For irrigation purposes, these *murabbas* are laid out along a water course, which in most cases is accompanied by a village path or road providing access to the fields. Each of these squares is again divided into 25 *killas* which are irrigated from the distributary in the manner shown in the inset of Figure 13. Thus, every square down to a *kiari* is divided into squares and rectangles, giving the fields a pattern quite distinct from those of the old, settled areas. As against this planned pattern of canals, roads and field boundaries, the pattern in the case of older villages was disorderly and heterogeneous in nature. An example may be seen in the pattern of landholding in a village in Multan district, which is utterly confusing with each landholding divided into small splinters of all shapes and sizes.

Village Homestads: That every colonist must settle on his allotted land and build himself a house has always been the practice in India. However, during the British administration it was decided that as part of the colonization program the colonist should build a house in an ordered manner upon a spot fixed by authority. Such a consideration

was ultimately reflected in the government's outlining in each village estate a fixed site for the village *abadi* and a definite allotment of site to each individual.²² Although a few changes in the arrangement and execution of the plan did occur from time to time, the general pattern of village homesteads in canal colonies maintained a similarity in design and layout.

Generally, village *abadi* comprised one *muraaba* (square of 25 acres) and, in some cases where the village estate was large, a village covered as much as two murabbas. The village *abadi*, of a square or rectangular shape, was intersected generally by two great, open streets at right angles to each other and some 30 or 40 feet wide. At the

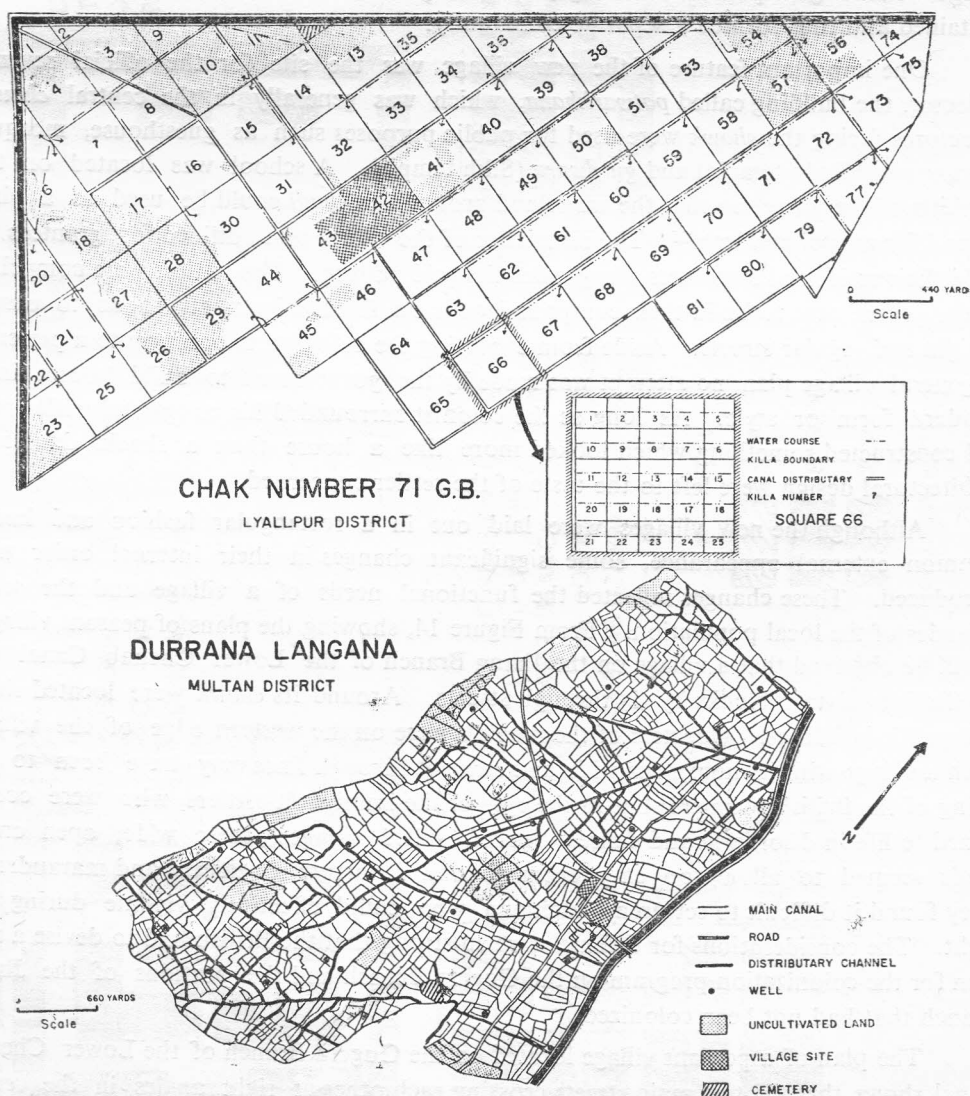


Fig. 11. OLD AND NEW VILLAGES

crossing of these two main streets was a plaza called the *chowk*, around which the shops and public buildings were generally located. In the center of the *chowk* was a well, which provided water for domestic use.

The four squares into which each *murabba* was divided were further partitioned off into a number of blocks.²³ Colonists were given from $1\frac{1}{2}$ *kanals* (30 *marlas*) to 3 *kanals* (60 *marlas*) for each square held, while shopkeepers and menials were allotted plots ranging from 6 *marlas* to 20 *marla*, all depending on the colonization project. The tenants received allotments averaging 20 *marlas* each. The colony of menials,²⁴ although not quite as detached as in the older villages, was generally to one side of the village. Although a part of the village, the colony of menials was as far as possible self-contained and thus formed a separate community.

One important feature of the new village was the site for the official revenue collector, the building called *patwarkhana*, which was generally in the central *chowk*. Structures facing the *chowk* were used for public purposes such as guesthouse, mosque, *dharamsala* (Hindu temple) and *gurdwara* (Sikh temple). A school was located on the outskirts of the village so that the wasteland around the *abadi* could be used as a playground for school children.²⁵ The remainder of the village was outlined for grantees to build their residential structures along a definite grid pattern. The settlers were compelled by the government to build their compound wells on fixed alignments so as to ensure straight and regular streets. Aside from expecting the colonists to conform to a prescribed general village plan, no attempt was made by the government to build houses in a standard form or style. As long as the colonist surrounded his compound with a wall and constructed something which looked more like a house than a shack, details of architectural design were left to the taste of the settler concerned.

Although the new villages were laid out in a rectangular fashion and had a common external appearance, some significant changes in their internal order were introduced. These changes reflected the functional needs of a village and the social attitudes of the local population. From Figure 14, showing the plans of peasant villages, it will be observed that a village on the Jhang Branch of the Lower Chenab Canal was divided into sixteen blocks by six through streets. Around its *chowk* were located shops and public buildings. Quarters of the menials were on the western edge of the village. Such a village with its numerous wide and straight through lines may have been to the liking of the British planners; but in the eyes of the immigrant settlers, who were conditioned to life in disorderly and densely-packed walled villages, these wide, open cross-roads seemed to allow too easy entrance and departure for thieves and marauders.²⁶ They found it difficult to set up a watchman who could effectively vigilate during the night. The considerations for defense were so strong that the British had to devise a new plan for the colonization program on the Gugera Branch and the portions of the Jhang Branch that had not been colonized.

The plan of a peasant village located on the Gugera Branch of the Lower Chenab Canal shows that the two main streets crossing each other at right angles in the center were the only through streets. The lesser number of exits in such a village facilitated the

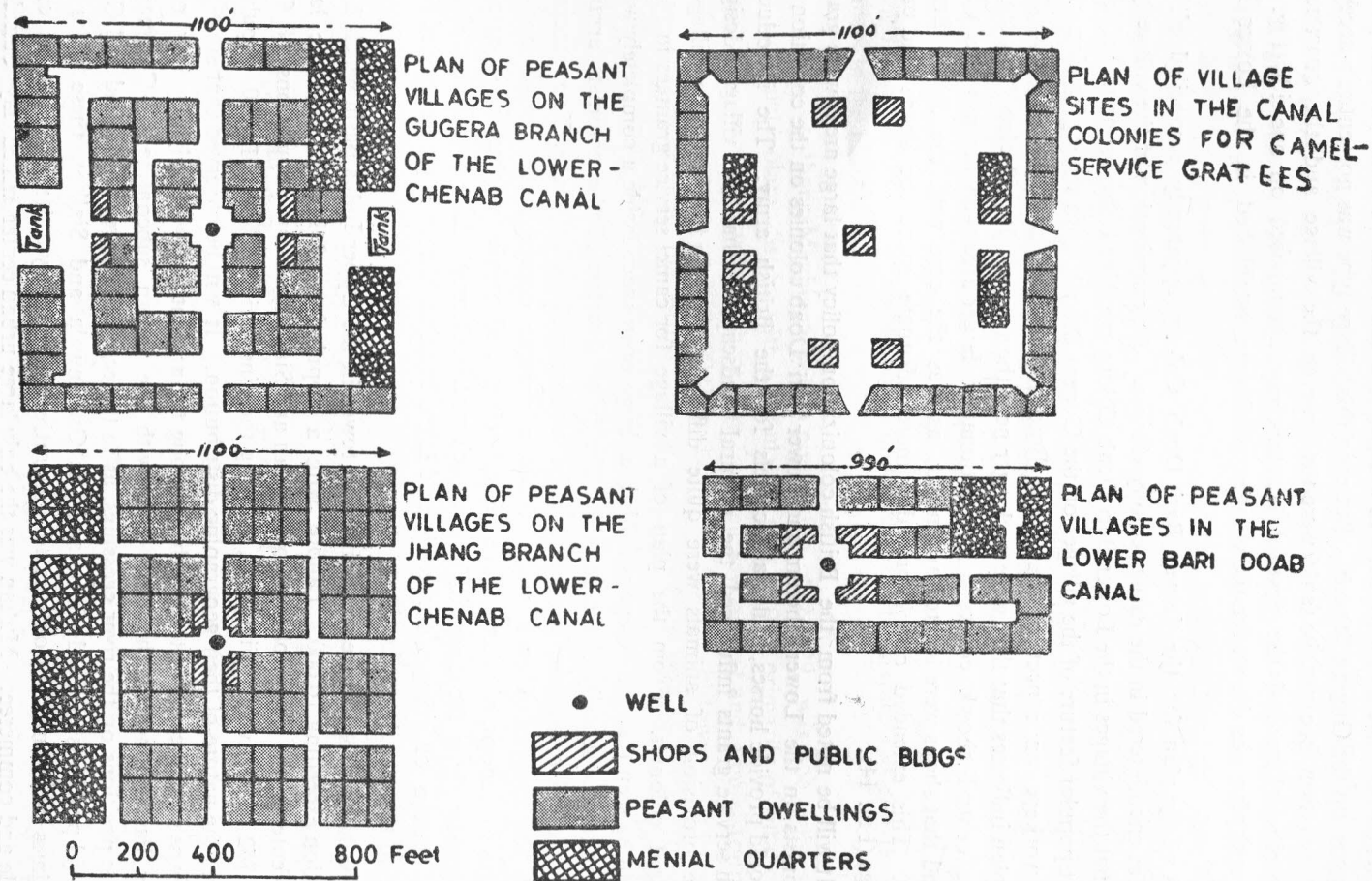


Fig. 12. VILLAGE PATTERNS IN THE CANAL COLONIES

work of watch and ward by night. The establishment of the shops at the ends of the main street rather than on the *chowk* was another important change in the internal plan of the villages on the Gugera Branch. But even this village type was not entirely accepted by the population, because the tanks were too close to the village and the quarters of the menial workers and the peasant grantees were juxtaposed on one side (Fig. 12). Thus, a new plan was drawn for the villages which were established in the Lower Bari Doab Colony.

A village plan for the Lower Bari Doab Colony apparently reconciled all the difficulties encountered in the earlier colony villages. An examination of the village plan shows that the villages in the Lower Bari Doab Colony combined the economy of exits, the most popular feature of the villages on the Gugera Branch, with the segregation of the menial workers, an aspect of the Jhang Branch villages. The absence of tanks in the village plan indicates that they were no longer near the village. It will also be observed that the central *chowk* covers a proportionately larger area than in the earlier village types and that shops were located around it, as was the case with the Jhang Branch villages. This extended *chowk* provided more adequate space for shops and public buildings (Fig. 14).

It will be noted from the British colonization policy that large areas were granted to colonists in the Lower Jhelum and Lower Bari Doab colonies on the condition that they would provide horses, mules and camels for the British army. The introduction of such service grants influenced the cultural landscape in that the villages designed for the provision of animals were quite different in design from the other villages in the canal colonies. From the plan of a village for camel service grantees in Figure 12 it will be seen that the village provided a large open space inside a completely walled enclosure for the security of the camels. The living quarters of the colonists, arranged in a rectangular fashion, formed a solid wall around the enclosure. Four gates were built in the middle of each wall. While a mosque occupied the central position, structures for shops, a school, revenue collectors and menial workers were arranged symmetrically along the inner rim of the enclosure. Although there were minor changes in the pattern of villages for mule and horse breeders, the basic plan remained quite similar to the one shown here.

As late as 1881, there were only nine towns in the Upper Indus Basin which had a population exceeding 10,000. Lahore, with a population of 149,369, was the largest urban center in the basin followed by Multan and Sialkot, having populations of 68,674 and 45,762 respectively. Figure 13, showing the nine cities of over 10,000 population, indicates the nature of their geographic distribution. It will be observed that six of these nine towns were located in the northeast along the ancient highway which by way of the Khyber Pass connected the Near East with the Indian subcontinent. Commanding strategic positions on the river crossings, as in the case of Lahore, Wazirabad and Gujrat, or central positions in the doab uplands, as Gujranwala and Sialkot, these cities from early times functioned not only as administrative and military centers, but also as centers of trade and commerce. Multan was the only large urban center which lay outside the

urbanized northeast. However, its development as an urban place may also be attributed to its strategic location on the Chenab River. Lying on the southern route from Afghanistan (through the Bolan Pass) into India, Multan from the Middle Ages acted as a commercial and military key to the basin. Between these two urbanized axes, *i.e.*, Lahore and Multan, the settlements that existed never developed beyond subsistence level and 10,000 in population.²⁷

The extension of irrigation by the British into *doab* lands and their planned settlement accompanied revolutionary changes in the urban pattern of the basin. Agricultural expansion not only meant the planned establishment of villages, but also organized development of towns and cities. Government authorities were of the opinion that to effectively administer the newly emerging rural communities and to properly dispose of their agricultural surpluses, the establishment of towns providing such services would be necessary. Therefore, the laying out of planned market and administrative centers connected by an efficient system of transportation became an important adjunct of the irrigation-colonization program. The policy of creating new villages and urban communities simultaneously brought about rapid changes in the nature and growth of urban centers in the basin.

In 1881, Jhang-Maghiana, with a population of 21,629, was the only settlement in the canal colony district with a population over 10,000, primarily of rural character. Only six decades later in 1941, there were fourteen new market and administrative towns, each with a population over 10,000 (Fig. 13).²⁸ Of these, eight towns were founded and developed entirely by the British during the years from 1881 to 1941. Three of these towns—Lyallpur, Montgomery and Sargodha—had already surpassed the 30,000 mark in 1941. Lyallpur, founded in 1896 as both an administrative and commercial center for Lyallpur district, underwent phenomenal population growth. From total of only 9,171 persons in 1901, its population increased to 69,930 in 1941, an increase of about 800 per cent in 50 years. Montgomery also had a phenomenal rate of urban growth, its population rising from 3,178 in 1881 to 38,345 in 1941. Sargodha, founded after the census of 1901, had in 1911 a total population of 8,849 which increased to 36,420 in 1941. Both Sheikhupura and Khanewal were newly founded towns and appeared for the first time in the 1921 census data. Sheikhupura's population increased from 3,487 in 1921 to 22,272 in 1941, while the population of Khanewal increased from 5,647 in 1921 to 17,036 in 1941. Okara and Nankana Sahib were established after the 1921 census and were the newest towns with populations of over 15,000 in 1941.

Population growth in the older cities was at a greater rate than ever before, although it compared poorly to the growth rate in the new urban centers. The increased rate of urban growth in the older cities was, however, consequent upon the irrigation expansion in the canal colonies. Lahore, still the largest city in the basin, increased its population from 149,369 in 1881 to 671,659 in 1941. The population of Multan, standing a poor second, increased from 68,674 in 1881 to 142,768 in 1941, followed closely by Sialkot where the population increased from 45,762 to 138,717.

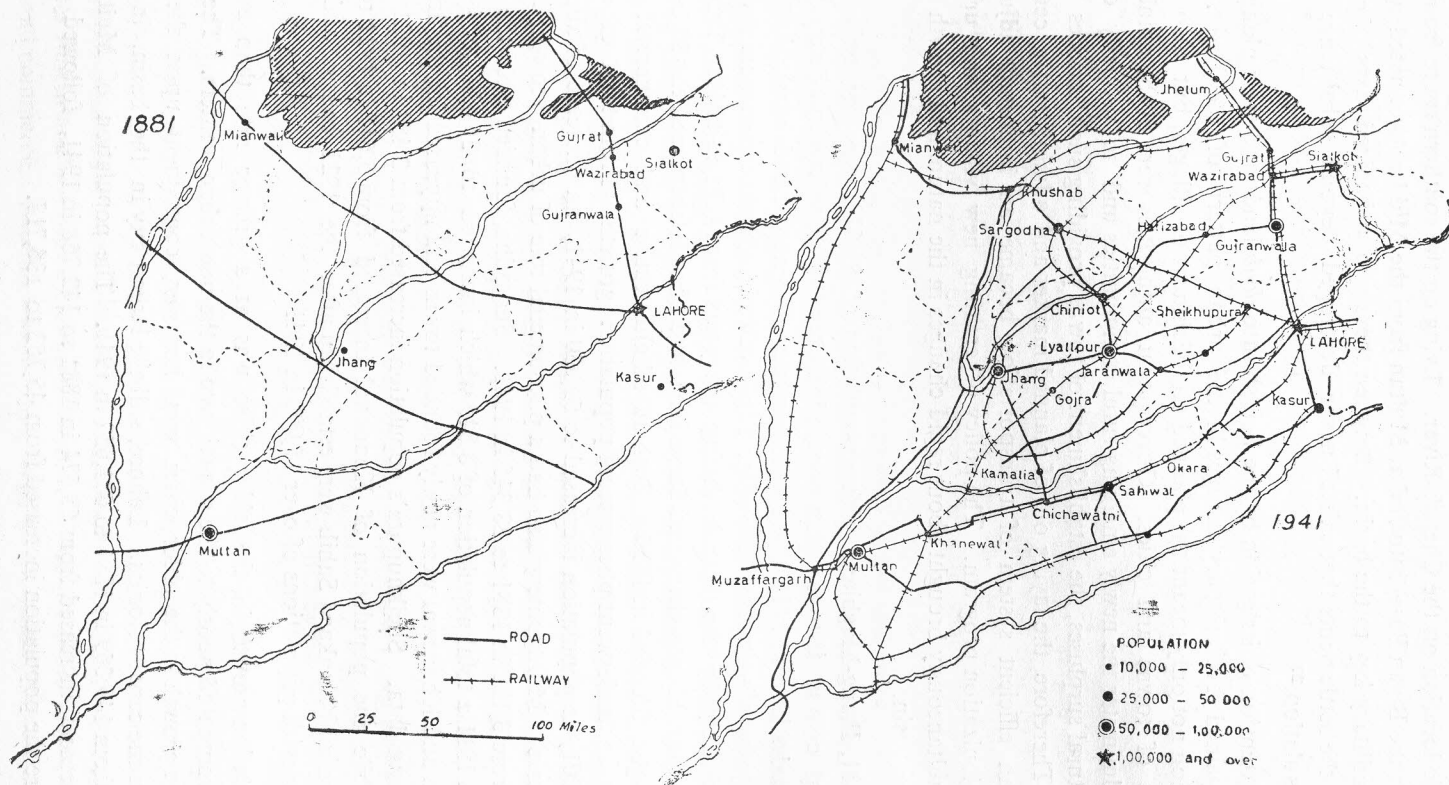


Fig. 13. URBAN AND TRANSPORTATION PATTERN

Location and Layout of Colony Towns

One distinguishing feature of the new colony towns was that none of them was located on a river.²⁹ Since they were to function primarily as market and administrative centers, it was thought necessary to locate them, as far as possible, on a railway line. The close relationship that exists between the railway and the colony towns can be estimated from the fact that all of the fourteen new towns were located on a railway line. These towns not only served as district or tehsil headquarters but also as grain markets. To avoid unhealthy competition, it was thought expedient to locate them at a distance from each other. Although no rigid policy was followed by the colonization officers, it was found desirable to allow from twenty to thirty miles between one town and another.³⁰ Each of these colony towns had a tributary area or a hinterland with a radius of ten to fifteen miles of perennially irrigated land. It was assumed that the agricultural surplus of the hinterland would be collected and distributed for export by the market town concerned. Thus, the planned development of market centers with the specific purpose of controlling and coordinating export trade initiated an era of commercialized agriculture and urban expansion in the basin.

The colony towns were distinct from the older urban centers in that they were designed and planned ahead of settlement. They were generally laid out in a rectangular design, and each block was demarcated beforehand for a specific function. The functional classification within a town was done with the purpose of creating a self-contained urban community, although markets (*mandi*), factories, school, hospitals, *etc.* were generally excluded from the block system of the layout (Fig. 14). The location of a *mandi* or a factory or an elevator was determined by the position of the railway line. Generally, they were located on the side of the town along which the railway line passed. As for the *dhobi ghats*,³¹ cemeteries, slaughterhouses and brick kilns³² these were located at a distance from the town. Commonly, a *gadda-khana*³³ was found near the *mandi*; the inn for travellers (*serai*) as close as possible to the railway station. The sweepers and cobblers' (*chamars*) quarters were located always at a short distance from the town.

As for the design of the colony towns, they were generally laid out in a rectangular pattern and can easily be distinguished from the irregularly grown old cities. However, Lyallpur, the earliest planned colony town, was designed like Madrid along a radial pattern with its streets radiating from the central square. In the case of towns constructed later on, a rectangular pattern was adopted. Although a rectangularly planned town had the disadvantages of numerous exits and of allowing hot winds and dust, from administrative and sanitation points of view they were found to be more desirable.³⁴

A town was functionally classified into three types of land use: (1) for residences, (2) for combined shops and residence and (3) for bazar shops (business district). The location of commercial and residential areas varied from town to town. Generally, one can say that the main bazar, consisting of shops only, was located around the central *chowk*; and the main streets which connected the *chowk* and the *mandi* were lined with combined shops and residences. The map for the town of Chichawatni, perhaps the best designed colony town, shows the general pattern of urban land use. It will be observed that most

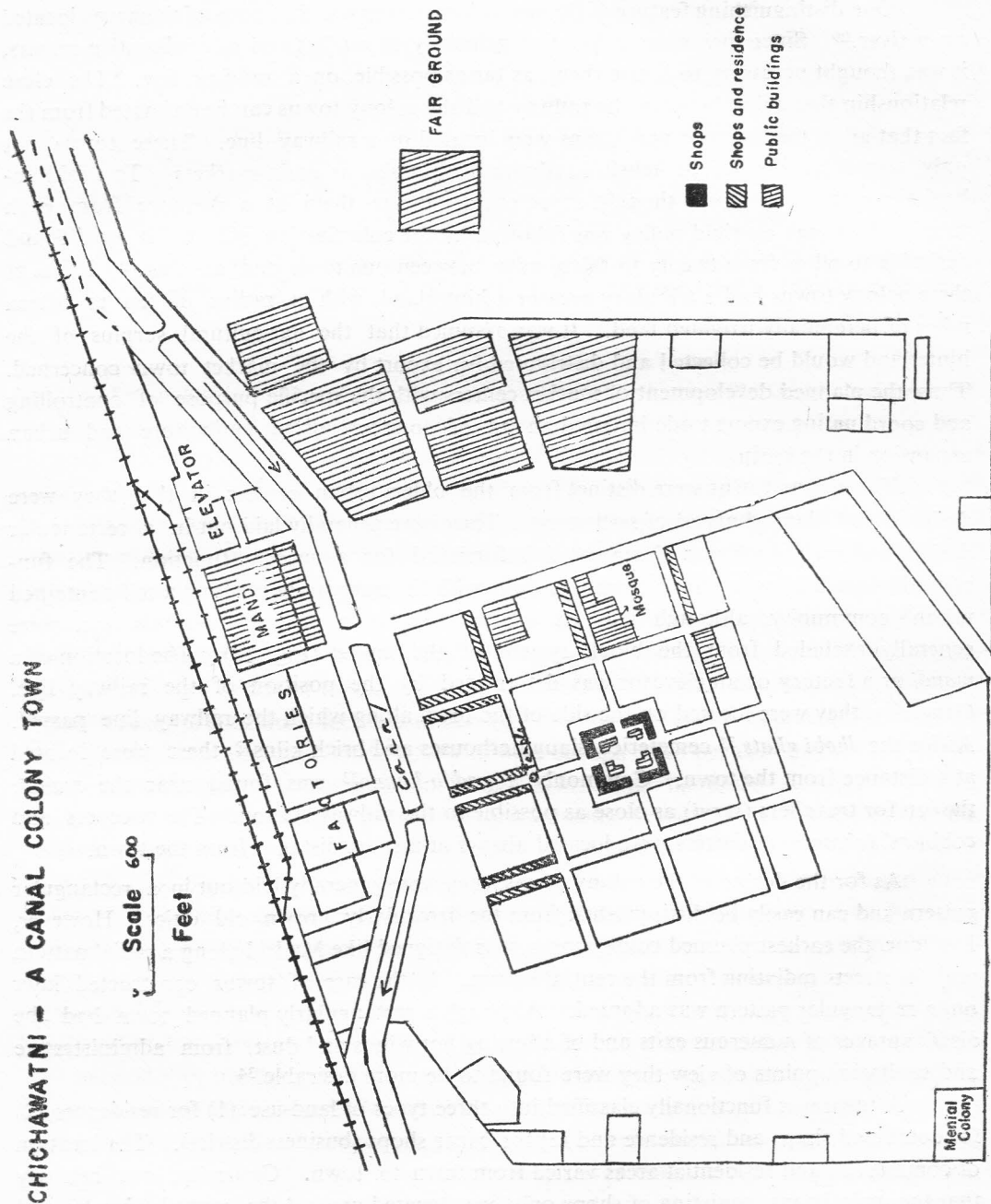


Fig. 14

of the shopping area is either around the market square or in the direction where the *mandi* and other public places such as schools, mosque and hospitals are located (Fig. 14). In towns which did not have a *chowk*, the bazar shops were arranged along the main streets. To encourage concentration of the shopping area along a street, the town planning committee saw to it that the main street followed the natural run of traffic and that it ran directly to the *mandi*.

TRANSPORTATION AND TRADE

Irrigation development and extension in the Upper Indus was accompanied by some revolutionary changes in the pattern of transportation and trade. The transport system that existed at the time of British occupation in 1847 comprised both road and river transport. The road transport system was land oriented in that it provided trade connections between India and the countries of Central Asia, Western Asia and Europe. The river transport system acted as a feeder to the cities or towns located on the land routed, oriented roughly in an east-west direction (Fig. 13). The existing pattern of transport and trade clearly was inadequate and ill-oriented for the purposes of the British, who entered India from the sea and were a maritime power. To them a sea-oriented transport system, which would connect the Indus Basin with England, was necessary before any commercial relationships could be anticipated.

The early experience of the British in irrigation had demonstrated great possibilities for agricultural expansion and trade. It was felt that reclamation of large, empty areas through irrigation could provide great quantities of surplus agricultural raw material for consumption in European markets and also provide possibilities for imports of finished products into the basin from England. However, the British soon recognized that no irrigation project intended to rapidly increase agricultural production could succeed financially unless efficient means for the distribution of that production existed in the area. Unless transport facilities were provided to carry surplus produce to distant markets, it would be of small advantage to undertake large irrigation projects to increase production. They naturally assumed that if the increased agricultural produce did not find a market, no profit would result from growing it, and it would not be grown.

Two important technological changes, both external to the region, that occurred in industrialized Europe contributed significantly to the development of the present regional pattern of transport and trade. First, railway and metalled (macadamized) roads that made their appearance in the early nineteenth century in England were introduced into the basin soon after its annexation. Second, the Suez Canal was opened in 1869 and the steamships, providing cheaper and faster transport, followed thereafter. The intricate network of railways in the basin made commercially possible the export of its agricultural surpluses to needy areas in the subcontinent and, together with the steamships, linked the agricultural system of the basin with industrial markets in England and Europe. While through the port of Karachi railway transport connected the distant places within the basin with markets abroad, the intra-regional movement of agricultural goods was facilitated by the construction of an elaborate network of metalled and bridged roads which

were largely ancillary to the railway network. Thus, it may be said that if it were not for the concomitant development of transport facilities by railways and roads, the irrigation extension program undertaken in the basin could not by itself have advanced far along the road to intensive agricultural development. It was the improvement of transportation and its linking with the overseas markets that really brought about the change from subsistence farming to the growing of commercial crops such as cotton, wheat, sugar cane and oilseeds.

Transportation Development

The initial impetus to the development of transport in the basin, however, derived from strategic and military considerations than from the standpoint of accelerating agricultural growth and trade.³⁵ The internal disorder and political instability that followed the Sikh rule, combined with constant fear of invasion from the northwest, necessitated an efficient and well-coordinated transport system. Therefore, soon after annexation of the basin the old highway connecting Peshawar with Lahore was hastily repaired and surfaced.³⁶ This highway was constructed to defend British territory against attacks from Afghanistan and Central Asia. Subsequently, a number of cantonments were established at strategic points such as Wazirabad, Lahore, Jhelum and Gujrat, from which reinforcements could easily be supplied in the event of an invasion from outside or an internal disturbance.³⁷ Even the railways, which were to supersede roads as the major means of transport, were laid out with a view to strengthening the military position. The first railway line, connecting Lahore and Multan, was completed in 1865.³⁸ Passing through the arid waste of the Lower Bari Doab, it was more a military connection than a trade route. In 1883, Lahore was connected to Peshawar by what was the most strategic route, which became known as the Trunk Line. The railway running south from Peshawar to Multan, completed in 1890, also was strategic in importance and almost a dead loss commercially.

The road and railway systems developed during the first forty years of British occupation were militarily a success in that they restored political stability in the British occupied area, but in time of peace their existence as purely military enterprises could not be justified economically. On the other hand, the early British experience in the Lower Chenab Project indicated that the success of an irrigation project depended greatly on an efficient means of transport in the canal colonies. It was thought seriously for the first time that there was no wisdom in pushing on the construction of canal ahead of the provision of transport facilities. Likewise, until there was the agricultural surplus to move, the building of roads and railways would hardly prove feasible. Thus, the extension of irrigation and the provision of an efficient transport system were considered interdependent and complementary in nature. It may, therefore, be stated that although initially the roads and railways were motivated by military considerations, when agriculture expanded as a result of irrigation development, they were extended more on the basis of economic and commercial considerations.

Railway and Road System: A Policy of Coordination

It will be remembered from the preceding text that the roads and railways built during the first fifty years of British administration in the basin were mainly of military significance, and whatever transport facilities were made available to the public were only incidental. The three railway lines connecting Lahore, Multan and Peshawar in the form of a triangle and two roads running from Multan and Peshawar parallel to the railway and converging at Lahore provided effective administrative control of the area but failed to accrue any economic benefit. It was realized that roads and railways running along each other duplicated transport facilities and tended to generate unnecessary and wasteful competition between rail and road transport. Therefore, the government was of the opinion that in the development of a transportation system, railways and roads should be regarded as complementary rather than competitive in nature. It was thought that the road system in future development schemes should be built with a view to linking the cultivators with the local markets and the nearest railway station, while the railways should be laid out as the connecting link between the area of production and a distant market.³⁹

The pattern of railway and road transport that evolved in the beginning of the present century illustrates to what extent the British government observed the policy of coordinating rail and road transport. An examination of Figure 13 will show that the railways and roads completed before 1900 constituted the major trunk lines on which a more elaborate transport system was built. The pattern of transport that evolved in the central canal irrigated districts was, however, distinct in that it established a certain hierarchy in the use of transport means. The railway lines built after 1890 served as the branches of the trunk lines that connected Peshawar, Lahore and Multan with the port of Karachi. These branches collected the agricultural produce from the different *doab* areas and exported it by means of the Trunk Line. The roads, on the other hand, were built in a manner to facilitate transport of agricultural goods to the railway station, thereby acting as feeder lines for the railways (Fig. 13). The new policy of coordinating rail and road transport was naturally directed towards increasing the competitive power of the railways, while it deprecated the importance of road transport and limited the possibilities for its expansion.⁴⁰ Thus, while the railway mileage in the basin increased from 410 miles in 1872 to 4,441 in 1920, the corresponding figures for road (metalled) mileage increased from 1,036 miles to only 2,938 miles.⁴¹

River Transport

The expansion of irrigation and the development of surfaced roads and railways meant a sharp decline in water transport and the building of ships and boats.⁴² Until 1880, the rivers of the Upper Indus system carried a busy trade and were important avenues of transport. The accounts of Lahore and Multan reveal that the Indus system had busy inland water transport and the boats in service were of considerable size; at Lahore, about 800 miles from Karachi, the boats were 60 tons and upward. However, because of a sharp decrease in the river level due to large withdrawals made by irrigation

anal combined with competition from railway and road transport, navigation by rivers virtually came to a stop.

TRADE AND COMMERCE

Improvement in transportation and irrigation expansion brought about a sharp change in the pattern of trade and commerce. The previous overland trade in precious metals and handicrafts with countries of Central Asia and Europe was superseded by an overseas trade complex that integrated the agricultural resources of the basin with the industrial economy of England. The export of agricultural products such as wheat, cotton, pulses and oilseeds to overseas markets converted the regional economy of the Upper Indus from a subsistence to a commercial type within a period of only fifty years. This rapid change may be attributed to the development of road, railway and sea transport, which helped interconnect the Upper Indus Basin with the overseas markets.

The trade and commercial relation that were maintained between the Upper Indus Basin and the western world is indicative of the mercantilist policy of the British government. The fact that the whole regional economy was made to complement that of England, whether as market or as source of agricultural raw materials, brought about a complete reversal in the basin's pattern of trade. Until the beginning of the nineteenth century, its chief exports were "specialized goods" such as indigo and salt and manufactures of fine quality and workmanship such as cotton and silk piece goods. In return, specie, woollens, "novelties" and other special manufactures were imported.⁴³ By the end of the nineteenth century, the overseas trade relations between England and the Upper Indus Basin had become entirely different from those existing in the early nineteenth century. The surpluses of wheat and the summer cash crops made available by large irrigation projects became important articles of export. The export of wheat on a large scale for consumption in England was made possible by the opening of the Suez Canal, and by the 1880's it headed the list of exports. The exports of summer cash crops, among which raw cotton, oilseeds, sugar cane and rice were important, also increased rapidly.

The introduction of a cash crop economy naturally affected the local industry. The cheaper Lancashire cotton goods, made of raw cotton imported from the Indus Basin ousted the previously coveted muslin goods from European markets and even invaded the Indian and Far Eastern markets. Other imports, besides manufactured goods, included gold and specie, which continued to be important, and other manufactured items such as machinery, millwork and various types of metal products. Thus, it may be argued that while the British trade policy vastly increased the overseas trade of the basin, it turned the basin from an exporter of artistic manufactures and greatly demanded specialities into a source of foodstuffs and raw materials for an industrializing England and other European countries.

The nature and order of trade that developed in the Upper Indus Basin during the British administration can be judged from Table 4. Although the data given are for the whole basin, formerly the Punjab province, it gives the basic impression about the scale

on which foreign trade was carried out. It will be observed that the export trade showed a proportionately more rapid increase than the import trade. Exports from the whole basin increased in value from Rs. 37,300,000 in 1882 to Rs. 440,500,000 in 1919-20, showing twelve times as much increase. The imports into the basin, on the other hand, increased from Rs. 71,000,000 in 1882 to Rs. 528,700,000 about eight times as much increase during that period.

TABLE 4.—*Foreign trade of the former Punjab Province** (1882-1920)

Year	Imports		Exports	
	Weight (mds.)	Value (Rs.)	Weight (mds.)	Value (Rs.)
1882—83	6,300,000	71,000,000	10,300,000	37,300,000
1892—93	12,200,000	92,000,000	16,000,000	69,400,000
1902—03	25,100,000	154,600,000	24,900,000	115,000,000
1911—12	55,100,000	298,400,000	56,600,000	268,800,000
1919—20	65,500,000	528,700,000	41,300,000	440,500,000

*The figures for value were recorded in the former Punjab province; thus, the value of imports presumably includes the cost of transport to the market, while the value of exports is exclusive of this item. Source : Hubert Calvert, *The Wealth and Welfare of the Punjab*.

The export of wheat to markets outside the basin has always been the major item of the trade complex. However, large quantities of surplus wheat became available only when extensive irrigation works were undertaken. Between the years 1886 to 1895, that is before the opening of the Lower Chenab Canal, the available surplus wheat amounted to only 278,000 tons a year. Only a decade later in 1905, the surplus wheat available for export amounted to 1,193,388 tons, 39 per cent of the total production under wheat. Of this surplus wheat, 1,136,447 tons or 37 per cent was exported through Karachi to overseas markets, while only 2 per cent was distributed in India outside the basin (Table 5).

TABLE 5.—*Internal and external trade in wheat of the former Punjab Province** (1901-1920)

Year	Total Production (in tons)	Total Net Exports (in tons)	Exports to Karachi (Practically all of which went overseas)	Balance of Exports to Places in India, other than Karachi, outside the Basin
1901—02	1,834,484	525,894 (29%)	424,373 (23%)	101,521 (6%)
1903—04	3,062,030	1,193,388 (39%)	1,136,447 (37%)	56,941 (2%)
1906—07	2,641,285	1,164,933 (44%)	826,101 (31%)	338,832 (13%)
1909—10	3,607,774	978,400 (27%)	881,300 (24%)	97,100 (3%)
1912—13	3,242,375	948,529 (29%)	756,273 (23%)	192,256 (6%)
1915—16	2,481,296	878,646 (35%)	694,880 (28%)	138,766 (7%)
1917—18	3,425,500	648,001 (19%)	331,490 (10%)	316,511 (9%)
1919—20	3,884,372	965,775 (25%)	439,075 (11%)	526,600 (14%)

*Source : Hubert Calvert, *The Wealth and Welfare of the Punjab*.

The year 1906-07 was the peak year when 1,164,933 tons or 44 per cent of the total wheat produced in the basin was exported. Of this, 826,101 tons or 31 per cent was for consumption in overseas markets, whereas 338,832 tons or 13 per cent was consumed within the subcontinent. Although the figures and percentages for wheat exports have varied considerably, as is evident from Table 6, the trend of more and more wheat consumption within the subcontinent is apparent. The change can be seen from the figures for the year 1919-20, when despite the fact that acreage under wheat was the largest since 1901-02, only 439,075 tons or 11 per cent of the surplus wheat was exported from Karachi, while 526,700 tons or 14 per cent of the surplus wheat was consumed within India. This in turn shows the increasing pressure of population on the available food resources.

CONCLUSIONS

An analysis of agricultural data has shown that irrigation during the British period attained great importance. In 1891, only half of the total cultivated land was under irrigation, while in 1946 nearly 80 per cent was irrigated. This expansion was attained largely by building an intricate network of canals which meant a relative decline in importance of well irrigation. In 1890, 60 per cent of the total irrigated land was under irrigation from wells, while in 1946 they accounted for only 22 per cent of the total irrigated area, while 78 per cent was watered by canals.

British irrigation expansion also brought important changes in the pattern of agricultural land use. In the new crop complexes that evolved, an increase in the relative proportions and values of the *kharif* crops was witnessed. Although both *rabi* and *kharif* crops showed a continued increase in acreage, the increase under *kharif* crops was proportionately greater. In 1905, *kharif* crops occupied 25 per cent of the total cropped land, while in 1946 they had risen to 40 per cent. The increased acreage under such summer crops as cotton, rice, sugar cane, and oilseeds, paved the way for the introduction of a commercial agriculture hitherto unknown in the basin.

Irrigation development brought in its train a rapid increase of population in the basin. It has been shown that in the thirty years between 1891 and 1921 the population increase in the canal irrigated districts was at a phenomenal rate, while the densely settled northeastern districts showed a decline. The migration of new colonists from the overpopulated districts into the *doab* upland districts, combined with better health and economic conditions, contributed to the rapid population increase in the canal colonies. However, following the year 1921, while the population in the canal colonies continued to grow at a rapid rate, the population of the northeastern districts also began to increase as rapidly as in the canal colonies. The fact that population densities in the northeastern districts were much higher in 1941 than in 1901, shows that the policy of the government to reduce pressure on land by shifting population to new irrigated land proved only a temporary solution to the problem.

The planned program of colonization that the British Government undertook left a strong imprint on the settlement pattern of the basin. It has been demonstrated that

the nature and arrangement of farms, villages and irrigation canals in the new colonies are distinct from those existing in the older settlements. Properly outlined villages, rectangular in shape, stand in contrast to the irregularly shaped traditional villages. The planned establishment of new *mandi* towns as market centers was another feature of distinct change in the morphology of landscape in the basin.

The development of planned *mandi* towns was accompanied by the building of an efficient transport system. The networks of railways and metalled roads were so designed that they tended to complement each other in the transport of agricultural raw materials to the port of Karachi, enroute to overseas markets. While the roads helped move the surplus agricultural produce to the *mandi* towns, the railways, on which the *mandi* towns were located, carried them to Karachi for their ultimate shipment abroad. It was on the basis of this planned system of transportation that the agricultural economy of the Upper Indus Basin became integrated with the industrial markets of England and Europe. The export of cash crops such as wheat, cotton, rice, sugar cane and oilseeds to overseas markets converted the regional economy of the basin from a subsistence to a commercial type.

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1. The Statistical Department of British India published annually a report on the agricultural statistics on both the provincial and district levels. The agricultural data in this study have been primarily obtained from India, Statistical Department, *Agricultural Statistics of British India*, 1890-91, 1905-6, 1910-11, 1915-1916, 1920-21, 1925-26, and 1930-31 (Calcutta: Office of Superintendent of Government Printing, India).
2. It may be pointed out in the case of Jhang district that in 1890-91 it included the present district of Lyallpur, which was then irrigated extensively by the Lower Chenab Canal.
3. The percentage increase in the case of Gujrat district can be explained by the fact that during this period extensive areas were brought under irrigation by the Upper Jhelum Canal.
4. Great Britain, Royal Commission on Agriculture in India, *op. cit.*, p. 343.
5. *Ibid.*
6. Roberts and Singh, *op. cit.*, p. 140.
7. Hubert Calvert, *The Wealth and Welfare of the Punjab* (Lahore: Civil and Military Gazette Press, 1922), p. 147.
8. *Ibid.*
9. As suggested by Roberts, if we take Rs. 10 per *maund* (approximately 80 lbs.) as the average of cotton, the total value of the cotton crop in 1946-47, including the Indian part of the basin, would not amount to less than Rs. 180 million as against Rs. 520 million from wheat if priced at Rs. 5 per *maund*. See Roberts and Singh, *op. cit.*, p. 414.
10. *Ibid.*, p. 253.
11. The agricultural impact of the construction of the Lower Chenab Canal, which had been partially completed, was already evident in the district of Lyallpur, through which it largely ran. Before the construction of the canal, only a few hundred acres of land were under cultivation, lying largely along the Ravi River. The Lower Chenab Colony really began to operate around the beginning of the 20th century, and according to the census of 1905 there was already about a million acres under cultivation. But this change was conspicuously localized in the district of Lyallpur. As against this, the adjoining districts of Jhang and Montgomery each had 435,365 acres and 411,917 acres respectively. It must be remembered that water

available from the combined rivers of the Chenab and Jhelum, in the case of Jhang, and the Sutlej and Ravi in the case of Montgomery, had brought large areas under inundation irrigation.

12. The acreage shows the increase under oilseeds already made as a result of the completion of the Lower Chenab Canal before the census was undertaken. The acreage in fact must have been much less than that if this canal had not as yet been in operation.

13. Indeed, Sialkot showed a considerable increase in rice area between the year 1905 and 1946, increasing from 5 to 11.6 per cent. However, this increase did not occur so much due to irrigation as to the fact that rice had become an important cash crop in the canal districts and thus acreage under it was expanded at the expense of the other crops.

14. All the data on population in this study are based on India, Census Commissioner, *Census of India, The Punjab*, 1881, 1891, 1901, 1911, 1921, 1931, 1941, (Calcutta: Superintendent of Government Printing) and Pakistan, Office of the Census Commissioner, *Census of Pakistan, The Punjab*, 1951 and 1961 (Karachi: Manager of Publications).

15. *Census of India, The Punjab*, 1911.

16. *Census of India, The Punjab*, 1931, p. 63.

17. *Ibid.*

18. Paustian, *op. cit.*, p. 87.

19. It may be pointed out that a rapid increase of 32.9 per cent in the case of Montgomery and 28 per cent in the case of Multan may be attributed to the benefits that the districts gained from the completion of the Sutlej Valley Project in 1926 and the Haveli Canal in 1940.

Source: *Census of India, The Punjab*, 1881, 1891, 1901, 1911, 1921, 1931, 1941.

20. The reason for this decline was mainly that in 1901 nearly 103,390 settlers, who immigrated into the Lower Chenab Colony, indicated their district of origin as Sialkot, while 25,352 came from Gujrat district.

21. Beazley and Puckle, *op. cit.*, p. 159.

22. The earlier conditions for the Lower Chenab Colony merely laid down that the tenant should settle permanently on the estate where his lands were located. This, however, was vague in meaning and the settlers in earlier parts of the scheme started to build their homesteads on their own allotments, thereby tending to create a dispersed pattern of settlement. The government soon realized that such settlement conditions would be administratively inconvenient and not conducive to the creation of a homogeneous village community. At the beginning of the 20th century, therefore, it was decided that "the tenant shall build a house on a site allotted to him by the collector or, with the permission of the collector, on his own land." This condition postulated fixing an *abadi* site for the colonists in a village. See Beazley and Puckle, *op. cit.*, pp. 213-14.

23. The internal distribution of the land for building sites on the Rakh Branch of the Lower Chenab Canal was left to the colonists, who carved out their own irregularly shaped compounds at will. Such random occupation of sites had its obvious disadvantages, and for peasant village on the Jhang Branch a standard plan was devised in which areas of each compound were laid down.

24. The menial workers in the villages are generally the blacksmith (*lohar*) carpenter (*tarkhan*), sweeper (*chuhra*), washerman (*dhobi*), barber (*hajjam*), potter (*kumhar*), cobbler (*mochi*), waterman (*maskhi*).

25. Beazley and Puckle, *op. cit.*, p. 218.

26. *Ibid.*, p. 214.

27. Jhang-Maghiana on the Chenab was the only exception with a population of 21,629, but in fact it was an overgrown village.

28. According to the census definition, urban areas include municipalities, civil areas and cantonments not included within municipal limits, etc. and any other continuous collection of houses inhabited by not less than 5,000 persons, which census authorities treat as urban for census purposes. However, in this study only those urban areas are included which were either administrative or market centers.

29. Chiniot is not a new colony town, but is in fact an old settlement. It had a population of 15,685 in 1901, while in 1941 it had risen to a total of 34,437.

30. Beazley and Puckle, *op. cit.*, p. 255.

31. A *dhobi ghat* is generally located on a water course, canal or a tank where washermen wash clothes for the residents of the town. The *dhobi* (washermen) settlement is generally found near to the washing site.

32. Generally, a town site is selected where the possibility for getting soil for the purposes of brickmaking exists. At these sites, a brick kiln is built, which makes bricks for construction work in the town.

33. A *gadda-khana* is an open space which is used for leaving carts during the market hours.

34. Beazley and Puckle, *op. cit.*, p. 256.

35. Trevaskis, *op. cit.*, p. 223.

36. The northern part of the basin has for centuries been the great highway for armies, traders and travellers from Central Asia, the Middle East and Europe. A highway was originally laid out by Sher Shah Suri, the Emperor of India, in the 16th century and later was developed by the Moghals, who used the highway for military campaigns as well as trade.

37. Spate, *op. cit.*, p. 479.

38. Calvert, *op. cit.*, p. 53.

39. The Royal Commission report on agriculture in India illustrates the government's policy towards coordinating road-rail transport in these words, "Without good and efficient roads no railway can collect for transport enough produce to render its operation profitable, while the best of roads cannot place the producers of crops destined for markets overseas or in distant parts of the sub-continent in touch with the consumer. We trust that it may be found possible in the future to avoid in India the senseless and wasteful competition between rail and motor traffic that is today taking place in many European countries. We apprehend that, where roads exist parallel to railways, it may be difficult to arrange for a policy of cooperation between the two forms of transport. But in planning new programs of road and railway extensions, we hope that roads may be designed to serve rather as feeders of the railways than as competitors for such traffic as the railway is capable of carrying efficiently and economically." See Great Britain, Royal Commission on Agriculture in India, *op. cit.*, p. 377.

40. G. B. Jathar and K. G. Jathar, *Indian Economics* (London: Oxford University Press, 1957), p. 239.

41. Calvert, *op. cit.*, p. 54.

42. N. H. Moreland, *India at the Death of Akbar* (London: Macmillan and Co., Ltd., 1920), p. 167.

43. Vera Anstey, *The Economic Development of India* (4th ed.; London: Longmans, Green and Co., 1952), p. 330.

MULTAN : PHASES OF URBAN GROWTH

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LOCATED within a narrow Mesopotamian region, formed by the converging tributaries of the Indus, Multan's origins and traditional functions as a trading post, belong to antiquity. Tradition identifies the present site with the strong city of the Mallis, stormed by Alexander in 327 B.C. A well established trade route, from Hindustan to Persia and Afghanistan, passed through it and Multan has been a leading trade centre for centuries, throughout the Mughal period.¹

THE CITADEL AND THE WALLED CITY

Foundations of Multan appear to have been laid on two raised mounds of earth, separated by the intervening bed of the river. The northern mound with its citadel containing the fort, ancient temple of the Sun-god, and later tombs and monuments was and is still a distinct landscape-piece, detached from the city. The city itself, separated from the citadel by depression of the river bed in the north, was enclosed by a brick wall on the remaining three sides. The Ravi clinged to its ancient watercourse and, in seasons of high flood, found its way up to the city, as late as the first decade of this century,² by way of its abandoned bed.³

Fig. 1 is a reproduction of an old sketch of Multan which depicts the old city environs well. There were few habitations outside the walled area, and inside pattern was arduously congested. A wide approach⁴, rising from Husain Agahi in the north, led to the main Chowk Bazar for a depth of half a kilometer, inside the walled core. At the termination of Chowk Bazar stands Masjid Wali Muhammad, built in 1757, with attached shops on three sides. From here three narrow bazars, each specializing in different items, trifurcated and led to three different openings (gates) towards the south and southwest. Among these the Harem Gate Bazar with general merchandise, attires and perfumery shops was more alluring to the customers.

EVOLUTION OF MULTAN'S TOWNSCAPE DURING BRITISH PERIOD

Multan city was the last major outpost conquered by the British in 1849, to establish their sway over the Subcontinent. Mulraj, the Raja of Multan, though paying tributes to the Maharaja at Lahore, had defied British authority and resisted even after the fall of that city. However with the establishment of British Rule, a cantonment and municipality for Multan was created in the same years as that for Lahore, i.e. 1853 and 1867 respectively. But here, the municipal limits did not embrace large areas as the city itself was very compactly built and there were very few suburban localities. Unattractive climate and semidesert environs were prohibitive factors in the growth of the town till the extension of cultivation through canals was established. However, when the hinter-

land of Multan became a district of cotton, sugarcane and cereals, with emerging Mandi towns like Khanewal, Mian Chunnu, Vihari, Jahania and Burewala etc., in the vicinity, the city prospered in many spheres. Development of irrigation and extension of cultivation also checked intensity and frequency of dust-laden windstorms, which have been among proverbial characteristics of Multan.

Multan's physical growth during the British period could be evaluated as an outcome of two important functions, administration and trade. As the two functions involved governmental and private participation, a duality of emerging patterns is much in evidence. Multan's Town Improvement Trust came into existence at a very late stage (1944), when haphazard suburban growth had already taken roots.

ADMINISTRATIVE CONSOLIDATION AND TOWN EXPANSION

Construction of a Circular Road around the city was first to come, but in case of Multan the wall was retained intact, along most of southern and southwestern side, as *alang* or raised passage. As the inner city itself occupies raised surface, its removal would have exposed the foundations of many buildings and structures.⁵ Thus, as a matter of fact there are two roads along the southern periphery of the old city, an outer road (on the outer general level) and an inner road following the raised level (6 to 8 metres high) but conforming to the ground level of the interior. The archways of four, out of six city gates are retained till today and the road entrances through these archways climb up to make the difference in outer and inner levels.

It was outside the walled city that new morphological patterns were introduced. The Cantonment was naturally the first planned locality, established 6 kilometre to the west of the old city. Grid plan of the streets, roadside greens and parks, a Mission hospital and an Anglican church building became the standard landmarks of the new locality. The Civil Station area, which grew later, along Abdali Road and Bahawalpur Road, was nearer to the Cantonment than the city itself. A small railway colony, (adjacent to cantonmen railway station), Divisional Offices of North Western Railway, and marshalling yards were other planned additions of this period.

A large flour mill with labour quarters, and a Metal Works, producing metal trunks, despatch boxes, surgical instruments and hospital requisites were the first but important manufacturing concerns established in 1880's.⁶

CHANGED PATTERN OF TOWN ECONOMY AND CONSEQUENT TOWN GROWTH

Till the early years of this century, the main economic function of Multan city was overland trade. The Kandhar traders used to bring fruit, drugs, raw silk and spices which traders from Multan then passed on further to the east. The items of purchase for Afghani traders were indigo, European and country cotton cloth, sugar and shoes. Multan's locally manufactured goods were chiefly silk, cotton cloth and carpets. Country shoes were also manufactured in great numbers, mainly for export. Apart from this caravan trade with Afghanistan and Persia, Multan had its traditional links with other

towns of the Indus Valley via the rivers. Till the coming of railways, large quantities of raw produce were shipped by country boats from Sher Shah, the port of Multan to Karachi via the Indus mouth.

Ancient trade links were greatly affected by the introduction of railways, while the prosperity of the surrounding new towns and colony chaks effected a great change in the nature and type of trade goods. Hosiery goods and coarse cloth manufactured on traditional handlooms changed the design and pattern of trade as better quality cotton became locally available. Internal regional trade became more attractive and old caravan trade links weakened as efficient means of transport became established within the hinterland and with overseas British lands.

With increase in city's population, new residential localities grew outside the walled city in great number. This growth was phenomenal along Railway Road where small manufacturing units and wholesale dealers in country goods had established their shops. However, all such extensions were unplanned and haphazard. Even Nawan Shehr (New City) a locality nearer to the Civil Station, grew in congestion and without any serious street plan, shopping or civic provisions.

In 1938 a scheme for cooperative housing was proposed by the then Municipal Commissioner, but his plea to develop a modern residential locality in the suburbs of the city remained unheeded.⁷ However, later in 1944 the provincial Government established Multan Improvement Trust to look after the town's growth.

MULTAN'S GROWTH SINCE INDEPENDENCE

Soon after its inception, Multan Improvement Trust found its schemes to be of much demand as a new chapter in history began with the exit of the British. The influx of refugees in 1947 and subsequent expansion of trade, industry and commerce warranted development of several residential localities, educational buildings, shops and industrial concerns. One of the earliest schemes drawn by the Trust was thus immediately taken over by the Provincial Administration and developed as one of the first satellite towns in the province, named as Mumtazabad.⁸ The growth of this locality did not proceed according to expectations as it was located quite apart from the main city, across the railway line. Later schemes were nearer to the city and many were drawn to fill in uninhabited pockets between the city and cantonment area. Among these, Hasan Parwana Colony, a residential cum commercial locality, occupies a central position and has been speedily developed mostly by middle class tradesmen.

Before considering the second satellite town and other residential extensions, mention must be made of the founding of the Nishtar Medical College to the north of the Civil Station in 1951. This Medical College, with attached hospital, staff quarters and students' halls of residence form a compact modern sector in the morphology of Multan. In early 1960's construction of new buildings for the Government College, Teachers Training College with attached school, and hostels for these institutions covering an area of 37 hectares, brought another compact addition of public institutions to the growing city.

A couple of years before the development of the later educational institutions another residential scheme Gulgasht (Satellite town No. 2) was executed on the western side of Bosan Road. This area being nearer to the city (about 2 kilometers) not only became a quick-success itself but many other small residential colonies sprang up concurrently.

The Karachi-Lahore Highway forms a distinct divide to the north of which are the major planned extensions as compared to unplanned growth immediately in the neighbourhood of central city. (See Fig. 2). The Cantonment itself, Civil Lines, other administrative offices and District Courts, smaller residential quarters like Lawyers' Colony, Pir Khurshid Colony, Gulgasht and the newly developed educational campus, all are on or nearer to the northern side of the Highway. Other institutions located at different points along this highway are the main Bus Station, Central Telegraph Office, many cinemas and hotels. Old Emerson College opposite the District Courts on this road has been taken over by Government College for Women. This sectoral differentiation is in sharp contrast to southeastern sector where unplanned growth has continued unchecked.

Multan's new expansion will assume more linear pattern than what has appeared upto now. Expansion towards the east along the Highway is already in progress and New Multan Township is planned along this road. New Multan Township is to cover 105 hectares for the present. It is located south of the Highway as a logical extension of town's other northern extensions. However, opposite to this area, on the other side of the road, some residential and industrial concerns have already appeared on private agricultural land. This whole area fell outside the municipal boundary till recently.

Keeping in view the fast pace of city's physical expansion, the Provincial Town Planning Department has established a Master Plan Organization for the city. The plan is to consider possible avenues of growth for a 20 years period ; (i.e. up to 1885) when the estimated population of Multan would be 1.7 millions.⁹

URBAN ECONOMY AND ROLE OF HANDICRAFTS AND COTTAGE INDUSTRIES

Age old traditions of handicrafts and other local manufactures play an important role in the economy and employment characteristics of Multan. Among these, the production of glazed and coloured tiles known as 'Kashi Kari' has declined as there is little demand for the same in modern architecture. However, the few remaining craftsmen of Multan have adapted their skills to the making of decorative vases, bowls and plates. Lacquered wooden toys, cosmetic boxes and other attractive goods of different patterns are also produced in great numbers. However, among the handicrafts typical to Multan only, are the products made from camel skin. Lamps, shades, vases, animal figures and other decorative pieces are made by moulding pulp of locally treated camel skin into different shapes. These goods are light in weight with exotic colour patterns, all done by hand. The art is confined and practised by a few families of craftsmen, who also engage in selling of their products.

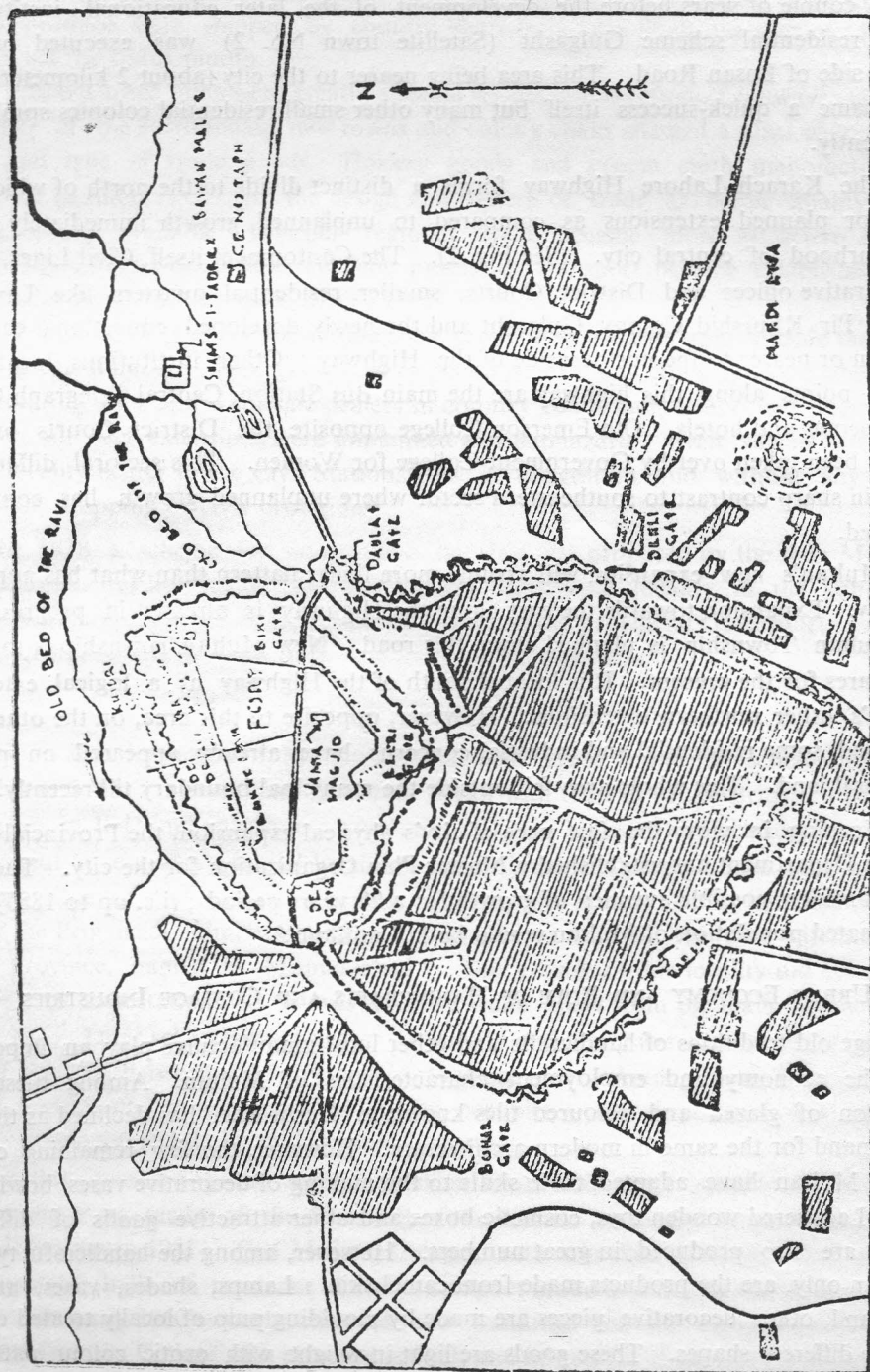


Fig. 1

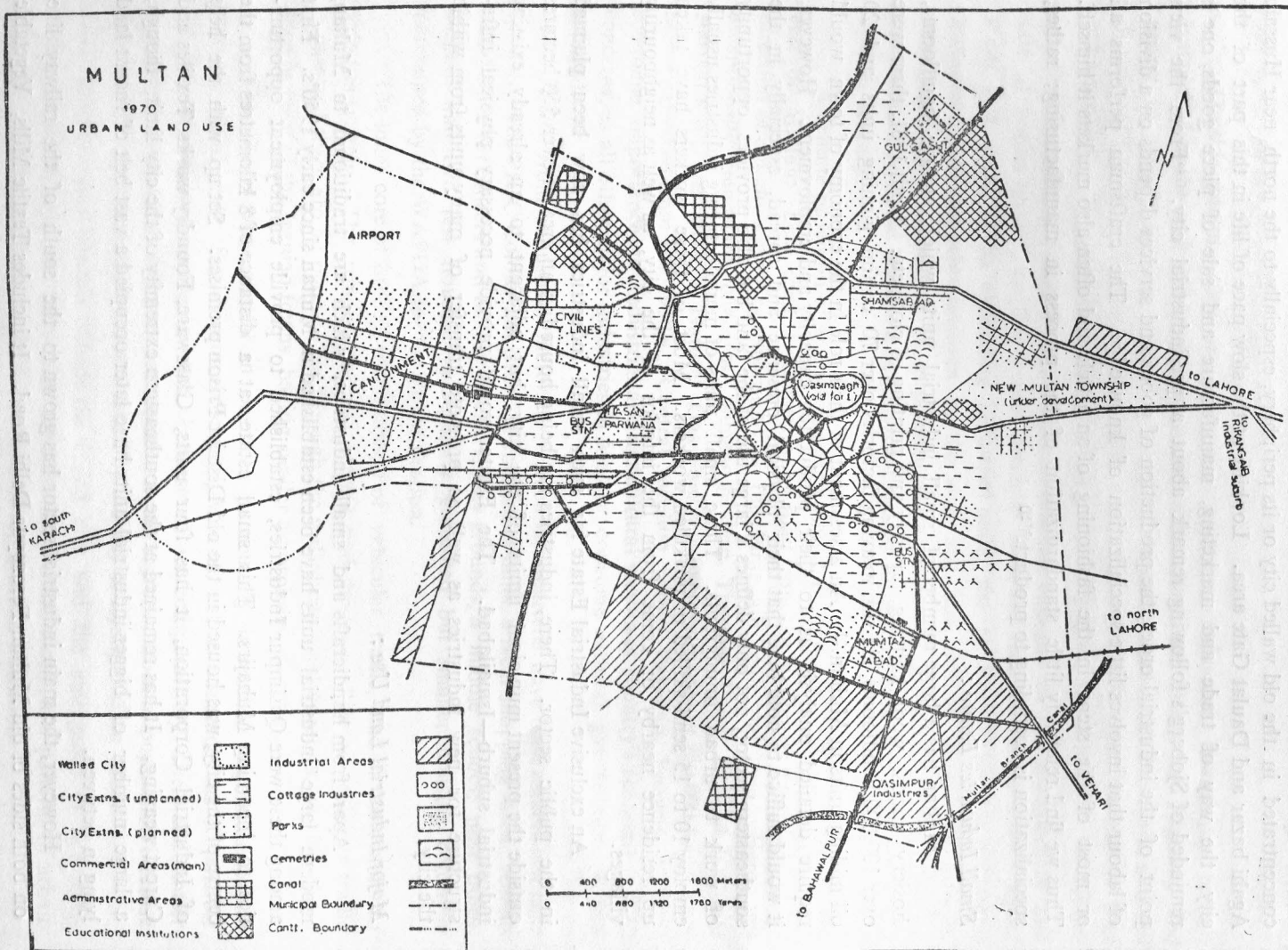


Fig. 2

The handicraft workers, their homes and hearths, as also their sales shops are concentrated in the old walled city or its periphery, especially to the north, near Hussain Agahi bazar and Daulat Gate area. Looking at the slow pace of life in this part of the city, the way of trade and marketing, manufacture and sale of piece goods, one is reminded of Sjoberg's following remark about a pre-industrial city. "From the view point of the industrial order, the production of goods and services depends on a division of labour that involves little specialization of knowledge. The craftsman performs all or most of the steps in the fashioning of an article and often also markets it himself. Thus we find relatively little standardization of the process in manufacturing; rather, specialization is according to product."¹⁰

Small Industries Estate :

Multan has a large number of small industrial units which include handlooms, hosiery goods, wool knitting, tapestry and printing of cloth etc. Uptil 1961, there were over 100,000 handlooms, six silk weaving factories over 70 cotton ginning units and 20 oil milling units in Multan.¹¹ An assessment of their role in the economy of town would require detailed analysis as to their production capacity and employment. However, it would suffice to note here that their physical presence and spread, especially in the southeastern sector, not only defines a large use of the land but also provides opportunity of work to urban immigrants. These small units of manufacturing industries usually employ 10 to 15 semi-skilled or unskilled workers. Most of these workers have taken up residence nearby or come from the interior of the city, as well as neighbouring villages.

An exclusive Industrial Estate for such small industries has now been planned in the public sector. There, industries are being housed in an area of over 550 hectares outside the present municipal limits of the city, but adjacent to an already existing industrial suburb—Ismailabad. The Estate would provide necessary physical infrastructure for new industries as well as promote transfer of many units from within the city.

Major Industrial Land Use :

Apart from handicrafts and small industries, which are traditional to Multan, modern large industrial units have been established in Multan since early 1950's. First among these were Qasimpur Industries, established to provide employment opportunities to incoming Muhajirs. This small estate, at a distance of 8 kilometres from the centre of the city, was housed in the old District Prison premises. Set up with the help of Industrial Corporation, it has four units, Glassware, Foundry works, Textiles and Carpet weaving. It has remained at the southeastern extremity of the city limit, though, a large number of bigger industrial units have later occupied a vast belt of vacant land lying in between.

However, the main industrial sector has grown to the south of the railway line on both sides of old Multan-Ferozepur-Delhi Road. It includes Textile Mills, Vegetable

Oil Mills, Metal Works, Fruit Preservation, Pharmaceuticals and Cold Storage Units.

The Suburban Industrial Townships :

Outside Multan City, we find two suburban industrial townships, namely Ismailabad to the west and Pirangaib to the east. Both are along the Highway and nearer to already existing railway stations of Muzaffarabad and Pirangaib, at a rail distance of less than 10 kilometres on either side. Commuting by road or rail is thus not a problem. However, both areas have developed largely as self-contained townships.

Ismailabad is a large private industrial concern, engaged in the manufacture and sale of cotton textiles, woollen textiles, artificial fibres and ready-made garments. Apart from vast areas of its expanding industrial units, the tendency to provide residential accommodation and other facilities to the staff and mill workers is gaining ground. This tendency is indicative of a planned social/industrial growth and when taken up conscientiously, could become a development similar to New Lanark (Scotland) movement of 19th century.

A definite provision of an industrial township has, however, taken shape to the east of Multan. Less than 4 kilometres by road from the municipal limits (and in the direction of old city's growing expansion) is the Pirangaib industrial area. Here, two exceptionally important concerns namely Multan Thermal Power Station (capacity 300,000 KW) and PIDC's Natural Gas Fertilizer Factory (capacity 250,000 tons), have been established since late 1950's. Central location within Pakistan, bespeak of their economic importance to industrial and agricultural sectors of country's economy. Both concerns, as all other major industries in Multan, consume natural gas as fuel or raw material.

Apart from industrial factories, residential quarters have been established near the site. The PIDC Colony has over 550 residential units, a local shopping area, recreational clubs for officers and factory workers, play grounds, a middle school, post office, hospital and two rest houses. A similarly patterned but smaller housing colony is maintained by the WAPDA for the Power Station.

The inner core of Multan is still devoid of vehicular traffic, and is accessible to pedestrians only. The winding narrow streets and byelanes allow no vehicular traffic to pass and there are no plans to cut through the walled city's old quarters, as has been done in most of the Iranian towns, having similar amorphous morphology.¹²

The city is very central in position, particularly in relation to communication net-work of Pakistan. For its central location, Multan was a contender as a possible site for the national capital.¹¹ But, because of its comparatively drier and hotter physical environs, it has fallen to 3rd position in the region. Both in population increase and economic growth it has been overtaken by the city of Lyallpur since 1961.

Morphological changes outside the walled city and the emergence of new residential localities, and the industrial suburbs, have introduced new patterns of urban land use. Multan is, therefore, in the process of rapid urban transition.

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4. This opening satrted from the bank of the river, before the change of its course took place. This place is now a rich bazar known as Bazar Husain Agahi.
5. The buildings and other structures are founded on the debris of earlier structures as well as the initial raised earth-mound.
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SOME OBSERVATIONS ON FREE FACE DEVELOPMENT IN THE BURBAGE BASIN (ENGLAND)*

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INTRODUCTION

THE term free face was introduced by Wood who defined it as "the face which weathers freely and whose slope is not subjected to the restraint of base level".¹ Since then this term has been widely used in the description of slopes. In the present study, free face is used in the same sense as cliff, defined by Savigear as "...a surface which is vertical or inclined at an angle of forty degrees or more."²

Three different types of free faces occur in the Burbage area, 1) Free faces along the course of the Burbage brook which have been formed as a result of the Post-glacial incision, 2) Free faces formed in the back slopes of the slumps, and 3) Free faces formed along the grit escarpment, far away from the direct influence of the Burbage brook.

The genesis of the first and second types of free faces presents no problems; they have therefore been left out of the present discussion. It is the last category of free faces whose origin is subject to considerable debate.³ The present study is therefore largely concentrated on them; where free face is used in the discussion, it refers to an 'edge' of this kind.

Free faces of the Pennines have been mentioned very frequently by earlier writers, however, rarely have these features been systematically surveyed in relation to slope form, nor have the deposits lying on their foot slopes been examined. The result is that references to the free faces are very often based on superficial observations. During the course of the present study, slopes have been measured in the field and the deposits overlying them are examined. Based on these studies an attempt is made to elucidate the mode of development of free faces in this area.

Evidence of Cryergic Activity

The foot-slopes of the free faces are everywhere littered with grit blocks, ranging in size from $3 \times 1\frac{1}{2} \times 1$ feet to $20 \times 15 \times 9$ feet. Over most of the area the blocks are covered with a vegetation of bilberry, bracken, mosses and lichen which indicates that they are no longer being moved.⁴ Roundness analysis of the blocks has been made, and it is suggested this material is the result of frost action.⁵ The effects of cryergic activity can also be seen on the bedrock exposed in the free faces. It appears that the efficacy of

*The paper is a portion of author's unpublished Ph.D. thesis "The Pleistocene Geomorphology of the Burbage Basin" (University of Sheffield 1967).

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frost action and the nature of its results were determined by the pattern and the density of joints and bedding planes. Where joints are relatively closely-spaced, the bedrock has been broken down into smaller blocks ; where however they are further apart, the joints themselves have been considerably enlarged, and in places filled with head material. Free faces also show remains of scars made by rockfalls and rockslides, which were initiated in the past cold climate.

Over most of the area, bedrock outcrops are buried under superficial material, ranging in thickness from four to nine feet. This consists of gravels, cobbles, and block-sized material embedded in fine sandy matrix. Particle-size analysis have been made of the fine fraction ; in no case does it contain more than five per cent clay. This material is extremely unsorted, and in places is overlain by a fossil soil belonging to the Allerd (C-14 dated to 11590±360 Yer. B. P.). Clearly this is a head material produced by frost action.⁶

The lithological and petrological similarities between the head and the bedrock exposed in the free faces suggest that the superficial material is largely derived by the weathering of the free faces. Head deposits are found up to half a mile from the free faces and occur on slopes as gentle as five degrees. Preferred orientation analyses of this material suggest that it was moved largely by soliflual processes.

Influence of Lithology and Structure

Free faces are formed in rocks that are relatively resistant to weathering. Weathering by frost action is determined to a very large extent by the density of divisional planes. "Other things being equal, well-jointed and well-bedded rocks are readily disintegrated by frost weathering ; more massive rocks are less completely broken down." The characteristics of bedding and joints are to a very large extent the result of lithology and structure.

Lithologically the rocks in this area may be grouped into three broad divisions; the coarse grit, sandstone and shales.

1) Grit is a coarse-grained sandstone rock, predominantly consisting of pebbles and coarse grains of quartz and feldspar. It is generally massive-bedded ; the spacing between the bedding planes varies from one to three feet. When weathered, it sheds debris of block-sized material ($2 \times 1\frac{1}{2} \times 1$ ft.) Exceptionally, as near Fox House quarry, very large blocks ($20 \times 12 \times 8$ ft.) may be produced.

2) The local sandstones are rocks with an average grain size of less than one-eighth of an inch. They contain quartz, feldspar and a variety of heavy minerals. Normally layers of sandstone roughly half to one inch in thickness are separated by extremely fine layers ($1/20$ in.) of silt. Consequently the sandstones can be split very easily into thin tabular fragments. On weathering they produce fragments of smaller sizes than cobbles. Particle-size distributions of some of the slope deposits suggest that eight per cent of the material that falls in between cobbles and gravel-size is formed of sandstone.⁷

3) Shale outcrops cover the greater part of the area. It is largely micaceous, but may incorporate bands of arenaceous shale and mudstone, in places iron nodules may

also be present. Generally it is thin-bedded, ranging from 0.05 to 0.4 inches. On weathering it produces angular fragments of medium and fine gravel size, which are largely embedded in a sticky mass of clay.

The tectonic history of the Pennines has left the Millstone Grit with a general grid of joints, these range from a few inches to several feet in width. During rain most of the surface water is directed through the joints ; they carry almost all the water which percolates into the grit bed.⁸ It appears that during the cold climatic phases these joints formed ideal sites for the formation of large ice masses.

The joints are much closer in the sandstone, while they may show considerable variation in the grit. Shale on the other hand possesses very few joints. As a whole the density of divisional planes is very high in shale, low in grit and medium in sandstone. With regard to frost weathering the grit is least affected, the shale most affected, while sandstone occupies an intermediate position. Thus free faces are practically inhibited from shale and sandstone and are largely confined to the less jointed parts of the grit rocks.

MORPHOLOGY OF FREE FACES AND FOOT-SLOPES

Free Faces

The most striking features of a free face when examined at close quarters are its bedding planes and joints, which have been given topographic expression by means of differential weathering and erosion. The spacing of the bedding planes in a free face depends on the lithological characteristics of the rock ; where rocks are coarse grained they are massive-bedded, while fine grained rocks are thin-bedded. Where bands of fine sandstone occur, they have been deeply etched out by weathering ; this is particularly so when they occur at the base of free faces. In such places 5-6 feet of deep inweathering has taken place, producing overhangs. In massive-bedded rocks, such as grit, individual bedding planes are picked out by weathering and free faces have been weathered into joint blocks.

The most spectacular features of the free faces are joints. Usually two sets of joints are present, one is parallel to the free face, while the other is approximately at right angles to it. The joints that are approximately normal to the free face cut the bedrock into slices of different thicknesses. These joints vary from a few inches to four feet in width ; they are usually narrow (2-5 in.) when they occur close together, but are very wide (3-4 ft.), when they are further apart, most joints are wider at the top, but narrow down at the bottom. Fragments of rock may be occasionally found wedged in the joints. Where the joints are wider, they are filled with head material very similar in composition to the material of block fields.

The joints that are parallel to the free faces are also important features. They are very wide (4-5 ft.) near the free face, but are narrow (1-6 in.) away from it. Where these joints are well developed they must have been sites of very intense frost action. It appears that ice masses have greatly enlarged these joints, by displacing the grit blocks

and creating large chasms up to six feet in width ; elsewhere large rockslides, 100-200 feet long have taken place. It appears that these joints facilitated to a very great degree the weathering and subsequent retreat of free faces.

Free faces show recession scars of different sizes, left by rockfalls. Where a lens of fine sandstone occurred in the coarse grit, the differential weathering of the beds has resulted in the formation of caves. Free faces also exhibit weathering forms that are independent of the structural planes of parting and are related to more subtle texture or petrological variations. Thus the presence of iron nodules in the grit beds have initiated deep circular hollows and where large-sized quartz pebbles occur, honey-comb weathering has developed.

Foot-Slopes

Free faces in the Burbage area are joined to the structural terrace below by concave foot-slopes, which rise gradually in inclination from seven degrees on the terrace to twenty-two degrees near the free face. In places the change from the gentler to the steeper slope is gradual and the profile shows a smooth concave-upwards element of curvature, while in others the junction between the gentler and steeper slope is abrupt, and the radius of curvature is short. The foot-slopes are usually smooth and gentle where the free face is massive but are steeper where sandstone or highly jointed grit is present.

The foot-slopes are characterized by the presence of large angular blocks, which in places measure more than twenty feet across. Near the free faces the blocks are merely jumbled together, exhibiting large voids five to six feet deep, are largely devoid of any vegetation cover. Lower down on slopes of fifteen degrees, blocks are only partly covered with vaccinium and show voids, though less frequently. Blocks can be rarely seen on slopes of seven to ten degrees, as they are often covered with wash deposits and carry a continuous mantle of grasses, through which only the exceptionally large blocks protrude.

Sections exposed along the Parson Brook indicate that the concavities are largely cut in the bedrock. It appears that when a concavity is cut wholly in shale or in sandstone the resulting slope is a smooth curve, where however alternate bands of sandstone and shale occur, the concavity is very irregular. Where the overlying rubble is thin, the irregularities formed by lithological variations in the underlying rock are very prominent. On the other hand where the overlying head material is relatively thick, it masks the variation in the bedrock but produces a surface slope that is much steeper than that of the underlying bedrock.

Sections exposed in the concavities show that the head material consisting of large blocks is in places covered by melt-water deposits which are largely composed of sand and fine gravels. In some places this material is overlain by sandy wash ranging in thickness from four to five feet.

It is very significant that where free faces occur at present, there are no indications of springs or streams. During rain most of the drainage on the steeper parts of the foot-

slopes is in the form of runnels, which flow under large blocks. Only on the lower gentle slopes where a continuous vegetation cover is present, does surface drainage appear and very shallow gullies are formed.

PREVIOUS EXPLANATIONS OF THE ORIGIN OF FREE FACES IN THE BURBAGE AREA

Previously many attempts have been made to explain the origin of free faces. Some of the earlier writers considered these features to be the work of man. Thus Hargrove commented "...the faces of rock in their natural state are rude, rounded or broken in a variety of uncouth angles, instead of which we meet with smooth perpendicular walls of stone which give reason to suppose a tool was used here." In the nineteenth century opinion about free face genesis was considerably divided. One group of workers believed marine erosion to be the most important factor in their formation.⁹ Mackintosh remarked "...most of the cliff and projections and pillars of rock hitherto attributed to erosion and weathering are really due to former action of sea during the last great submergence." Another group of workers considered them to have been produced by rain, wind and streams.¹⁰ Independent of these two schools of thought, Goodchild in a study of the limestone scars in Derbyshire, suggested that "not only the terraces of limestone, also the scars of sandstone and grit originated due to glacial erosion."¹¹

In the present century attempts have been made to describe the relationship between the lithological and structural characteristics of rocks and free faces. Thus Winter emphasised the significance of joints,¹² while Gilligan suggested that micro-structure, *i.e.*, the different strength, expansion, and solution rate of constituents, could be as important as the micro-structure in the formation of free faces.¹³ The importance of lithology and structure was also recognised by Fearnside, who suggested that free faces may well be due to the differential weathering of grit and shale beds.¹⁴ Apart from these scattered references the only important contributions to the study of free faces have been made by Palmer, Radley and Linton.¹⁵

Palmer and Radley

Palmer and Radley suggested that free faces were produced in two stages.¹⁶

1) River valleys were glaciated; this resulted in the considerable lowering of valley floors and the undermining of the valley slopes, so that the edges of cap rocks were exposed over a larger area.

2) Glaciation was followed by a cold phase, during which the edges were subjected to diurnal or seasonal freezing and thawing. The active layer above the permafrost led to an extensive series of land-slides of melted shale, over frozen shale, resulting in the retreat of the superjacent free faces. It is agreed that free faces could be formed by periglacial processes; however, their mode of development as suggested by Palmer and Radley is disputed.

Firstly, it has been established that the Burbage area was not invaded by ice during the Last Glaciation,¹⁷ therefore the edges need not necessarily have originated by the undermining of valley-side slopes by glacial erosion.

Secondly there is no evidence of landslipping in front of the free faces in this area, and it would appear that the role of landslides in the retreat of a free faces has been over-exaggerated. It is more likely that the retreat of the free faces was accomplished by processes other than landslides.

Linton

Linton believes that the free faces are exhumed features, produced by subsurface weathering in a warm climate.¹⁸ He suggests that in a warm inter-glacial or in pre-glacial times a weathering profile would develop on a sloping surface. Both above and below the escarpment, the zone of weathering would be only a few feet deep, but nearer the scarp slope and for some distance behind it ground water would be free to circulate, both more rapidly and through a greater vertical distance than elsewhere. As a result of this circulation, rock rotting in this zone would push the boundary of sound rock some distance inward from the surface of the declivity. The onset of cold conditions would result in the removal of the fine-grained products of weathering and the downward displacement of the corestones, so that the free face feature already in existence below the surface would be exhumed.

In support of his hypothesis Linton refers to the presence of rounded corestones, the bimodal distribution of block field material, the rounded edges of the free faces and the adjustment of rock to weathering as evidence of former subsurface chemical weathering. The so-called corestones have been examined in the field in several places; roundness analysis show that they are generally angular and it is suggested that they are more likely to have been produced by frost weathering. The bimodal distribution of block field material is by no means a reliable criterion for chemical weathering; indeed it has been suggested that this is a common feature of the weathered material that is produced in a frost climate. Neither are the edges of the free face found to be rounded when examined in detail. In any case, slight roundness on the edges or any structural adjustment exhibited by the free face in general could be produced in the Post-glacial. At present no evidence exists to prove differential subsurface rotting, either in interglacial or pre-glacial time.

A HYPOTHESIS OF FREE FACE ORIGIN

With the onset of cold conditions vegetation is destroyed and soil and regolith are left loose and free to be carried by the processes of wash and solifluction.¹⁹ On steeper slopes where the removal of weathered material is relatively rapid bedrock is exposed. With increasing cold, chemical decomposition is replaced by mechanical weathering due to gelifraction. After precipitation or snowmelt, surface water is drained by joints, the water is dispersed throughout the rock but there is a greater concentration in the joints and bedding planes.²⁰ On freezing, ice masses develop along these zones. The lithological and structural variations in the Millstone grit influence the development and localization of ice masses.

Where a pre-existing convex slope is formed on rocks with a high density of divisional planes such as sandstone, shale or highly jointed grit, there is a greater concentration of ice masses and weathered debris is produced faster than it is removed, and accumulates on the foot-slopes.²¹ As more and more material is added, the debris accumulation encroaches on to the bedrock, thus burying it and producing a convex-concave slope. In these situations slope decline occurs as suggested by Davis.²²

Where a less densely jointed, massive grit is underlain by sandstone, frost action along the junction of grit and sandstone creates overhangs, ranging from a few inches in the initial stages, to several feet in the later stages. Such basal sapping by gelifraction leads to the collapse of the overlying grit rock, which may leave releasing scars in the bed rock, and the initiation of further rockfall by undermining.

In places where basal sapping by gelifraction is accompanied by frost bursting in the joints parallel with the free faces, individual blocks of bedrock or large slices of free faces up to 100 feet in length may slip along joint planes and result in extensive rockslides. The weathered debris produced by rockfalls and rockslides accumulates at the base of the bedrock as talus,²³ and is gradually removed by talus creep, solifluction and meltwater.²⁴ Because the bedrock is relatively massive, the rate of weathering and production of weathered debris are no more rapid than the rate of removal.²⁵ In such situations a free face results, which is perpetuated by basal sapping, and slope replacement occurs as suggested by Penck.²⁶

Basal sapping of resistant superjacent rocks is also responsible for the perpetuation of free faces in the humid tropics.²⁷ In the latter area, however, it is effected by spring action and gulying rather than by the gelifraction, rockfall, solifluction and wash processes that operate in a cold humid climatic zone.

For the development of concavities on the footslopes of free faces, it is necessary that the bedrock underlying the debris slopes be removed *pari passu* with the retreat of the free face above, otherwise a bench feature develops in the front of the free face. To illustrate this problem, the upper portion of a slope profile is selected. In this example it appears that the free face was initiated on a convex-concave slope, at the junction of grit and sandstone at *Q*. For the slope form *abc* to develop, it is necessary that not only the grit rock *A* but also the underlying sandstone *B* be removed.

Saviegar has suggested that this type of slope is reduced by gullies and runnels in West Africa.²⁸ An examination of footslopes in the Burbage area suggests no evidence of gulying; nor is it possible for this process to carry such large blocks, as are littered on these slopes. Rather it is possible that as the weathered debris is moved downslope by solifluction, it incorporates the underlying weathered bedrock and thus lowers its slopes. While this would appear to be an effective process on the gentler slopes, it is doubtful whether it could have been very effective on the steeper gradients, immediately below the free faces where the large blocks are generally lacking in fine material.²⁹

It is significant to note that when rain falls at present, water flows under the blocks in the form of runnels and carries fine material from amongst them as well as from the

weathered bedrock. This is deposited as wash material on the lower gradients of the concavities. It is possible that a similar process operated during the cold phase.³⁰

It is well known that a large quantity of meltwater is released in summer in periglacial areas.³¹ It is possible that the release of meltwater on the steeper parts of the block covered slopes may have removed fine material from the head as well as from the underlying frost-weathered bedrock and have resulted in the displacement of large blocks. It is suggested that in this manner the underlying bedrock was reduced in height contemporaneously with the slow removal of blocks by talus creep.

That such a process did exist is evident from the meltwater deposits that are widespread along the concavities. Such deposits have also been recognised in Southern England and Denmark.³² It appears that erosion by meltwater was very effective where such less resistant rocks as sandstone and shale were present. On these lithologies a smooth concave foot-slope was produced.

Field evidence suggests that concavities at the foot of free faces are very sensitive to lithological and structural variations in the underlying bedrock. Where a band of massive grit exists, it stands out as a prominent bench. Depending on the number of grit bands, several such benches may occur, which in most cases will be covered by large grit blocks.

Where the sandstone band which separates the grit beds forming the bench feature and the free face is very thin it will affect the course of slope evolution in two ways. Firstly the free face will be weathered very slowly; secondly, because the weathered debris lacks fine material, its removal will also be very slow. Under these conditions the lower grit bench will no longer be buried under the debris carried from the free face and it will form a free face in the same manner as free face upslope (Fig. 5, C). Depending on the number of grit bands a series of free faces will be created. The retreat of the free faces will leave in their front, broad terraces which will be covered by blocks. A pre-existing convex slope formed by massive-bedded grit with thin bands of sandstone may also initiate a number of free faces which will form terraces as they are weathered back. Such rock-cut benches have been termed *altiplanation terraces*.³³ They have been reported from Arctic regions and have also been recognised in relict form in the British Isles and Europe.³⁴

Where the free face-forming grit incorporates thin bands of sandstone or highly jointed grit, a stepped free face may be produced. The risers of each step may retreat back leaving in their front *altiplanation terraces* in different stages of development. As can be seen, *altiplanation terraces* may be formed due to the retreat of free faces in different situations, and it is not always easy to decide whether they have been produced from an initially concave or convex slope or from different grit bands in a single free face.

When an outlier of grit occurs in an area, predominantly covered by shale or sandstone, free faces are formed in the capping grit on all sides, for example, Carl Wark and Higger Tor. In such cases the retreat of free faces from all sides may almost consume the whole of the bedrock stratum; only the relatively more resistant parts may survive frost weathering, and dot the landscape as tors.

AGE OF THE FREE FACES

By the end of the Tertiary, climatic deterioration had set in, thus marking the beginning of the Pleistocene. This epoch was characterised by repeated glaciation of certain areas. It is now generally agreed that there were at least four major phases of glaciation, during which a greater part of the British Isles was invaded by ice. Stratigraphic evidence suggests that the early glaciations were more widespread, while the later glacial phases were relatively more localized. Interglacial periods of milder climate are held to have intervened between glaciations. "These show the effects of a definite climatic cycle from sub-arctic conditions at the close of the proceeding glacial period, through a stage of amelioration to a climatic optimum, with conditions rather warmer than those of today and then a gradual recession of temperature ending in sub-arctic conditions, before the onset of the next glaciation".³⁵ In other words every phase of glaciation was preceded and followed by a phase of periglaciation. Sub-arctic conditions also persisted over a greater part of Britain outside the limits of ice advances.

No systematic stratigraphic work has been carried out on the glacial history of the Burbage area. Most of the glacial studies do not extend beyond superficial observations.³⁶ This is largely due to the fact, that much of the glacial material has either been completely eroded, or where it is found, it has been very much disturbed by periglacial processes, and does not lend itself to detailed stratigraphic investigations.

So far evidence of only one glaciation (glacial erratics), probably the Antipenultimate Glaciation, has been found in this area. This area was certainly not glaciated during the Last Glaciation,³⁷ nor is there any evidence of Penultimate Glaciation, as the ice during that phase was confined to the lower valleys of Derbyshire.³⁸ It would thus appear that during these two glacial phases, periglacial conditions persisted throughout the Burbage basin.

If every glaciation is preceded and followed by a phase of cold climate, then it is logical to suppose that any Tertiary weathered material would have been removed and free faces initiated in the manner suggested above during the cold phase preceding the Antipenultimate Glaciation. We do not know the extent to which the free faces so formed were modified by the following phase of glaciation; nor is it possible to estimate the effects of the intervening cold and warm phases.

It is reasonable to assume that by the beginning of the cold phase corresponding to the Penultimate Glaciation, the Tertiary landscape had already been considerably altered. It is possible that some free faces still existed, and that others had decayed and been replaced by convex-concave slopes. The evidence of summits suggests that during this cold phase, there was an active period of free face development, and it is probable that most of the free faces that we find today were initiated during this period.

If the weathering of free faces in the post-Glacial period can be relied upon as a good estimate of the resistance of free faces to chemical weathering during the last 10,000 years, then it is probable that at least some of the free faces formed during the Penultimate periglacial phase survived the Last interglacial.

The development of free faces was renewed with the onset of cold conditions in the Last Glacial period, and it is likely that much of the present form of the free faces was shaped by cryergic processes during that phase. With the cessation of cold conditions at the end of zone III, it appears that the active development of free faces also came to a halt.

POST-GLACIAL MODIFICATION OF FREE FACES

With the amelioration of climate in zone IV, it is probable that soil and vegetation developed over a greater part of the area and reached its highest development in the climatic optimum.³⁹ There is no evidence that the onset of Atlantic and Sub-Atlantic conditions seriously affected the vegetation cover on the foot-slopes of the free faces. There is reason to believe that the foot-slopes must have carried a very deep soil and vegetation cover throughout the period from zone IV to the end of zone VIIB. It is likely that during this time some free faces became overgrown by mosses, lichen, creepers and other kinds of arboreal vegetation, particularly along joints. There is evidence that in some cases joints were filled with wash material and free faces completely buried under vegetation. With the removal of vegetation by man in Sub-Atlantic period it is likely that these free faces would have been re-exposed. It appears that since then some of them have been covered again by *deschampsia*, *calluna* and *vaccinium*. In some places even this moor vegetation has now been largely destroyed by burning which has resulted in the widespread erosion of *calluna* peat and the underlying sandy material. As a result of this, free faces have been re-exposed in places. At present the sandy material that fills the joints is being attached by the processes of wash; this is being deposited as small spreads in front of the free faces.

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NUCLEAR GEOGRAPHY A CONCEPTUAL FRAMEWORK

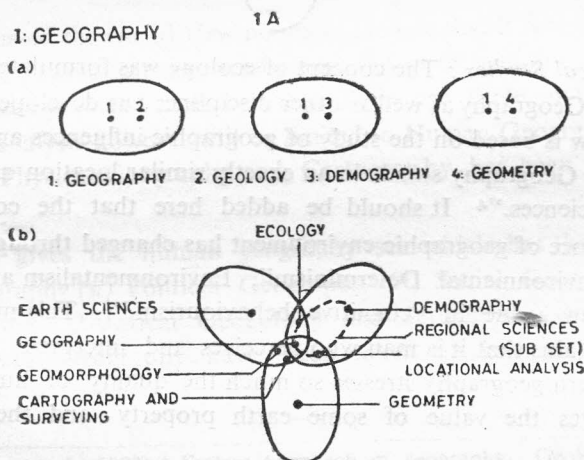
BY MOHAMMAD ASLAM KHAN*

It is the purpose of this paper to provide a conceptual framework to improve the understanding of the field of Human Geography and to illustrate the spatial organisation of its various branches and links between them allied disciplines. The methodology is based on a system approach. "A system is an entity consisting of specialised inter-dependent parts. Most systems can be sub-divided into sub-systems by searching for modules with high degree of internal connectivity and lower degrees of intermodule interaction. If larger modules can be partitioned into smaller modules, it is possible to talk of a hierarchy of system and sub-systems".¹ The procedure adopted in this study is set out in the accompanying diagrams which show how the pattern of links change at different stages in the system as a whole.

The basic idea for this conceptual framework has been derived from Haggett's model² (fig. 1a) which attempts to organise the relationship of Geography to other allied subjects in the form of simple sets. Thus, at initial level three pairs of sets were identified in this model on the basis of close relationship of Geography to three other fields of study. These included :—

- (1) Geography — Demography (Huminties)
- (2) Geography — Earth Sciences (Geology)
- (3) Geography — Geometry.

Haggett attempted to combine these three pairs of sets in the next stage (fig. 1b) and showed the inter-relationships between them and also the concepts and approaches emerging from the combinations.



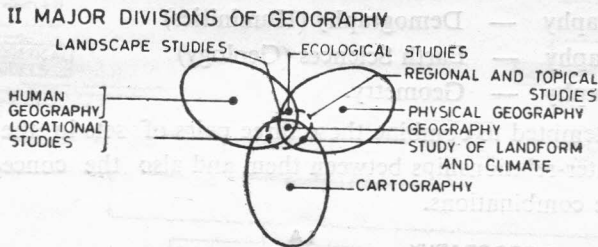
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Haggettdid not extend this idea any further. However it is possible to develop the same approach further in geographic scale to explain the scope and status of various branches of Geography.

Traditionally the geographers have produced detailed descriptive accounts to analyse the scope and status of Geography and the relationship between its branches and allied disciplines. This approach tends to be not only too complex and lengthy but also lacks in a conceptual framework. An effort has been made in the present study to make this procedure simple and precise by providing a basic framework and developing the analysis into a step by step approach. The achievement of this task implies two things :- Firstly, there is a need of analysing the varied view point in Geography and Secondly, the ability to monitor vertical integration between various branches of geography and their horizontal integration with the allied disciplines. Both aspects have been given due consideration in this analysis

VARIED VIEWPOINTS IN GEOGRAPHY

The main emphasis in diagram 2 is on the links between the three main branches of Geography viz. Physical Geography, Human Geography and Cartography. The interaction between which explains the varied view-points and methods in the geographic field e. g. (1) Ecological Studies, (2) Landscape Studies, (3) Regional and Topical (Systematic) Studies and (4) Locational Studies.



1. *Ecological Studies* : The concept of ecology was formulated by Haekal³ and the ecological study in Geography as well as other disciplines has developed under his influence. The ecological view is based on the study of geographic influences and as Hartshorne puts it, "This school in Geography stands in an exactly similar location as does plant ecology to the biological sciences."⁴ It should be added here that the concept of geographic influence or influence of geographic environment has changed through times. Expressed in terms of strict "environmental Determinism", Environmentalism and Possibilism in past, it has found a new value in "cognitive behaviourism."⁵ This modern view (cognitive behaviourism) explains that it is man who perceives and interprets physical surrounding. "This is why modern geography stresses so much the quality of human resources...it is man who perceives the value of some earth property and thereby creates a new resource."⁶

2. *Landscape Studies* : The landscape studies give the explanatory description of the visible features of earth's surface as the expression of man's activity". Man's role

as a morphological agent was recognised as early as 1864 by Marsh,⁷ but it was Carl Sauer⁸ who played a major role in developing this particular theme in a Geography.

3. *Regional and Topical (Systematic) Studies* : The regional concept or the desire to identify areas of the earth surface which are homogeneous according to some criterion or criteria has long been an integral feature of geographic analysis. The general purpose of regional study is to provide accurate, orderly and rational description of the variable character of the earth surface, what Hartshorne¹⁰ terms as the "Areal Differentiation" of the earth surface.

While Regional Geography focusses on a specific area, topical geography investigates "a particular group of features produced by one kind of process wherever these features may occur in the world."¹¹ This apparent dualism, however, resolves itself if we consider the topical and regional aspects as two applications of the regional method¹² ...for understanding the areal differentiation of the earth. Whittlesey in support of this view states, "The study of a topical field in geography involves the identification of areas of homogeneity which is the regional approach ; the study of the regions that are homogeneous is terms of specific criterion make use of the topical approach because the defining criteria are topical."¹³

Locational Studies : The rising tide of interest in location problems in geography is a comparatively recent phenomenon. "The strongest development of locational theory has come from one of the social sciences, economics, rather than from within Human Geography... Both the early classics of locational theory, by Von Thunen (1875) on agricultural location and Weber (1909) on industrial location were concerned essentially with economic location."¹⁴ So too were Losch¹⁵ and Isard.¹⁶ This growing literature on locational analysis has had tremendous influence on geographical thoughts and this influence can be witnessed in some excellent contributions on location theory by Christaller,¹⁷ Bunge¹⁸ and Haggett¹⁹ produced in Germany, America and England respectively.

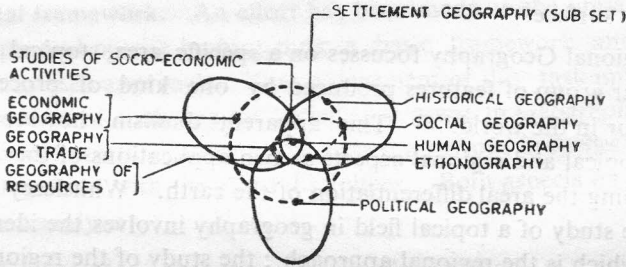
Having discussed the varied view points in Geography, it remains now to analyse the spatial integration amongst the various branches of Geography at the lower level in the scale. It has been pointed out earlier that there are three major sub-divisions of Geography. This analysis however will be limited to Human Geography and its branches only. The case of Physical Geography and Cartography has been discussed separately elsewhere.*

Diagram 3 gives the human geography set which has three main components (i) Economic Geography (ii) Political Geography (iii) Social Geography. In addition, there are two sub-sets, Historical Geography and Settlement Geography. These five branches of Human Geography have been taken up individually in the onward analysis.

* See Khan M. A. (1972) A System Approach in geography. Geological Bulletin. Volume 6. Peshawar University.

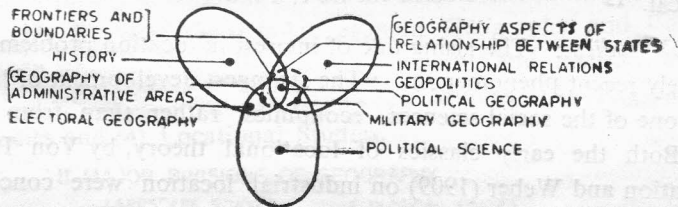
Political Geography :—The scope of Political Geography has been explained in Diagram 4. This branch of Geography has close relationship with History, Political Science and International Relations. In the centre one can find the geopolitics sub-set. Geopolitics is considered as a "simple application of techniques of Political Geography to the problems of international affairs"²⁰, and as such it fits very well in the position shown in the diagram.

III SUB DIVISIONS OF GEOGRAPHY

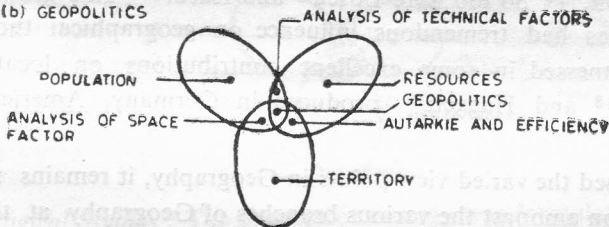


IV POLITICAL GEOGRAPHY

(a)



(b) GEOPOLITICS



Economic Geography :—The case of economic geography has been taken up in diagrams 5a & 5b. This branch of Geography has seen tremendous progress in recent years—so much so that many of its branches have voluminous literature on their own. These include Manufacturing Geography, Agricultural Geography, Marketing Geography etc. Another important aspect of this change is the increasing application of techniques and methods of Economic Geography to identification of economic problems and their solution. This subject is increasingly being used in planning to solve such problems as industrial location, resource conservation and management, marketing etc. It has been tried to depict all this in the diagrams. Fig. 5a shows the relationship of Economic Geography to other allied disciplines, and 5b has tried to analyse the subject matter of economic geography itself with a three fold sub-division of various economic activities viz. primary, secondary and tertiary, and resulting subfields emerging from the analysis of these activities.

Social or Cultural Geography :—Social Geography Culture Geography as it is called in America is the next branch of human geography which has been dealt with in

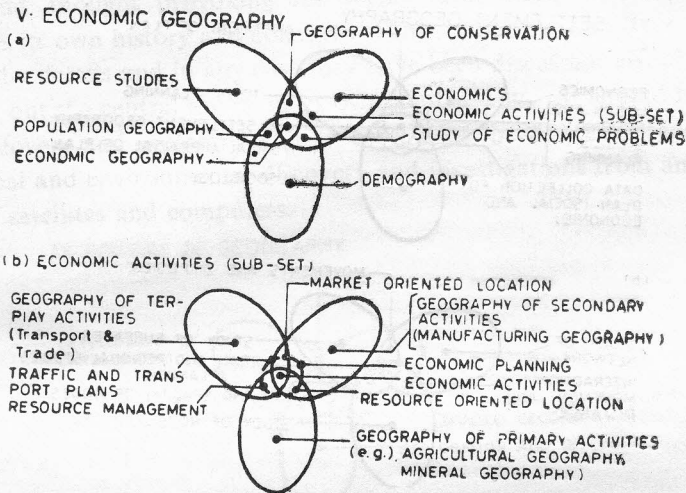
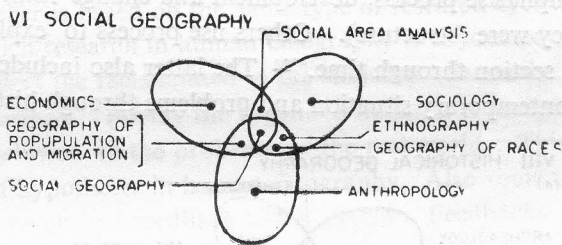
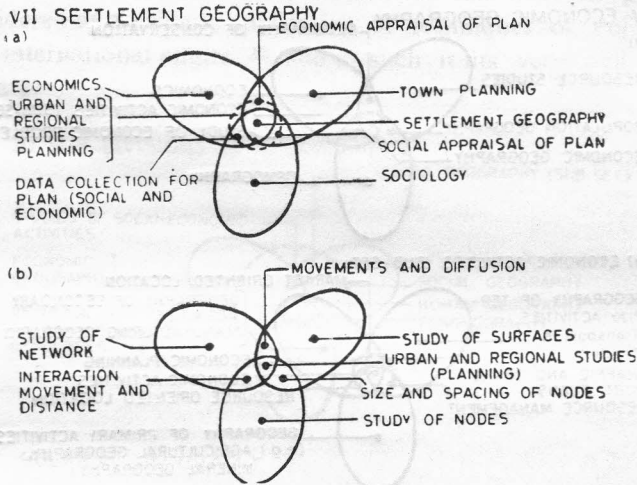


Fig. 6. The diagram clearly brings out the content of Social Geography which has been divided into population and migration analysis, areal analysis of racial or ethnic structure, and social area analysis. The figure also show how this field is related to Sociology, Anthropology and Economics.

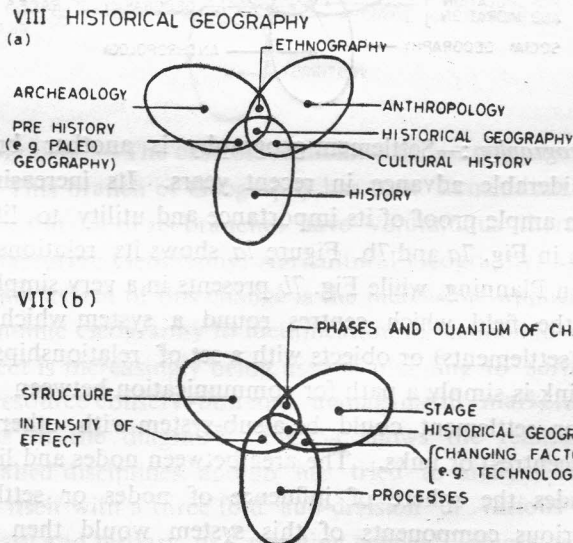


Settlement Geography :—Settlement geography is another branch of Geography which has seen considerable advance in recent years. Its increasing use in practical planning provides an ample proof of its importance and utility to life and society. Its case has been shown in Fig. 7a and 7b. Figure 7a shows its relationship with Sociology, Economics and Town Planning, while Fig. 7b presents in a very simple manner the whole subject matter of the field which centres round a system which may be defined as a collection of nodes (settlements) or objects with a set of relationships or links (network) between them. A link is simply a path for communication between any two nodes in a system. A nodes or settlement could be a sub-system with other sets of nodes (e. g. service or shopping centres) or links. The area between nodes and links can be referred as surface. It includes the sphere of influence of nodes or settlements. A detailed analysis of the various components of this system would then involve the study of interaction between the settlements leading to such systematic studies as size and spacing

of settlements (Hierarchy), their functions, physical structure, transport network, analysis of movements (such as journey to work, shopping trips etc), economic base etc.



Historical Geography :— Apart from their interest in present, geographers also recognise the significance of genetic aspect. Diagrams 8a and 8b present the case of Historical Geography. “How far and in which manner one shall trace the present back into the past depends on the nature of problem as well as the interest of investigator.... Some geographers emphasise process, development and change rather than actual distribution of areas as they were (structure). Others use process to explain the character of of an area as a cross section through time.”²¹ The latter also include those who focuss on the explanation of contemporary situation and problems through historical study.

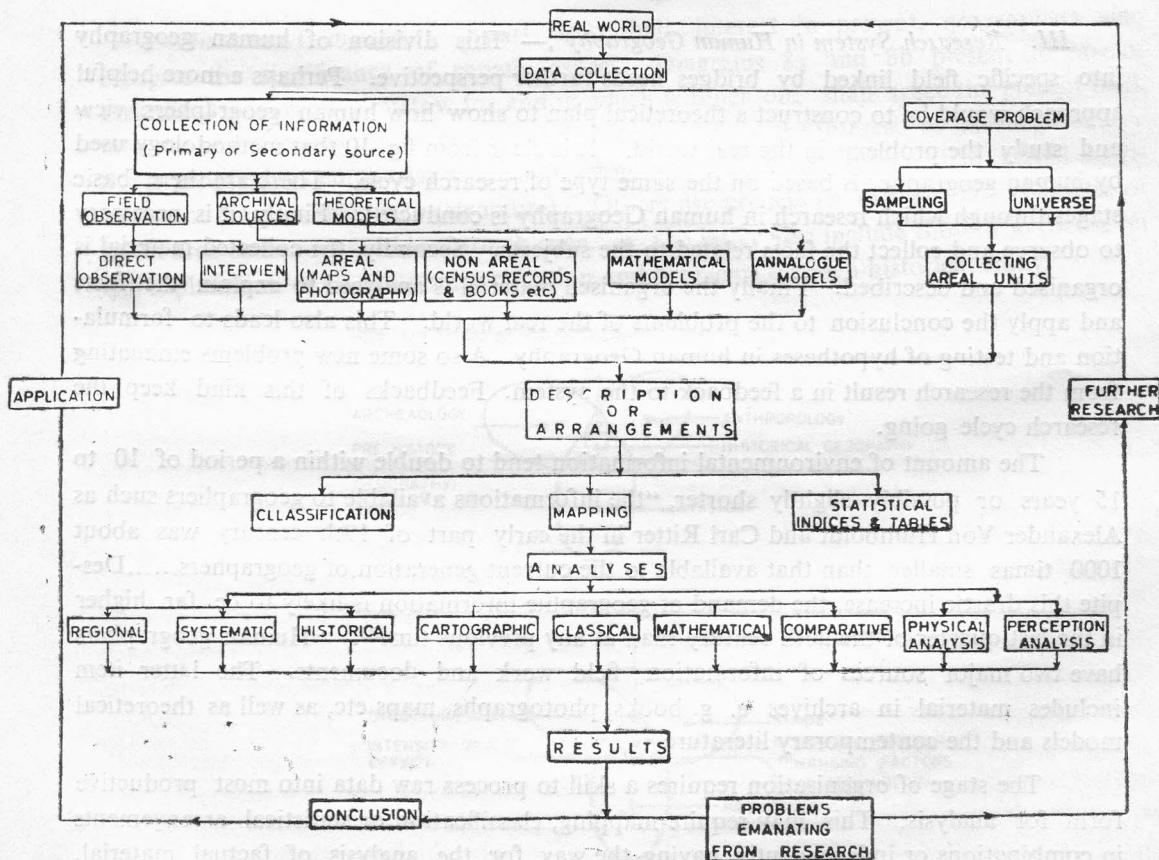


Berry²⁴ classifies, the various kinds of analysis in which the geographer engages into three main classes :

1. Systematic or spatial —spatial distribution and associations ;
2. Regional—The description of particular places and codification of their areal differentiation ;
3. Historical—Either of the above in past cross section of time, or any of the elements in the above compared through time.

Prescott²⁵ on the other hand has divided analysis into four types, (1) cartographic analysis-involving the study of areal distribution of a single element. (2) Classical analysis-referring to the painstaking and through reconstruction of all relevant aspects of a single event on a series of closely related events. (3) Mathematical analysis-based on mathematical procedures and use of models. (4) Comparative analysis-include three general types of comparison in space and time.

- (a) Comparison of two distinct areas at the same time ;
- (b) Comparison of single area at different times ;
- (c) Comparison of different areas at different times.



The present author has divided analysis into two main type physical and psychological or perception analysis. The first type involves extensive or intensive observations of various phenomena by direct physical means. This can include qualitative as well as quantitative analysis. The second type of analysis is designed to find out the attitudes of a policy maker or large number of people to a specific situation. This type of analysis can help in building behavioural models which can be applied to the real world. The central idea of this analysis is derived from a system of psychology. It has been developed by two groups of scholars known as realist and relativist with slightly divergent approaches. The former include those who, "consider the physical world as experienced by us is essentially as it appears to the senses and that its existence is independent of our knowing it". "The later, "neither support nor deny absolute existence, they are concerned with psychological reality or what we make or form of what comes to us. The chief notion of relativism is that a thing derives its qualities from its relationship to other things, that knowledge is a matter of human interpretation and not a matter of what exists, out there external to man²⁷. "The perception of reality then is directly related to the individual's conception of it. Thus a planner or policy maker whether in city or national government would try to search for environmental effects and deficiencies in the framework of his own perception and knowledge. "To super impose a conceptual structure on reality appears to be a reaction natural to man when forced to cope with the unknown²⁸". This analysis of psychological environment therefore has become very popular in geography in recent years.

Whatever is the type of analysis the ultimate aim is to predict and test the results against the real world. "Indeed the best one can hope from existing theory is that it will provide the way to better things... The building, testing and rebuilding of hypothesis is the slow path by which progress in Human Geography has been made. Testing particularly in terms of probabilities provides the appropriate check to the theoretical excesses and a way in which new ideas may be thrown up."²⁹

CONCLUSION

This paper has sketched in the theory of an approach to the analysis of linkage in an evolving system, each component of which should be taken up within the whole i. e. when one takes into consideration an individual field e. g. Economic Geography, it should be treated as a sub-system of a greater system which is Geography. One principal advantage of such models is their apparent ability to improve the information level without going into excessive details. In general, the system approach is assumed to pass through five phases, ³⁰system study, system planning, system formulation, system design and development, and feedback analysis. Feedback analysis is as important as other phases because, "Fitting a model is analogous to the manufacture and assembly of a new piece of electric machinery... Along the way, a considerable redesign tinkering and mutual adjustment of parts is inevitable".³¹ Room for feed back and improvement is left open in the present study. Any bit or connections in the system may be removed or replaced by something better at any time without disturbing the general framework.

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BOOK REVIEW

POLITICAL GEOGRAPHY by J. R. V. Prescott ; pp. 124 ; Index ; charts & graphs ; list of references ; published, Methuen & Co. Ltd. London, 1972 (in Field Geography Series Ed. W. B. Morgan & J. C. Pugh).

J. R. V. Prescott's "Political Geography", published in the Field Geography Series, appears at a time when there is so much overlap in the themes of cultural, social and political geography. "Political, economic and urban geography are the three main branches of human geography based on the prime human needs of organisation, food and shelter." Thus he opens his argument on a lucid note and brings to bear on his very readable 124-page work the clarity of outlook for which new generation of geographers is assiduously striving. It is a guide book, rich in bibliographic information, for those intending to pursue studies in the modern trends in political geography. Topically not wide enough in scope, and at places thematic heaviness is conspicuous, the author, nonetheless, gives a fair measure of freshness to his exposition.

The first chapter on "The Concept of Political Geography" has been abstracted in tables 1.1 (p. 5) and 1.2 (p. 15) depicting respectively the "Influence of Geographical Factors on Politics" and the "Influence of Political Ideas & Actions on Geography". On some points he makes allowance for differences of opinion ; on others his views can be differed with. The political ideas, for instance, take shape in a particular geo-cultural setting ; and the influence of economic and political geography, important ele-

ment in a cultural setting on political ideas should be considerable. The dichotomy between "decision" and "Action" (table 1.2) is arguable. Actions normally follow decisions. Through the impact of "political action" such elements of political geography as boundary and landscape are influenced by "political decision." That the influence of "decision" on boundaries is negligible while that of "action" is significant does not leave one wiser.

In the chapter on "Methods of Political Geographers", he dwells extensively on the methodology that political geographers have evolved. Obviously, quantification and applied mathematics have his attention. The significance of this approach is already established geography. However, he cautions against their indiscriminate application in a relationship study in which man and vastly complex world of his psychology occupy the central place. He makes bold effort to point out some obvious limitations :

...in no case has mathematical analysis of the more advanced kind improved our understanding of processes or causes." (p. 50).

"Electoral Geography, whose mathematical methods have been most fruitful, is particularly difficult to study mathematically on a comparative basis." (p. 51).

The danger of too much reliance on quantitative permutations is well illustrated in the example of China. According to Fuck's Formula:

$$(\text{power} = \text{production} \sqrt[2]{\text{population}}) \quad (\text{p. 46})$$

she should have, by 1970 surpassed both U. S. A. and U. S. S. R. in economic power and political prowess.

The discussion on borderland and frontier settlements (in the chapter on "Frontiers & Boundaries") and the influence of economic factors on their evolution is enlightening. The amusing episode that the author recounts of his border-crossing in West Africa (p. 72) is symptomatic of sensitivity of human-relationship to the slightest political change. In fact, it is on the "variation in political motivation" that policies governing internal organization and external relations hinge. As long as 'motives' evade analysis, political geographer will be at the loose end ; visitors will have their passage blocked by borderpost checker ; and their papers will fare no better !

"Political Geography & Public policy" is a restatement of a proposition that has been projecting itself in the relationship between state policy and state management for many decades. In the developed countries geographical factors are given weight in policy-making at different policy-levels. Illustrat-

ing his point on public policy (p. 100), he comes to a fair enough conclusion : "Geographers with specialist interest, will find common interest in the results of policy applications." The socio-economic patterns of the twentieth century societies are complex and problems arising from them are not the sole concern of economists and administrators. A geographer's role should acquire greater accent and the influence of his expertise on public affairs needs to be reckoned with. The author, however, has a pertinent question to ask : "To what extent political geographers should involve themselves in research into policies?.....(and) to which extent should political geographers focus on particular aspects of policy ?" (p. 102) These questions do not necessarily restrict a political geographer's premise but oblige him to a greater measure of discretion.

This instructively developed monograph should commend itself to the enthusiastic students of political geography.

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PAKISTAN GEOGRAPHICAL REVIEW was instituted in 1949, replacing Punjab Geographical Review, which was started in 1942. The object of this publication is the dissemination and exchange of scholarly knowledge. Its volumes contain research articles on various topical and regional themes of Geography with particular reference to Pakistan. The Review is published half-yearly in January and July.

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