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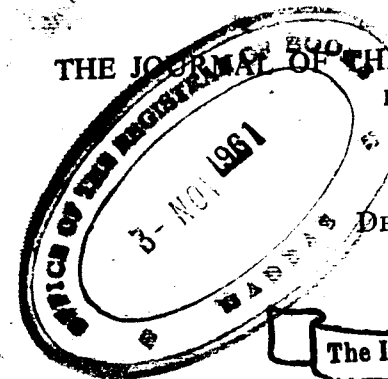
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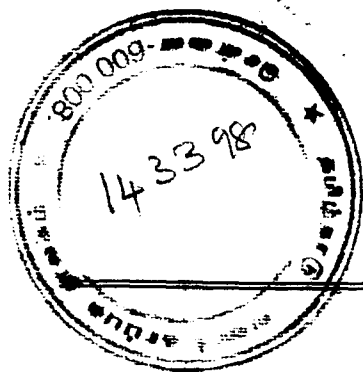
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NOTICE

Members and Subscribers are informed that the subscription for the current year for the Indian Geographical Journal has fallen due on the 1st January 1961. They are requested to kindly send their remittances with arrears, if any, to the Treasurer, Indian Geographical Society, 17-C, ARAVAMUTHU GARDENS, MADRAS-8.

M. N. VASANTHA DEVI,
Hon. Secretary.

THE INDIAN GEOGRAPHICAL JOURNAL

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The Editor takes no responsibility for the views expressed in the Journal. Authors alone are responsible for their respective statements.

CZECHOSLOVAK AGRICULTURE IN FACTS AND FIGURES

By

VACLAV EREMIAS,

Deputy Minister of Agriculture, Forestry and Water Economy.

The development of Czechoslovak agriculture between the years 1949-1960 has clearly shown that capitalist economists were wrong when they said that the change-over to the socialist system of farming must necessarily result in a drop in production. The total growth of agricultural production in the Czechoslovak Socialist Republic over the past 10 years has amounted to 20.8%. It increased substantially in the period of the second Five Year Plan (1956-1960).

The socialist sector in Czechoslovak agriculture increased relatively quickly.

The number of unified agricultural co-operatives reached their highest point at the end of 1959, when there were 12,560 unified agricultural co-operatives in Czechoslovakia. In 1960, 40% of these co-operative farms were joined into larger economic units, so that their number decreased by the end of last year to 10,816. The amount of agricultural land farmed by co-operatives however increased to 12,287,500 acres (the amount of arable land to 8,512,500) that is 67.3% of the total agricultural land.

The state farms are responsible for 15%, and other enterprises of the socialist sector for not quite 5% of the land. At the end of 1960 the state farms farmed 2,760,000 acres of land.

AGRICULTURAL PRODUCTION:—

Even though during the first and second five-year plans there was a considerable increase in agricultural production, this growth was not satisfactory. Over the past ten years an average of rather more than a 2% annual increase was achieved. In the third five-year plan very high aims were laid down for agriculture. They are however realistic and can be fulfilled, because co-operative farms are becoming economically stronger and are introducing the technique and technology of mass production. Apart from that the state gives agriculture great advantages. For instance the total investment in 1961-1965 is considerably larger than the amount invested in agriculture in either of the first five-year plans. Agriculture is getting much more fertilizers and more mechanised; extensive amelioration work is also to be carried out.

1. PLANT PRODUCTION:—

The structure of land sown to crops in the Czechoslovak Socialist Republic is gradually changing. Areas devoted to paying fodder root and technical crops are being extended. The structure of the areas of main crops in Czechoslovakia (in % areas of land sown to crops) is as follows:

	1955	1960	1965 (Plan)
Grain	52.7	50.8	51.7
Technical crops	7.3	7.8	7.8
Potatoes	12.2	11.0	10.0
Vegetables	0.9	0.9	0.9
Fodder root crops	26.9	29.5	29.6

The average yield per acre increased during the second five-year plan in the case of the majority of crops. For the third five-year plan the reckoned increase is still greater:

Quintals per hectare	1955	1960	1965 plan	Index		
				1960 1955	1965 1960	1965 1955
Wheat	20.4	23.1	27.—	114	117	132
Rye	18.9	20.5	25.—	108	122	132
Barley	20.1	24.7	26.5	122	107	132
Sugar beet	285.1	347.—	327.4	121	94	114
Potatoes	127.3	92.3	180.—	73	198	141
Permanent meadows	49.3	47.5	66.—	96	138	134

A considerable increase in gross and market production is connected with the acreage and yield. The development of gross and market plant pro-

duction in the Czechoslovak Socialist Republic is as follows: (in thousands of tons):

Gross Production	1955	1960	1965 plan	INDEX		
				1960 1955	1965 1960	1965 1955
Grain total	5261	5906	7081	112	119	134
Wheat	1473	1504	1998	102	132	136
Barley	1291	1744	1842	135	106	143
Maize for grain	391	593	720	152	121	184
Potatoes	7905	5254	9002	68	172	114
Sugar beet	6152	7890	7972	128	101	130
Fodder crops calculated to hay	11175	11196	14867	100	133	133
do maize for silage	326	1424	2688	425	189	824

Market production. (*)

Grain total (without seed crops)	1599	1640	1805	102	110	112
Wheat	554	365	466	66	84	128
Rye	438	506	614	115	122	140
Malt barley	477	669	630	138	132	96
Maize	31	30	35	96	116	112
Edible pulse crops	44	78	100	176	128	226
Potatoes	1421	1293	1360	91	105	95
Sugar beet	5109	7853	7972	152	157	101
Hops (in 50 kg.)	101	146	194	144	133	192
Vegetables and strawberries	412	572	742	139	130	180
Fruit	91	200	265	220	132	292
Grapes	18	13	55	68	300	439

(*) Under 1955 is the average for the years 1955-1957.

The measures taken in plant production are mainly aimed at increasing the production of crops valuable as fodder. For this reason the market production of some crops (e.g. wheat, potatoes and maize) will not increase in the third Five Year Plan; it is reckoned that the difference as against the total amount of production will remain in agriculture, in order to strengthen the fodder basis from its own sources.

2. ANIMAL PRODUCTION:—

Animal production in the Czechoslovak Socialist Republic has had an upward trend over recent years, though it has grown unevenly. In the third Five Year Plan we reckon with a further increase in the number of farm animals and in the yield obtained from them. The improved fodder bases and a further increase in the technology of mass production should help towards a substantial increase of the market production of animal produce.

The development in the numbers of farm animals is shown by the following table (in thousands):

	1955	1960	1965 plan	Index		
				1960 1955	1965 1960	1965 1955
Total livestock	4107	4394	4800	106	109	116
of this sows	2084	2065	2300	99	111	110
pigs	5285	5860	5680	110	97	108
of this sows	470	510	580	106	114	123
sheep	1000	680	600	68	88	60
poultry	23367	28900	27500	124	96	116

In relation to the land and the total number of livestock the development is as follows:—

	1955-57	1960	1965 (plan)
Percentage cows of the total number of cattle	50.5	48.1	47.9
Percentage sows of the total number of pigs	8.4	8.7	10.2
Number of cattle per 100 hectares of farm land	55.8	59.7	66.7
Number of cows per 100 hectares of farm land	28.2	28.2	31.9
Number of pigs per 100 hectares of arable land	104.7	113.5	109.2
Number of sows per 100 hectares of arable land	8.8	9.9	11.2
Number of poultry per 100 hectares of farm land	327.7	392.9	381.9

The yield that is achieved in the Czechoslovak Socialist Republic and that is planned to be achieved in 1965 is shown by the following table:

	1955-57	1960	1965 plan	Index		
				1960 1955-57	1965 1960	1965 1955-57
Milk yield of one cow per year in litres	1707	1800	2350	105	130	138
Average live weight:						
Cattle for slaughtering in kilograms	383	397	417	103	105	109
Pigs for slaughtering in kilograms	104	101	88	97	87	85
Number of weaned young:						
Calves per 100 cows	72.9	76.5	82.5	105	108	113
Piglets per sow	10.5	10.2	12.1	97	118	115
Average egg yield per hen	100.7	102.3	134.—	102	130	132

Development of market production of main kinds of livestock products (in thousand tons, million litres and per head).

	1955-57	1960	1965 plan	1960 1955-57	1965 1960	1965 1955-57
Total meat production	672.3	788.9	1029.0	117	130	153
Of this:						
Beef	292.3	346.5	445.—	119	128	152
Pork	321.5	369.5	505.—	115	136	157
Poultry (meat)	10.9	25.7	32.—	236	124	294
Milk	1834.3	2312.3	3455.—	126	149	189
Eggs	959.8	1280.—	1807.—	134	141	194

3. MARKET PRODUCTION:—

As can be seen from the surveys shown, market production — especially as a result of socialisation — has increased more rapidly than gross agricultural production itself. While the total amount of gross agricultural production increased 11% in 1960 as against 1955 (plant production by 7% and animal production by 17%), the turnover of market production has increased in the same period by 28%, plant production by 18% and animal by 33%.

A decrease in the share of market production in total production occurred during the second Five Year Plan only in those cases where their increased use as fodder had been planned. For instance, the percentage of purchase of the total production has decreased in the case of wheat (from 36.6% to 21.2%), maize (from 7.6% to 5.2%) and potatoes (from 16.2% to 14.6%), whereas in the case of other crops, which serve mainly for human consumption, the share of purchase in the total production has increased (for instance in the case of rye from 44.3% in the average years 1955-1957 to 51.1% in 1965, in the case of malt barley from 35.9% to 37.3%, pulses from 69.7% to 82.1%, and vegetables from 45% to 52.7%).

The same is true of animal production, where especially in the third Five Year Plan a growth of the share of market production in the total production is reckoned:

% of purchase in production	1955-57	1960	1965 (plan)
Total meat production	74.—	74.6	80.4
of this:			
beef and veal	100.—	100.—	100.—
pork	63.4	65.4	72.2
poultry (meat)	18.9	28.3	39.—
milk (plus farm butter)	51.7	61.4	64.3
consumer eggs	50.6	50.5	60.2

II. ENSURING THE GROWTH OF AGRICULTURAL PRODUCTION IN THE CZECHOSLOVAK SOCIALIST REPUBLIC.

A number of measures are taken to ensure a steady increase in agricultural production. Considerable means are granted to agriculture for investments, amelioration, purchase of means of mechanisation, ensuring of technical development, research and the use of the newest discoveries of agricultural science in production, an increase in the production of artificial fertilizers etc. Attention is devoted to uncovering reserves, decreasing harvest losses, maximum use of mechanisation, the introduction of progressive technology of agricultural mass-production into all branches, the training of key people and their correct development.

1. INVESTMENT CONSTRUCTION:—

The total investment in agriculture in 1951-55 amounted to 12.48 thousand million crowns, in the second Five Year Plan 30.1 thousand million crowns were invested and in the third Five Year Plan it is reckoned that the total investment will amount to almost 42.6 thousand million crowns, that is more than the whole amount invested over the past ten years. This means that in 1951-55, 1733 crowns were invested into every hectare of farm land, in 1956-1960, 4179 crowns and in the third Five Year Plan this sum will amount to 5,915 crowns.

A large part of the investments are intended for the Unified Agricultural Co-operatives (65%), and the remainder for the state sector, and this includes sums for amelioration, which will be carried out for the co-operative farms by enterprises of the state socialist sector.

During the third Five Year Plan the following are to be built from the total amount of investments: cowsheds for 712,000 milking cows and for 1,522,900 other cattle, pigsties for 285,900 sows and for 1,778,150 other pigs, irrigation will be carried out on 81,367 hectares of land and 199,761 hectares will be drained: 93,150 hectares will be irrigated by manure. Rivers and streams will be put in order over a length of 860 miles.

2. MECHANISATION OF AGRICULTURE:—

Although supplies of the means of mechanisation of agriculture were already considerable during the second Five Year Plan, the amount of machines and equipment delivered in 1961-1965 will be much larger. Altogether 111,760 tractors will be delivered, 11,200 of them caterpillar tractors, 10,000 lorries, 10,900 grain combines, 10,000 sugar beet combines, 5,000 potato combines, 27,500 silage combines, 20,000 reapers and binders, 11,000 threshers, 10,000 high-pressure presses, 152,780 trailer carts for tractors etc.

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The development of mechanisation in agriculture can be seen from the following:—

	1957	1960	1965 (Plan)
Arable land in hectares:			
For 1 wheel tractor (calculated at 15 HP) ...	116	72	34
For 1 caterpillar tractor ...	947	620	325
Trailer carts per tractor ...	0.98	1.05	1.46
Land sown to grain:			
For 1 grain combine (hectares) ...	604	385	164
For 1 reaper and binder ..	141	99	71
For 1 thresher ..	516	177	87
Land sown to potatoes:			
For 1 combine ...	5210	717	94
Land sown to beet:			
For 1 combine ...	—	300	23
Land sown to maize for food:			
For 1 combine ...	563	318	40
Land sown to maize for silage:			
For 1 combine ...	42	23	13

These figures are valid for the socialist sector; the drop in the figures of arable land or areas sown is also influenced by an increase in the areas of land in the socialist sector, especially in 1957-1960.

The situation in the deliveries of machines to agriculture is shown by these facts; in the third Five Year Plan there will be annual deliveries on the average of 7.5 times more tractors than in 1955, one half more grain combines, almost three times more beet combines, more than twice as many threshers and harvesters, etc.

The standard of mechanisation of the main work in agriculture will develop as follows (in percentages):

	1957	1960	1965 (plan)
Ploughing ...	58	80	95
Inter-row cultivation ...	30	65	80
Sowing of grain ...	43	76	88
Reaping of grain by combine ...	10	24	60
Reaping of maize for food by combine.	11	16	90
Reaping of silage crops by combine ...	70	80	95
Sugar beet lifting by combine ...	—	8	80
Potato lifting by combine ...	—	4	45
Loading of stable manure ...	—	24	85
Spreading of stable manure ...	—	10	85
Haycutting ...	52	83	90

3. ARTIFICIAL FERTILIZERS:—

The consumption of artificial fertilizers in the Czechoslovak Socialist Republic rises year by year. Whereas in the farm year 1949-50 only about 160,000 tons of fertilizer was put into the soil, in 1954-55 this was 326,000 tons, in 1960 almost 500,000 tons and in 1965 it is reckoned that almost 900,000 tons of fertilizer will be used. In the third Five Year Plan altogether 1,015.7 thousand tons of nitrogenous fertilizer (including ammonia) will be delivered, 1,045.8 thousand tons of phosphatic fertilizer and 1,315.3 thousand tons of potassic fertilizer. Altogether this means over the years 1961-65 deliveries of 3,376.8 thousand tons of artificial fertilizers.

The development of consumption is shown by this table:—

Consumption Kilogram per hectare of farm land	1954/55	1960	1965	Index		
				1960 54/55	1965 1960	1965 54/55
Nitrogenous (incl. ammonia)	10.7	20.2	39.7	189	197	371
Phosphatic	12.2	20.4	37.6	167	184	308
Potassic	21.7	28.7	54.2	132	189	250
Total	44.6	69.3	131.5	154	190	295

But of course not only artificial fertilizers are used. The soil must also in the first place have farm manure or composts. A national campaign for the production of compost in 1960 resulted in over 14 million cubic meters of compost.

4. NEW TECHNOLOGY OF PRODUCTION:—

New technology is the main means for fulfilling the high aims in the development of agricultural production. In animal production the spread of new methods of stabling is propagated (for instance deep straw under the animals), specialisation and the use of mechanisation. The training of those who look after the cattle and poultry is also important. In plant production the most important things are a systematic maintenance of the budgetted areas sown and the agrotechnical time-limits in the preparation of the soil, in cultivating the plants and reaping them, a careful choice of the species of seed, which will guarantee high yields, and the full use of all means of mechanisation. For instance in recent years in the Czechoslovak Socialist Republic there has been more cultivation of soft wheats, which increase the fodder basis. These species have great advantages; the yield amounts on the average to about 40 quintals a hectare and at the maximum even more than 60 quintals a hectare.

The new technology of harvesting is a great problem. To a great extent two or even three-phase harvesting is being introduced. It is reckoned that in 1961 this will be carried out on 20% of the total grain area, in 1963 on 35% and in 1965 on 60% of the total grain area.

A question connected with the mechanisation of field work is the care for decreasing harvest losses, which at the moment amount to 6-8% of the total harvest. For this reason a systematic fight is being waged in the

Czechoslovak Socialist Republic against harvest and storage losses and against pests, both in the case of grain and also other crops.

Special care will be devoted to the care of seedlings, so that high quality production and fertile species can be achieved.

III. CONCLUSION:—

The tasks that Czechoslovak agriculture has set itself for the third Five Year Plan are very big. In 1965 it is to produce on every hectare of arable land 1,230 kilograms of grain and 579 eggs and on every hectare of farm land 178 kilograms of meat and 746 litres of milk. (A litre is about one quart). As compared with 1960, 230 thousand tons more meat is to be purchased by state besides 1.1 thousand million litres of milk and 528 millions eggs.

The wide introduction of new technique and mass production technology in the socialist farms will play a decisive part in achieving these aims. It is especially important in view of the fact that the number of permanent workers in Czechoslovak agriculture has dropped in recent years. Whereas in 1950, 2,126 thousand permanent workers worked in agriculture, in 1955 this number was reduced to 1,797 thousand, 1960 it was 1,491 thousand and by 1965 it is to be decreased to 1,224 thousand. On the other hand this means that gross production per farm worker is greatly increased (in 1960 by 70% compared with 1950 and in 1965 by almost 50% compared with 1960).

All the measures taken in agricultural production will help not only to increase gross production and market production, but also to level out the differences between industry and agriculture.

SOVIET SCIENTISTS STUDY THE WORLD OCEAN

By

PROFESSOR L. ZENKEVICH,

*Corresponding Member of the USSR Academy of Sciences, Chairman of
the Academy's Oceanographic Commission.*

A plenary session of the Oceanographic Commission of the USSR Academy of Sciences was recently held in Moscow. In the Soviet Union there are over thirty research institutions engaged in studying the seas and oceans.

Prominent Soviet scientists, specialists in the field of oceanology and fishery, took part in the session. They summed up some of the results of underwater studies carried out. Reports were made by L. Zenkevich, Corresponding Member of the USSR Academy of Sciences, B. Manteufel, Doctor of Biology, Engineers V. Azhazha and O. Sokolov, Candidate of Engineering N. Vershinsky, and others.

Prof. L. Zenkevich, Corresponding Member of the USSR Academy of Sciences and Chairman of the Academy's Oceanographic Commission, gave an outline of the successes scored by the Soviet Union in studying the World Ocean, which is reproduced below.

The past decades have seen exceptionally broad development in the USSR of the study of the seas and oceans. And that is quite understandable. The USSR's borders are washed by 14 seas, among them two inland seas—the Caspian and Aral. All of them belong to the basins of three oceans—the Arctic, Atlantic and Pacific Oceans—and are very variegated both as to their physico-geographic and chemical features and as regards the broad variety of the fauna populating them. Among them there are such shallow and flat saucer-like seas as the Azov Sea, such giant seas as the Bering Sea with depths exceeding 4,000 metres, seas like the Black Sea — an anomalous water body with hydrogen-sulphide contaminated depths, as well as ice-clad seas of the northern outskirts of the USSR.

The salinity of the sea waters is quite different—from 0.8 percent in the Baltic Sea to 3.4 per cent in the Barents Sea, the Sea of Okhotsk, and others.

The Siberian outskirt seas are amply populated by relict brackish-water fauna—the heritage of the glacial era; the southern seas, such as the Azov and Caspian Seas, are also populated by relict fauna, but it is of a different genesis.

The Seas of the Soviet Union are not only an excellent object for all-round studies, but they also present a most important item of national economic significance. They concentrate in themselves rich vegetable and animal raw-material resources: cod fish, herring, haddock in the North; salmon, Kamchatka crab and dab in the Far East; sturgeon in the southern seas. All these seas also possess great algae wealth, the stocks of the Black Sea phytoplankton alone are estimated to be millions of large tons.

Intensive marine explorations are at present being conducted by many Soviet research institutions, among them the Oceanology Institute and the Marine Hydrophysics Institute of the USSR Academy of Sciences,

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the Arctic and Antarctic Institute, the USSR Institute of Fisheries and Oceanography, and a great number of local sea-fishery hydrometeorological institutes and biological stations, including the oldest of them—the Sebastopol Biological Station and the Murmansk Marine Biological Institute. The result is that many of the seas that wash the coasts of the USSR may be justly considered to be the best studied sea bodies in the world.

Soviet explorers of the seas conduct research in the open oceans as well. The studies initiated by I. Papanin's world famous drifting-ice station a quarter of a century ago have now covered the entire Soviet sector of the Arctic Ocean. Soviet research and fishing vessels are now furrowing the North Atlantic, the Norwegian and Greenland Seas.

It was twelve years ago that the "Vityaz," the flagship of the Soviet research fleet, started her world-famous studies of the Pacific Ocean and especially of its depths, including the greatest of them—over 11 thousand metres deep.

It is interesting to note that at the close of the forties and the early fifties of our century there were four major expeditions going on almost simultaneously, which pursued the aim of studying the ocean depths; a Swedish expedition on the "Albatross," a Soviet expedition on the "Vytyaz," a Danish expedition on the "Galatea," and a British expedition on the "Challenger II." Our knowledge of the ocean depths was greatly enlarged in those years. It is quite illustrative that even recently some scientists used to maintain that there could not be any life at depths greater than 6,500–7,000 metres. This assumption was refuted by the great variety of the fauna collected chiefly by the "Vityaz" and the "Galatea" expeditions from depths exceeding 10 thousand metres.

The deep-water explorations immediately put forward a number of problems that had not been touched upon before. Among them were the composition and distribution of deep-water fauna, the circulation of the ocean's deep waters, the relief of the ocean bed, the composition and distribution of deep-water sedimentation, the chemical balance of ocean waters, the vertical and geographic zonality of the ocean, and many others. The past decade has brought many important discoveries in these spheres and mapped the lines of further research. An American project involving drilling on the sea bottom through the entire depth of bottom deposits and the earth crust to the mantle has won extensive fame. If it is carried out, the scientists will get answers to the still unsolved important problems of the geological past not only of the ocean proper, but of our planet, too, as well as answers to problems in the fields of geology, geophysics, geochemistry, palaeo-climatology, and the structure of the sub-ocean earth's crust.

About half a century ago it became evident that it was in the sphere of research and economic development of the World Ocean that international forms of co-operation were to find extensive application, since the ocean does not belong to any particular country, and that its resources must be used jointly by many countries. In 1902 there originated the International Council for Studying the Sea, which set the aim of studying the north-western part of the Atlantic and of co-operating in utilising its fish resources. Since then there appeared many international associations with the purpose of jointly utilising and protecting the raw-material resources of the various parts of the World Ocean.

The commercial utilisation of various fishes, whales, seals, etc., the protection of the ocean's raw-material resources and waters against various types of contamination, including radioactive pollution, were included in the sphere of international peaceful co-operation for the benefit of humanity.

International co-operation in the sphere of oceanology grew particularly active while implementing the programmes of the International Geophysical Year (1957-1958) and International Geophysical Co-operation (1959). The USSR took part in the oceanographic research under the IGY and IGC programmes, sending out expeditions on large research vessels, among them, first and foremost, the "Vityaz," the "Lomonosov," the "Ob", the "Sedov," the "Sevastopol," as well as many other smaller ships with a total displacement of 35,000 tons. These vessels covered a route totalling 250,000 kilometres and made over 2,000 scientific anchorages.

When the IGY and IGC were over, international research did not stop.

The International Committee for Oceanographic Research drew up an extensive programme of exploring the Indian Ocean as the least studied part of the World Ocean, which called for the joint efforts of many countries with the primary purpose of extending the knowledge of its natural resources to be put to the fullest possible service of the peoples populating its coasts.

The USSR made the greatest contribution into this international programme as well.

The scientific expedition on the "Vityaz" took over a year and a half. In that period she made two cruises in the Indian Ocean under the international co-operation programme. In her last cruise alone the vessel covered over 30 thousand miles, making 280 scientific anchorages.

The scientists on the Soviet expedition vessel wiped out many "blank spots." They discovered new underwater mountains and volcanoes, ridges and depressions. They have defined the contours and relief of the big underwater ridges that cross the ocean: the Arabian-Indian and Central-Indian ridges. A deep trough with steep slopes and flat bottom at a depth of 5,400 metres was discovered in the region of the Chagos Islands.

In its last cruise the "Vityaz" expedition discovered a big underwater mountain 550 miles to the south-east from Ceylon. Scientists have now established that it is a large volcanic cone with several peaks, which rises over the adjoining areas by more than three kilometres. The least depth over the mountain is 1,550 metres. Formerly this spot was indicated as having a depth of 4,500 metres. The crew of the "Vityaz" has proposed to give this mountain the name of Afanasi Nikitin—the first Russian traveller to sail the Indian Ocean. Several other formerly unknown underwater mountains up to 2-2.5 kilometres high were discovered as well.

Large concentrations of manganese concretions were found in the central part of the ocean at depths of 4-5 kilometres. Sometimes the bottom is covered by an all-manganese crust.

Scientists have succeeded in determining the thickness (depth) of the earth's crust in the central part of the ocean. It totals seven and a half kilometres.

Hydrologists performed extensive work of exploring the chief currents of the Indian Ocean—the Somali and Equatorial currents and the monsoon

drift. They have found the current velocities to be rather considerable at depths of 500 to 1000 metres and over.

Ichthyologists have gathered an immense collection of fishes—450 species. They have found rare and hitherto completely unknown kinds of animals, and drew up maps of their distribution. Large concentrations of tuna fish were discovered in the Somali current area to the east from Africa.

Interesting research was carried out by hydrochemists. They have discovered hydrogen-sulphide contamination of the waters in a layer of oxygen minimum in the north-eastern part of the Arabian Sea and the north-western part of the Bay of Bengal. Such phenomena had previously been known only in the Black Sea and the Norwegian fjords. The presence of hydrogen sulphide in the Arabian Sea gives an explanation to the episodic fish-kill in this area.

While in Colombo, Bombay and Calcutta the "Vityaz" was visited by scientists of Ceylon and India who acquainted themselves with the work of the expedition.

On the 1st of August, 1961, the "Vityaz" set out again for a long voyage—to the central part of the Pacific. She will first visit Honolulu where the Tenth Pacific Congress will take place. The scientists on the "Vityaz" will take part in the work of the Congress. They will deliver a number of reports there.

Artemi Ivanov, one of the most prominent Soviet zoologists, several times took part in the Scientific exploration cruises of the Vityaz. He gathered a unique collection of ancient sea animals—the pogonophores—and studied their nature.

The Scientist's research helped to establish that the pogonophores were a new type of animal, very rich in species and very ancient. It approaches the chordal type which includes the vertebrates as well. Professor A. Ivanov devoted over ten years to studying these animals living in the ocean depths.

The work by A. Ivanov, Doctor of Biology and Professor of the Leningrad State University "Pogonophores"—has been awarded a 1961 Lenin Prize. It is the sum total of many years' research which has led to a discovery of world significance. The scientist's work and discovery has attracted the attention of foreign zoologists. A. Ivanov's works have been translated into many foreign languages.

An Atlantic expedition of the USSR Academy of Sciences, which has been working on the research vessels "Sergei Vavilov" and "Pyotr Lebedev" has recently returned to Leningrad.

One might think that the Atlantic is a well-studied area of the World Ocean, and nevertheless our knowledge of it is still insufficient. The development of physics has equipped the scientists with new means and instruments, and a new methodology of oceanological observation has now, come to the scientists' aid.

Apart from using echo-sounders for determining the depths, the members of the expedition made extensive use of seismo-acoustic methods for studying the ocean bottom. Working parallel on two vessels they succeeded in synchronizing their research and in tracing the progress of the given processes in time and space.

Having high-speed vessels and the latest apparatuses at its disposal the expedition carried out a great volume of work within a comparatively short time—138 days—performing research in the northern, equatorial and southern parts of the Atlantic. Extensive material has been collected by its biological section.

Large-scale work involving the study of the Black Sea and the eastern part of the Mediterranean is being carried out in the course of four years by the Sebastopol Station of the USSR Academy of Sciences and the Black Sea Station of the Academy's Oceanology Institute. Exploration of the Mediterranean is conducted under a programme co-ordinated with French research institutions. The last expedition of the Sebastopol Station worked in the Mediterranean for the first time in winter months.

The staff of the biological station will this year take part in studying the Red Sea and the Indian Ocean.

Such are some of the results of recent Soviet research in the World Ocean.

There is no doubt that the development of oceanographic research, the discoveries already made, and those that are to be made in the future will be of paramount importance to mankind.

UNDER GROUND WATER LEVEL IN THE BIST JULLUNDUR DOAB, PUNJAB (INDIA)*

By

DR. O. P. BHARADWAJ, M.A., Ph.D. (London), P.E.S.

Professor & Head of the Dept. of Geography,
Punjab University, Government College, Ludhiana (Punjab) India.

UNDERGROUND WATER LEVEL

Factors that affect the underground water level.

The following factors affect the underground water level in the Doab:

1. Structure
2. Relief
3. Soil Texture
4. Rainfall

and, 5. Drainage Channels.

1. Structure.

The character and arrangement of the rocks which constitute the Doab affect the occurrence and movement of underground water level. Deposits of the uplands consist of Older Alluvium or the *Bangar* which belongs to the Middle and Upper Pleistocene. These deposits are dark coloured and generally rich in concretions and nodules of impure calcium carbonate known as *Kankar*. The deposits of the Lowlands consist of New Alluvium or the *Khadar*. These deposits are light coloured and rich in calcareous matter and belong to the Upper Pleistocene. Both these deposits are pervious and the rain water percolates into them without any difficulty.

The Doab plain is flanked on the east by the Siwaliks which are composed of stratified beds of conglomerates, unconsolidated sandstones and clays, the sandstones being most predominant. The Siwaliks have been greatly dissected by the *Chos* and *Khads* which bring down large amounts of water and spread it on the Doab plain. This water percolates into the ground and adds to the underground water resources.

The flow of the underground water is significantly affected by the presence of the subterranean ridge called the Burrard or Delhi — Shahpur ridge which is a continuation of the Aravallis. The ridge runs under the Jumna — Sutlej divide, passing a little to the west of the Doab region. It continues west-ward upto the Salt Range (West Pakistan) where it appears above the surface of the plain in the shape of the Shahpur, Sangla and Kirana hills.¹ The ridge is formed of metamorphic and igneous rocks which are impervious, and obstructs the westward flow of the underground water from the Doab plain towards Rajasthan and Saurashtra. B.H. Wilsdon² made the following observations about this ridge:

Paper Read before the Indian Science Congress Association 1961.

1. Krishnan, M. S., *Geology of India*, 1949- p. 517.

2. Wilsdon, B. H., note on *statistical examination of the water-table in Ambala and Hoshiarpur districts*, 1925. This note is to be seen in the files of the Central Irrigation and Power Research Institute, Amritsar, Punjab (India).

From isolated observations at a few places in the Punjab, regions of 'excess density' have been detected. From the observations of the water-table there are also indications of some such barrier which outcrops at Sangla hill and Sargodha; this fits in with the fact that north of a line drawn between these points the water-table has risen dangerously near the surface while south of the line, the water gets rapidly deeper.

Fig. 1 shows the approximate alignment of the Burrard or Delhi—Shahpur ridge and indicates very clearly how it obstructs the direct flow of the underground water from the Doab to the west.¹

2. Relief.

The Doab plain slopes gradually and imperceptibly from east to west. The height of the plain is 1,000 feet above sea level in the east and it gradually slopes to 700 feet in the south-west. A large number of rainy season torrents or *Chos* come down the Katar Dhar and flow over the plain and the gentle gradient of the plain helps in the percolation of the large quantities of rain water into the subsoil of the plain.

3. Soil Texture.

The soils on the foot of the Siwalike are gravelly. As we go to the west, sandy, sandy loams, and loamy soils are seen. These soils allow water to percolate freely into the ground and thus help to replenish the existing stock of underground water.

4. Rainfall.

The Primary source of water is rainfall. The variations in the amount of rainfall affect the underground water resources of the Doab.

5. Drainage Channels.

(a) *The Rivers*: The Doab is bounded by the river Bias on the north and the Sutlej in the south. Large quantities of water percolate from these two rivers into the Doab plain by seepage and that adds to the existing store of water.

(b) *Chos, Khads and Beins*: There are eighty five *Chos* and *Khads* flowing down the slope of the Katar Dhar on the Doab plain. Most of the *Chos* are blind and spread their monsoon discharge of water on the surrounding area which in due course reaches the sub-soil. The *Khads* from the eastern slope of the Katar Dhar and the western slope of the Sola Singhi meet the Soan which flows throughout the length of the Una Dun and ultimately discharges the water into the Sutlej. This stream is responsible for draining a huge amount of water away from the hilly part of the Doab but a lot percolates into the ground to replenish the existing resources.

Some of the *Chos* unite to form the Beins, Eastern and Western, which flow throughout the length of the Doab plain and ultimately join the Sutlej. A good deal of seepage takes place from these *Beins*.

1. A relief model based on Figure 1 is to be seen at the Central Irrigation and Power Research Institute, Amritsar (Punjab) India. This model has been designed to study the behaviour of underground water in relation to the Delhi-Shahpur ridge.

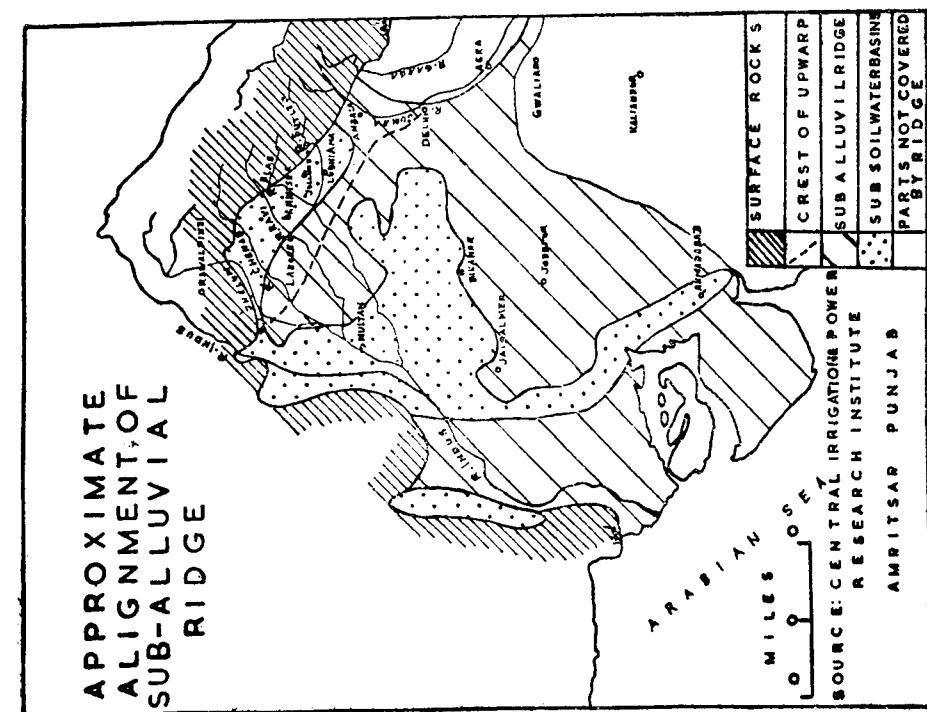


Fig. 1

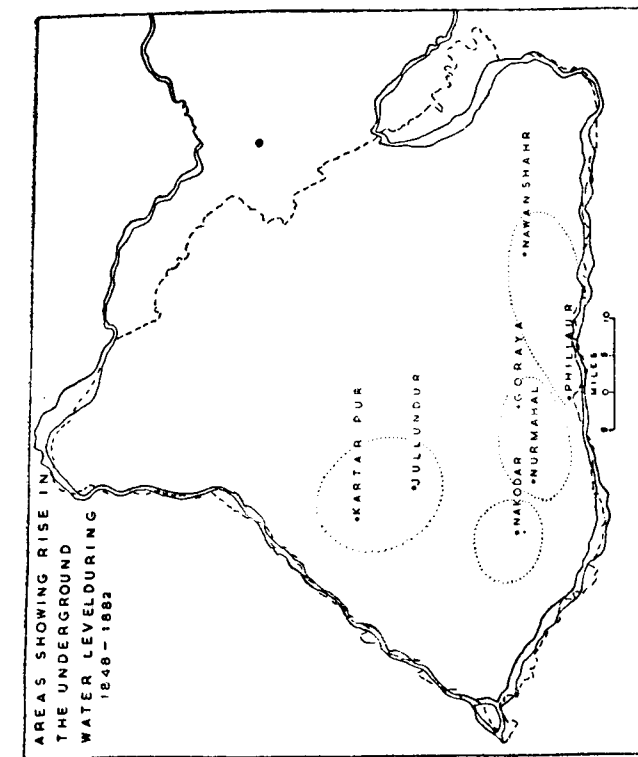


Fig. 2

(c) *The Bist Doab Canal*: Recently a new canal, called the Bist Doab Canal, has been taken out from the Sutlej to irrigate some parts of the Doab. Due to this canal the pressure on the existing wells will be considerably reduced and the present underground water suction or outflow will proportionately decrease and it would ultimately affect the sub-soil water level.

For any scientific study of underground water resources all the inflow and outflow factors and their intensity have to be taken into account. If the inflow exceeds the outflow, the water logging conditions are likely to appear and if the outflow exceeds the inflow the region is liable to be desiccated.

Unfortunately no data for all the inflow and outflow factors are available. The only available data are that of rainfall and that fortunately is available for a period longer than a climatic cycle. Therefore an attempt is being made to investigate the correlation, if there is any, between the decrease and increase in the amount of periodic rainfall and the rise and fall of water level.

Rise and fall of water level during the period 1848—1952.

B. H. Wilsdon, scientific research officer, Irrigation Research Institute, Punjab, investigated the problem in 1924 and reported that during the period 1848-1882 there had been a rise of water level in the following four areas of the Doab¹

- (a) Kartarpur - Jullundur
- (b) Nakodar
- (c) Nurmahel - Goraya
- (d) Nawanshahr - Phillaur.

Figure 2 is an attempt to show the location of these four areas. Unfortunately Wilsdon's paper contains no information on their extent beyond the above statement. The paper contains nothing to suggest how large the areas were.

During the period 1882-1908 all these areas registered a fall in water level. Wilsdon was of the opinion that the areas of fall of water level during the period 1882-1908 were coincident with areas of high irrigation intensity². The water drained away from the sub soil by means of wells, which were the only means of irrigation in these regions, has been the chief cause of the fall of water level. Wilsdon suggested that the water level might rise if a canal were constructed in the area to bring in irrigation water from the Sutlej.

H. W. Nicholson³, Chief Engineer, Irrigation branch P.W.D., Punjab, however, pointed out too many engineering difficulties in the construction of

1. Wilsdon B. H. Note dated 27th May, 1924 to the Financial Commissioner, Jullundur Division, 'The Changes in the Water Table of Jullundur District'. This note is to be found in the files of the Central Irrigation Research Institute, Amritsar (Punjab), India.
2. There was no practice of keeping a regular record of water level before 1926 Wilsdon collected his data from the settlement Reports of the respective districts. These data were recorded during the course of assessment of revenue survey in the respective area.
3. Nicholson, H.W., note dated 5th February, 1929, *The Construction of the Kharif Canal in the Doab*. This note is to be seen in the files of the Central Irrigation and Power Research Institute, Amritsar (Punjab) India.

the suggested canal. The area through which the canal would run was devastated by numerous *Chos*. A.N.M. Robertson¹ Superintending Engineer, Water Logging Investigation Circle, Punjab, forwarded proposals for constructing water storage tanks, afforestation of the Siwaliks and the formation of the *Wattbandi* societies. In order to popularize the system of *Wattbandi*, he also suggested that the problems should be examined by an expert from the Geological Survey of India.

Dr. G. De P. Cotter², Superintendent, Geological Survey of India, studied the problems on the spot in 1931 and ascribed the fall of water level to the following factors:

1. Decrease in the amount of rainfall.
2. Increase in the number of wells and consequent intensity of irrigation.
3. Decrease in the acreage of fallow land, due to an increase in the intensity of irrigation. He, therefore, suggested (i) to make provision for collecting the flood water by constructing reservoirs, so that the water may ultimately sink into the ground, and
- (ii) to construct earthen embankments or *Watts* round the fields so that the water may percolate into the sub soil.

Dr. E. Meckenzie³ Taylor, Director of the Irrigation Research Institute, Lahore (Punjab) also investigated the problem and observed that the intensity of irrigation and fall of water level seem to have no relation. He compared the survey maps of the years 1863 and 1921 and came to the conclusion that the areas of fall of water level were those from which the *Chos* had receded due to change in their courses. The absence of percolation of water from the *Chos* was responsible for the fall of water levels. He tried to establish that the water that percolated into the sub soil from the *Chos* added to the underground water resources. R. B. Bawa Natha Singh⁴, Superintending Engineer, Jullundur Circle, was of the opinion that there had been a decrease in the amount of rainfall during the last forty years and he considered that to be an important factor causing the water level to fall. He used the statistical method and showed that the ten yearly averages as given below clearly showed that there had been a steady decrease in the amount of rainfall during the previous forty years.

1. Robertson, A.N.M., note dated 13th January, 1930, 'The Depletion of the Water—Table in Jullundur and Hoshiarpur Districts' This note is to be seen in the files of the Central Irrigation and Power Research Institute, Amritsar (Punjab), India.
2. Cotter, G. De P., note dated April 1931, 'The Fall in the Water—Table in the Jullundur District.' This note is to be seen in the files of the Central Irrigation and Power Research Institute, Amritsar (Punjab) India.
3. Lacey, J. M. *Text Book of Hydrology and Ground Water*. 1926, p. 84. He is of the opinion that the water percolates more into the fallow land as compared to the arable land.
4. Inspection note number 2007 dated 2nd June, 1933 from Dr. E. Meckenzie Taylor to the Commissioner of Jullundur Division. This note is to be seen in the files of the Central Irrigation and Power Research Institute, Amritsar (Punjab), India.
5. Singh, R.B. Bawa Natha, note dated 7th May, 1934, *The Increase of Rainfall in the Doab*. This note is to be found in the files of the Central Irrigation and Power Research Institute, Amritsar (Punjab), India.

TABLE I
TEN YEARLY AVERAGES OF RAINFALL IN INCHES
FOR THE DOAB DURING THE PERIOD 1891—1930

Ten Yearly Averages in inches.		
1891 - 1900	...	34.45
1901 - 1910	...	31.58
1911 - 1920	...	28.71
1921 - 1930	...	26.61
Average for forty years	...	30.46

Dr. E. Meckenzie Taylor differed from R. B. Bawa Natha Singh and was of the opinion that the method of comparing the ten yearly averages was liable to be very much affected by the values for the 'end years'. He argued that had the Superintending Engineer, Jullundur Circle started his calculation in 1894, the following averages would have been obtained for 'ten yearly' intervals which are in each case different from those calculated by him.

TABLE II
TEN YEARLY AVERAGES OF RAINFALL IN INCHES FOR
THE DOAB DURING THE PERIOD 1894—1933

Ten Yearly Averages in inches.		
1894 - 1903	...	31.14
1904 - 1913	...	31.18
1914 - 1923	...	29.24
1924 - 1933	...	28.15
Mean for the forty years	...	29.23

He held that in order to ascertain whether or not the change in 'ten yearly' averages was significant, it should be seen if the difference of 'ten yearly' averages exceeded twice the 'standard deviation' for such averages. The standard deviation for the forty three years was 9.66 and that for ten yearly averages therefore comes to $9.66 \div \sqrt{10} = 3.05$. The difference between any pair of ten yearly means is consequently significant only if it exceeds 6.10. Applying this test to the statistical analysis as done by R.B. Bawa Natha Singh, it becomes clear that only 1891 — 1900 average is significantly greater than the 1920 — 1930 average and that the difference between no other pair approaches the significant limit.

In the statistical analysis as done by Dr. E. Meckenzie Taylor the biggest difference is 3.03 and consequently there can be no question of its having any 'significance.' Dr. E. Meckenzie Taylor argued that this method takes account of the continuity of time series and does not regard the isolated

1. The averages quoted here from Singh's note are based on the district averages i.e. the annual rainfalls of all the stations in the district. In this instance two districts, Jullundur and Hoshiarpur, were used and in all there were nine stations.
2. Taylor, Dr. Meckenzie, note dated 13th August, 1934, *The Change in the Mean Annual Rainfall in the Doab*. This note is to be seen in the files of the Central Irrigation and Power Research Institute, Amritsar, (Punjab), India.

annual values as 'Random Samples.' It is thus a superior method to the one applied by R. B. Bawa Natha Singh.¹

By using that method Dr. E. Meckenzie Taylor was able to prove that the fall in the amount of rainfall was insignificant.

Accordingly the 'Significance of change' in the amount of rainfall for the period 1926 to 1952 as calculated by Fisher's method is as follows:

TABLE III
TEN YEARLY AVERAGES OF RAINFALL IN INCHES FOR
THE DOAB DURING THE PERIOD 1926-1952.

1926 - 1934	...	24.72
1935 - 1943	...	25.99
1944 - 1952	...	32.22
Mean for the twenty seven years		27.64

The standard deviation for the twenty seven years is 7.56" and that for the nine yearly means comes to $7.56" \div \sqrt{9} = 2.52"$. The difference of nine yearly means is consequently significant only if it exceeds 5.04". The 1944-1952 average is significantly greater than both 1926-1934 and 1935-1943 averages. It is, therefore, concluded that there has been a significant rise in the rainfall during the period 1944 to 1952.

This significant rise in the amount of rainfall is responsible to a great extent, for the rise of the water level during the same period in the whole of the Doab.

THE REGIONAL DISTRIBUTION OF THE RISE AND FALL OF WATER LEVEL:

Figure 3 shows the isopleths joining the places having the same underground water level during June 1943. The exact position of the wells and the pipes which have been specially sunk into the ground for recording the underground water levels is shown on the map by means of dots and the figures by their side show the exact underground water levels in June 1943.²

The reference numbers by which these wells are recorded on the index map of the Irrigation Department of the Punjab (India) have been shown on Figure 4. The water levels during June are very significant because it is the month which precedes the wet season and the water level is at the lowest. The isopleth of 10 feet underground water level runs parallel to the Bias. The isopleth of 20 feet of water level runs almost parallel to the isopleth of 10 feet underground water level in the north, in the middle it bends to the east and after enclosing a part of the Doab Uplands it again begins to run

1. The method used by Dr. E. Meckenzie Taylor is the same as given in Fisher, R.A., *Statistical Methods for Research Workers*, 1944, pp. 114-168.
2. The data have been taken from the Central Irrigation and Power Research Institute, Amritsar (Punjab), India.
3. The data of underground water level for twenty one wells both for June and October 1943 and 1952 have been taken from the unpublished record of the Central Irrigation and Power Research Institute, Amritsar (Punjab), India. It is the regular practice to take the readings of underground water level during the months of June and October from the wells and pipes which are specially earmarked for this purpose.

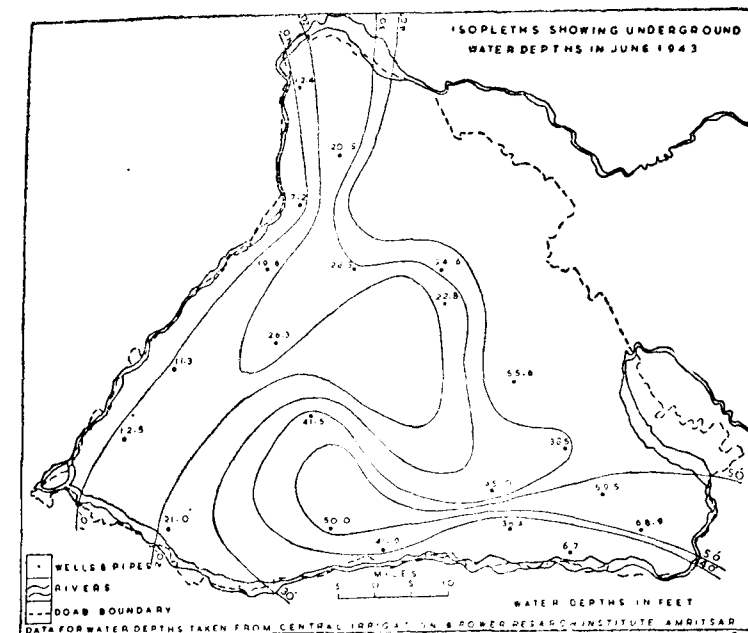


Fig. 3

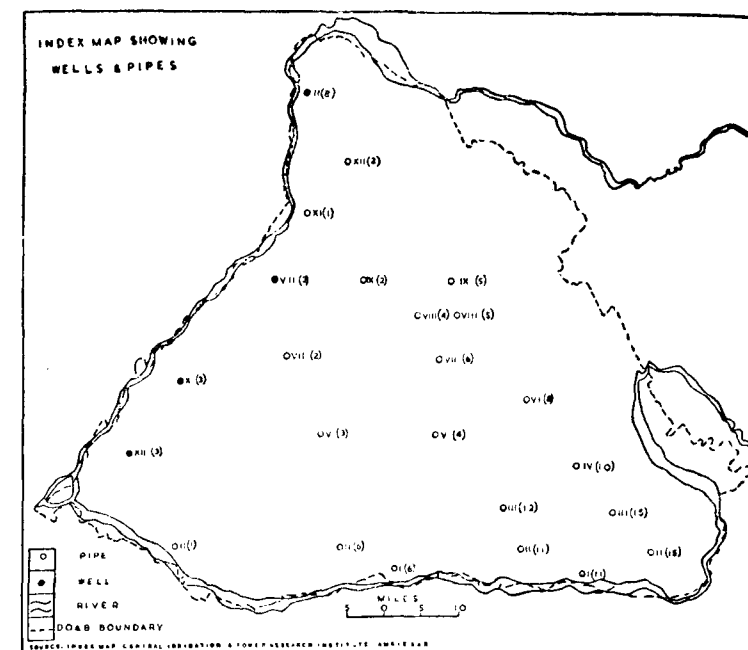
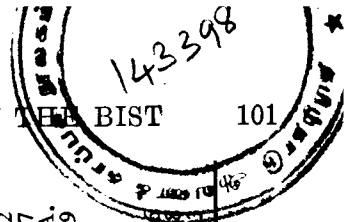


Fig. 4

TABLE IV.—UNDERGROUND WATER LEVELS IN DIFFERENT
WELLS AND PIPES DURING 1943 AND 1952.

Serial Number	Line number as given on the index map	Well or Pipe number as given on the index map	Village in which situated	Well or Pipe	Height above sea level	June 1943	Oct. 1943	June 1952	Oct. 1952
Along the Sutlej									
1	I	6	Phillaur	Pipe	803.7	41.4	41.4	39.6	37.4
2	I	11	Cholasuffat	"	819.3	6.7	5.2	N.A.	6.7
3	II	1	Pattwa	"	723.6	21.0	19.5	16.0	18.5
4	II	6	—	"	784.9	50.0	49.8	38.9	45.0
5	II	11	—	"	837.9	38.3	37.6	36.7	36.3
6	III	12	Nawanshahr	"	850.0	35.0	34.9	30.4	29.2
Along the Bias									
7	II	2	Bagowal	Well	847.1	12.4	5.7	6.0	3.5
8	VII	2	—	"	756.9	19.6	19.3	N.A.	18.3
9	X	3	—	"	722.9	11.3	9.2	11.5	4.9
10	XI	1	—	Pipe	772.7	7.2	6.0	8.7	6.4
11	XII	2	Dasuya	"	920.0	20.5	20.2	15.9	15.8
12	XII	3	—	Well	702.8	12.5	12.0	9.0	6.0
Along the Katar Dhar									
13	II	15	—	Pipe	1003.9	68.3	69.0	72.2	69.9
14	III	15	Sodhra	"	984.4('43)	59.5	59.7	45.4	46.8
					967.7('52)				
15	IV	10	Garhshankar	"	1000.0	38.5	36.9	33.5	31.2
16	VI	8	—	"	1040.8	55.6	56.0	46.9	46.7
17	VII	5	Suthehri	"	980.2	22.8	22.2	N.A.	N.A.
18	IX	5	Bassi Oassu	"	1061.9	34.6	32.1	22.7	17.9
Along the Central Region									
19	V	3	—	"	773.1	41.5	40.2	31.6	30.8
20	VII	2	Kartarpur	"	N.A.	26.3	26.2	19.6	19.8
21	IX	2	Hejwan	"	830.4	28.5	28.6	N.A.	15.3

1. Source = Central Irrigation and Power Research Institute, Amritsar (Punjab), India, unpublished record.
N.A. = Not available.



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parallel to the Bias in the South. The isopleth of 40 feet of water level runs parallel to the Katar Dhar but in the south it bends to the west to enclose a part of the south-east Upland. This makes it clear that the places having the highest water level are situated in the Bias Lowland and central part of the Doab Uplands, those having the lowest water level are situated at the foot of the Katar Dhar and over the south-east Upland (Fig. 3 and Table IV).

Figure 5 shows the isopleths joining the places having the same underground water level during October 1943. The isopleths have a pattern similar to that of June 1943. The only difference is that the underground water level, with a few exceptions, is higher.

Figure 6 shows the isopleths joining the places having the same underground water level during June 1952. There is no fundamental difference in their trend as compared to those of June 1943 but the figures indicate, with a few exceptions, a general rise in the water level throughout the Doab.

Figure 7 shows the isopleths joining the places having the same underground water level during October 1952. It again shows no remarkable change in the trend of isopleths but with a few exceptions, a rise in the underground water level is noticed as compared to the underground water level in June 1952.

The rise of water level when compared to the water level of October 1943 is alarming. In some cases the rise has been more than ten feet but the wells showing a rise of five feet and a little more are quite numerous. Water-logging of the soil has already appeared in places and if the rise continues water-logging can be expected to appear on a large scale.

The recorded data indicate that there has been a general rise in the underground water level throughout the Doab during the period 1943 to 1952. It has already been observed that there has been a significant rise in the total amount of rainfall during the last two decades and this rise in water level may be the result of the increase in the rainfall.

Figure 8 and Table V indicate the yearly rise and fall of underground water level at a pipe near Hoshiarpur from 1943 to 1952 both in June and October. The line showing the rise and fall in the amount of wet season rainfall (July to September inclusive) for 1943 to 1952 has also been marked on the figure. The figure indicates that there have been oscillations in the level of underground water both in June and October but the water level in October of each year has invariably been higher than that in June. The rise and fall of October water level has a direct relation to the rise and fall of wet season rainfall during this period.

Figure 9 and Table V show the yearly rise and fall of the underground water level at Garhshankar from 1943 to 1952 both in June and October. The line showing the rise and fall in the amount of wet season rainfall (July to September inclusive) from 1943 to 1952 has also been marked on the figure. The water level in October of each year has invariably been higher than that of June and the yearly rise and fall of water level has a direct relation with the yearly rise and fall of wet season rainfall during this period.

Figure 10 and Table V show the rise and fall of the underground water level at Nawanshahr from 1943 to 1952 both in June and October.

1. The data relate to pipe number 4, line number VIII situated near Hoshiarpur and the same is shown on the index map.

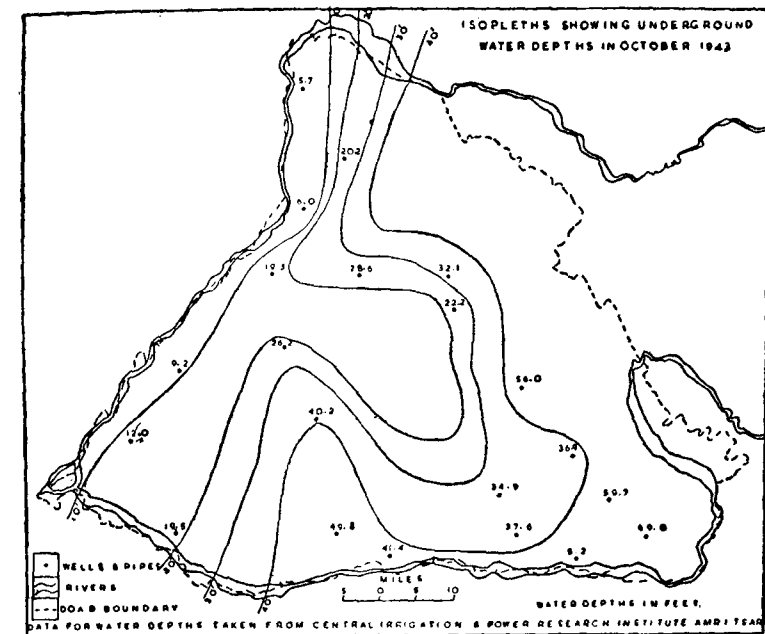


Fig. 5

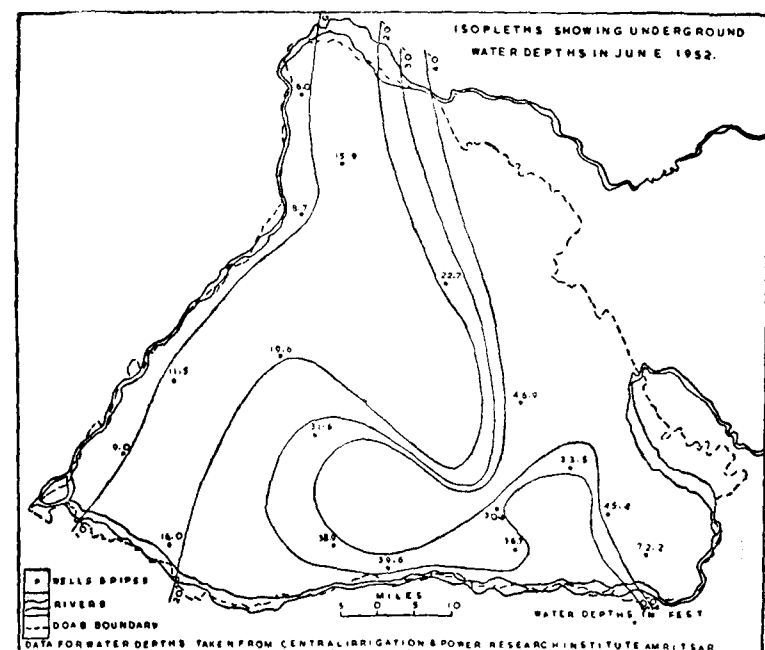


Fig. 6

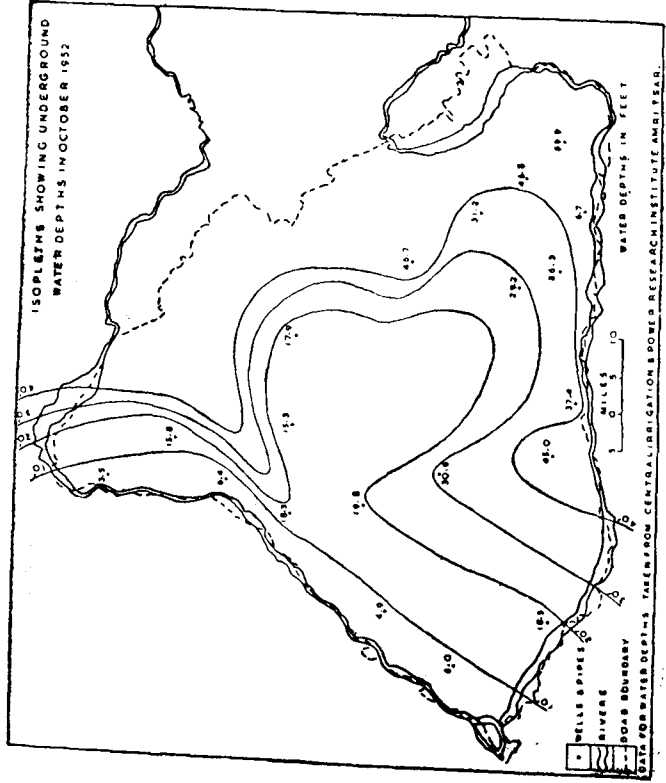


Fig. 7

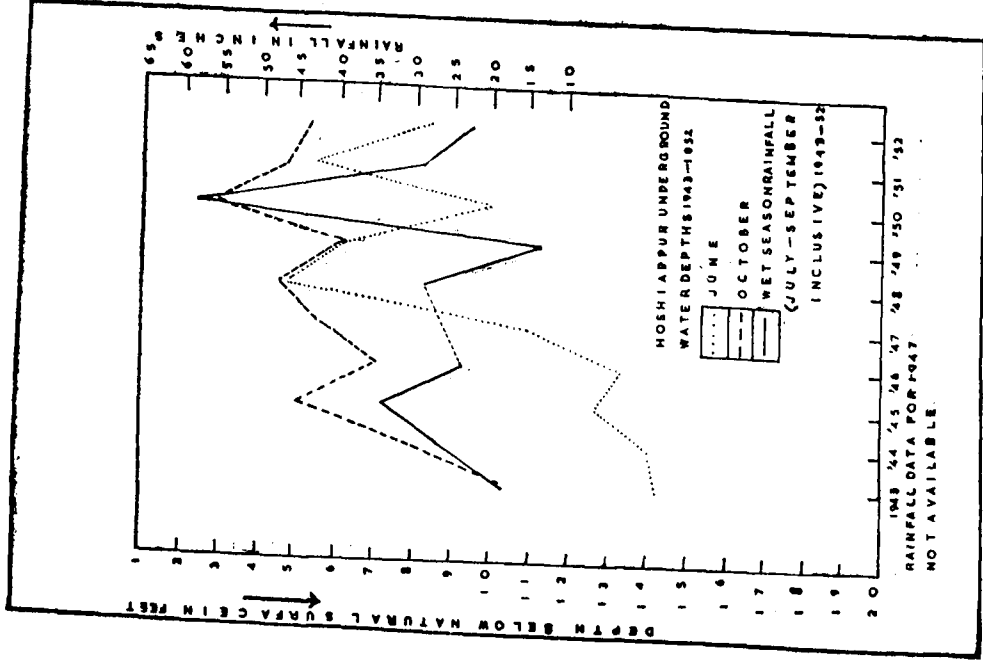


Fig. 8

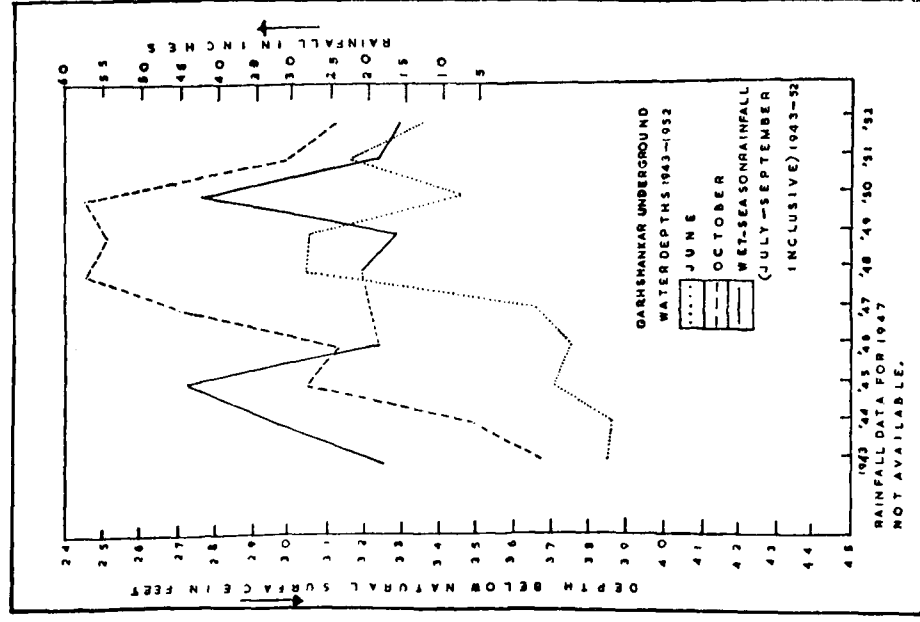


Fig. 9

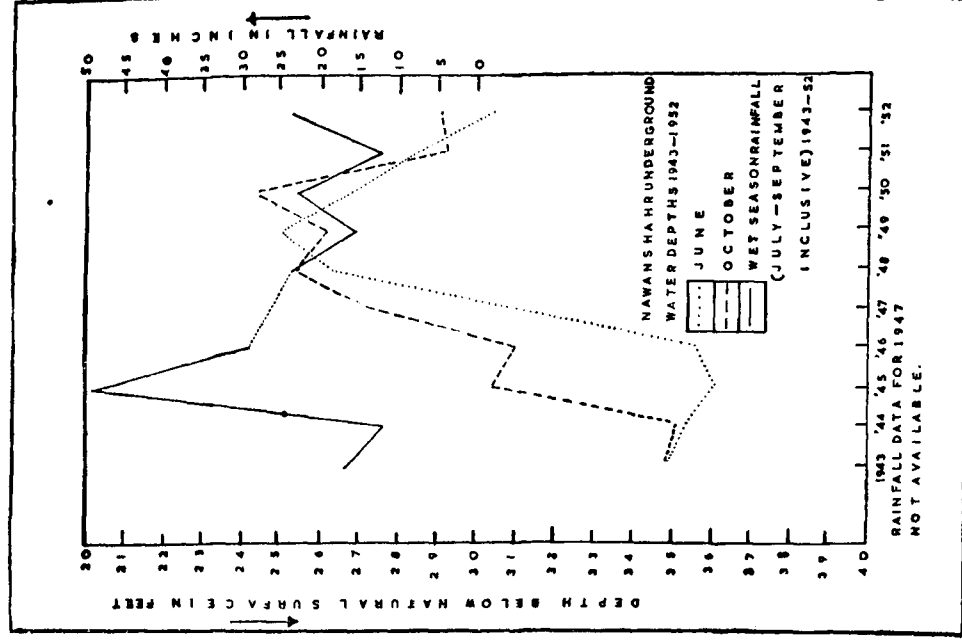


Fig. 10

TABLE V
UNDERGROUND WATER LEVELS AT HOSHIARPUR, GARHSHANKAR AND NAWANSHAHR
DURING THE PERIOD 1943 - 1952.¹

	HOSHIARPUR VIII (4)			GARHSHANKAR IV (10)			NAWANSHAHR		
	Depth of Water below the natural surface in June in feet	Depth of Water below the natural surface in October in feet	Rainfall of the wet season (July-Sept. inclusive) (1943-1952) in inches.	Depth of Water below the natural surface in June in feet	Depth of Water below the natural surface in October in feet	Rainfall of the wet season (July-Sept. inclusive) (1943-1952) in inches	Depth of Water below the natural surface in June in feet	Depth of Water below the natural surface in October in feet	Rainfall of the wet season (July-Sept. inclusive) (1943-1952) in inches
1943	14.2	10.5	18.32	38.5	36.9	18.13	35.0	34.9	17.15
1944	14.1	8.0	27.11	38.6	34.9	32.08	35.4	35.2	11.70
1945	12.6	5.0	34.23	37.0	30.4	44.18	36.2	30.4	48.80
1946	13.2	7.0	23.20	37.5	31.2	18.02	35.7	31.0	29.89
1947	11.0	5.4	N.A.	36.5	27.0	N.A.	30.9	27.2	N.A.
1948	4.6	4.5	27.47	30.5	24.5	20.60	26.3	25.4	23.12
1949	6.2	6.1	13.85	30.6	25.2	16.86	25.0	26.2	15.13
1950	10.0	2.4	57.80	34.6	24.5	42.03	26.9	24.4	23.12
1951	5.6	4.8	27.43	31.5	29.9	18.61	28.5	29.3	12.86
1952	8.6	5.3	22.41	33.5	31.2	15.65	30.4	29.2	23.94

Source : ¹Central Irrigation and Power Research Institute, Amritsar (Panjab) India, Unpublished record.
N.A. — not available.

The line showing the rise and fall in the amount of wet season rainfall from 1943 to 1952 has also been marked on the figure. The October water level is higher than that of June except in the year 1949. The curve of water level is quite sensitive to the rise and fall of the wet season rainfall (July to September inclusive) except in the year 1946, when the fall in the amount of the wet season rainfall has not been reflected by the fall in water level.

TABLE VI
AVERAGE WATER LEVEL AND AVERAGE RAINFALL
AT HOSHIARPUR, GARHSHANKAR AND NAWANSHAHR
DURING THE PERIOD 1943-1952.

		Average water level in feet in October during the period 1943-1952	Average rainfall in inches during the wet season (July to September inclusive) during the period 1943-1952
Hoshiarpur	...	5.90''	27.98''
Garhshankar	...	29.82''	25.24''
Nawanshahr	...	29.42''	22.85''

Table VI shows that the average water level at Hoshiarpur is the highest and it has the highest rainfall.¹

The water level at Garhshankar is 29.82 feet below the natural surface which is much lower than that at Hoshiarpur but the decrease in the amount of rainfall as compared to that of Hoshiarpur is not much.

Average water level at Nawanshahr is 29.42 feet below the natural surface which is almost the same as at Garhshankar and the amount of average rainfall is only about two inches less than that at Garhshankar.

This shows that the rise and fall in the amount of rainfall affects the water level but the rise and fall of water level is not proportional to the rise and fall in the amount of rainfall. This may be due to the fact that the rainfall is not the only determining factor. The factors of soil texture and seepage from the beds of the rivers have also a very important part to play.

The following facts emerge out of the above discussion :

1. There has been a rise in the water level in the whole of the Doab during the period 1943 to 1952. This rise is the result of the increase in the amount of rainfall during this period.
2. The water level is the highest in the Bias Lowland and the central part of the Doab.
3. The water level is the lowest on the foot of the Katar Dhar and the South-east Upland.
4. The water level in June is always lower than that of October of the same year.
5. There is a very intimate relation between the rise and fall of the water level in October and the wet season (July to September inclusive) rainfall.

1. This has been calculated by the author.

6. The rise and fall of water level is not proportional to the increase and decrease in the amount of rainfall.

7. The rise of the water level in the Bias lowlands and the central part of the Doab is alarming and there is every possibility of the area being water logged in the coming years.

8. The application of water from the Bist Doab Canal has increased the possibility of water logging conditions.

9. Any attempt to improve the agricultural techniques and the planning of land use without combating the water logging conditions are bound to prove abortive.

REMEDIAL MEASURES

In order to check the occurrence of water logging conditions in the Doab the following measures are suggested :

1. *Elimination of percolation from the Chos*: It should be made possible to discharge the flood water of the Chos into either the Sutlej or the Bias and its percolation into the Doab should be checked.

2. *Deepening of the Beins*: If the above is not possible or practicable, then the Eastern and Western Beins should be dug deeper so that they may act as drains for the flood water of the surrounding areas.

3. *Restricted Irrigation from the Bist Doab Canal*: The irrigation from the Bist Doab Canal should be 'restricted perennial'. The areas in which the water level is already high should not be irrigated.

4. *Blowing off of the Delhi-Shahpur Subterranean Ridge*: The alignment and the depth of the Burrard or Delhi-Shahpur ridge below the natural surface should be determined by geodetic surveys. If it is found quite close to the surface of the ground and at the same time if it is fully established that it stands in the way of the flow of the underground water towards Rajasthan and Saurashtra, arrangements should be made to blow off this impervious ridge in order to establish a direct contact between the ground water on either side of the ridge. This will relieve heading up of water on the Punjab side and desiccation and water scarcity conditions in the western states on the other side of the ridge.

5. *Installation of Tube Wells*: If the blowing off of the Delhi-Shahpur ridge is not readily practicable due to some technical difficulties, the second alternative will be to install a number of tube wells on the Punjab side of the ridge and deplete the water from the sub-surface rocks. This water could be carried to Rajasthan and used there for irrigation purposes. In view of the fact that huge amounts of hydro-electric power would be available from the Bhakra-Nangol Project, this scheme seems to be more feasible than the blowing off of the Delhi-Shahpur ridge.

INTERNAL MIGRATION IN INDIA— A REGIONAL ANALYSIS

By

DR. GURDEV SINGH GOSAL, M.A. (Panjab), M.S., Ph.D. (Wisconsin),
(Reader in Geography, Punjab University, Chandigarh).

INTRODUCTION :—

Migration from rural to rural, rural to urban and urban to urban places is not merely movement of people, but it is a fundamental factor helping to explain the ever-changing space-content and space-relations in a country. It is a vital process bringing in changes in the distributional pattern of population, and is thus basic to understanding the spread of people at any given moment in time. Demographic movement-natural increase (or decrease) and migration must be considered against the background of existing mass or densities. The base on which the movement takes place is important in giving the necessary perspective to either migration or natural increase.

Furthermore, mobility is one of the vitally important attributes of a population. Apart from its tremendous social significance, the residential stability or instability exerts a powerful conditioning influence upon all other demographic phenomena and processes. The original community, the one into which the newcomer intrudes, and the migrant himself are never again the same. In addition, the magnitude of internal migration in a region is a reflection of the expansion and diversification of its economic activities and the relative degree of its prosperity, except in areas of nomadic culture.

Unfortunately, the available information on internal migration in India is very meagre and is only indirectly derived. The only way of comprehending the magnitude and direction of internal movements of the people in the country is through the use of: (i) data on place of birth collected by the Census, (ii) linguistic data, (iii) other descriptive reports. The data on place of birth, which constitute the main source of information for this study, are believed to be roughly accurate¹. However, inherent in the use of these data are numerous handicaps :—

(i) A person's place of birth does not necessarily coincide with his residence as Indian wives generally return to their parents' home for their first confinement, and if this happens to be a few miles across a state or district boundary the child then becomes an immigrant at the next census. (ii) Moreover, the difference between place of birth and place of enumeration gives no indication of the number of moves the individual may have made during his life time. (iii) The place of enumeration may be entirely accidental and may have nothing to do with the individual's regular place of residence and work (iv) Lastly, the place-of-birth data give no precise indication as to when the migration took place and for what motives.

It may further be pointed out that the smallest administrative unit for which birth-place data are available in India is a district and thus from the

existing statistics we have no way of knowing anything about the size of intra-district movement of the people. It is to be remembered that a district in India is of fairly large size — on the average about 4000 square miles. Migration within such a large unit of area is not without significance, and if ignored it will adversely affect our comprehension of the real magnitude and direction of internal migration in the country. Throughout India a fairly substantial movement takes place within each district from rural to urban places, but it is not included in the district-wise data. The migration to small towns, in particular, is mostly from within the districts in which they are situated.

The underestimation of the magnitude of real internal migration in the country resulting from the non-availability of information on intra-district movement is, however, somewhat counter-balanced by the exaggeration which birth-place statistics cause because of their inherent handicaps in measuring internal migration.

In the absence of direct and exhaustive information on migration in India, this paper represents, therefore, only an attempt toward what can be accomplished from meagre and indirect data in a broad regional analysis of internal migration in the country.

THE MAGNITUDE OF INTERNAL MIGRATION IN INDIA :—

According to the 1951 Census there were as many as 38·5 million people who were not born in districts in which they were enumerated. Of these about 8·2 million were those who were born in areas which now constitute Pakistan but were enumerated in India*. Although in absolute numbers 38·5 million may indicate great mobility, it is only 10·8% of the total population of the country. If only State data were taken into consideration, then in 1951, 19·7 million people, 5·5% of the total population, were enumerated in States in which they were not born. Thus, from a comparison between the two figures of 38·5 million and 19·7 million it may be concluded that about 50% of the total movement is between the districts within the States and thus short-range, while much of the remaining 50% is inter-State which is in many cases a comparatively long-run movement. The relative importance of long-run migration, which was less than one-third of the total internal migration in India in 1921, has increased during recent years.

In 1931 only 3·59 per cent of the population of India and Pakistan combined lived in Provinces or States where they were not born². The figure for the Indian Union alone is likely to be slightly lower than 3·59 per cent as a larger part of West Pakistan (West Panjab, Sind and Bahawalpur State) has been an area of recent immigration which took place with the

* The partition of India in 1947 has greatly confused the real picture of internal mobility in India and Pakistan. In 1951, for example, there were 8·2 million people who had been born in Pakistan but enumerated in India at the census. Not all of them came after the partition. There were some people who had come to Indian Union areas much earlier than the partition. Secondly, there were quite many Indian Muslims (both in urban and rural areas) who were considered as migrants at earlier censuses in India but who left for Pakistan subsequent to the partition. In 1951, as much as 27·8% of the total urban population of India was Muslim (Kingsley Davis, p. 142). For a proper evaluation of the actual migration within India, it is, therefore, difficult to ascertain to what extent these two categories of people counter-balance those who came to India after the partition.

2. Davis, Kingsley, Opt. Cit. p. 107.

1. Davis, Kingsley : *The Population of India and Pakistan*, Princeton University Press, Princeton, N.J., 1951, p. 107.

expansion of canal irrigation. It may be recalled that the corresponding figure for the Indian Union for 1951 is 5.5 per cent. Thus during 1931-1951 the amount of long-run migration has increased. The increase is much more than might appear from the percentage figures of 3.59 and 5.5 as the base of the former figure is 275.5 million while that of the latter is 356.9 million. In actual numbers it has almost doubled, increasing from about 10 million to 19.7 million.

The pattern of inter-State movement, however, has been far from uniform (Table 1). Whereas there has been fairly considerable movement into the States of Assam, Panjab, Pepsu, West Bengal, Mysore and Bombay, those of Madras, Orissa, Bihar and U.P. have attracted far fewer. In Madras State for example, as much as 99.1% of its total population in 1951 was such as was born within the State. The corresponding figures for Orissa, Bihar and U.P. are 98.7, 98.6 and 97.8 per cent respectively. These figures suggest, among other things, the utter lack of economic opportunities which induce movement from other parts of the country to these States. In fact these are the States from which there has been a great deal of emigration to other parts of India and adjacent countries.

TABLE 1
INTER-STATE MIGRATION IN INDIA, 1951.

State	Total population	Not born within the State	% of total population not born within the State
U.P.	63,215,472	1,388,101	2.2%
Bihar	40,225,947	561,540	1.4%
Orissa	14,625,946	195,788	1.3%
West Bengal	24,810,308	4,600,662	18.5%
Assam	9,043,707	1,344,948	14.8%
Manipur	577,635	6,282	1.0%
Tripura	639,029	229,216	35.9%
Madras	57,016,002	550,920	0.9%
Mysore	9,074,972	620,343	6.8%
Travancore Cochin	9,280,425	206,823	2.2%
Coorg	229,405	66,148	28.9%
Bombay	35,956,150	2,407,953	6.7%
Saurashtra	4,137,359	133,850	3.2%
Kutch	567,606	14,780	2.6%
Madhya Pradesh	21,247,533	727,377	3.4%
Madhya Bharat	7,954,154	7,381,298	7.2%
Hyderabad	18,655,108	405,086	2.1%
Bhopal	836,474	84,378	10.0%
Vindhya Pradesh	3,574,690	90,835	2.5%
Rajasthan	15,290,797	654,380	4.2%
Panjab	12,641,205	2,839,976	22.4%
Pepsu	3,493,685	689,436	19.7%
Ajmer	693,372	200,874	29.0%
Delhi	1,744,072	1,026,762	58.8%
Himachal Pradesh and Bilaspur	1,112,466	41,814	3.7%

Note:—The states in this paper are those as in 1951.

The huge excess of emigration over immigration in these States indicates that under their existing economy and technology they are more or less full to their supporting capacity. Further natural increase of population in these States is thus bound to lower the existing level of subsistence. However, changes in economy and improvements in technology may change the present situation.

The important constituents of internal migration in India include rural-urban movement, movement to new farm lands, movement from small towns to large cities and marriage migration. Of the total internal movement the greatest component is that of the rural-urban migration. Unfortunately no data have been collected on this subject at any census. In the first two decades of the present century the urban population, like the rural population, increased but little. But from 1921 onwards the rate of increase has accelerated. In the absence of separate data on the natural increase of urban and rural population, it is not possible to determine what proportion of these increase in urban population during each decade has been due to natural increase and what proportion is due to migration. If, in order to assess the magnitude of rural-urban migration during 1921-1951, we apply the rates of natural increase of the total population to the urban population in each decade we find that, in these 30 years, of the total increase of 33.7 million in the urban population of the country only 12.9 million was natural increase and the remaining 20.8 million was due to rural-urban movement. As can be seen in the table below, with the acceleration in the process of urbanization, the rural-urban movement has quickened greatly during 1921-1951. The contrast between the decades 1921-1931 and 1941-1951 is particularly noteworthy.

TABLE 2
RURAL-URBAN MIGRATION IN INDIA
DURING 1921-1951.

Year	Urban population (millions)	Urban Pop- as % of total population	Increase in urban population		Natural increase in Urban Population (in millions)	Net migration (in millions)
			%	Absolute in millions		
1921	28.1	11.3	18.4	5.2	2.9	2.3
1931	33.4	12.1	31.1	10.4	4.2	6.2
1941	43.8	14.0	41.3	18.1	5.8	12.3
1951	61.9	17.3				

A comparison between the increase in the inter-State migration during 1931-1951 and the increase in the rural-urban movement during the same period shows that there is perfect parallelism between the two. Undoubtedly the long-run inter-State migration has been stimulated by increasing urbanization, particularly by the growth of large cities.

During the decade 1941-1951, the natural increase in the urban population is estimated to be about 5.8 million and the increase due to migration to about 12.3 million. The net increase on account of influx of displaced persons from Pakistan accounts for about 2 million and the balance of about 10.3 million represents migration to towns from rural areas within

the Indian Union. As the natural increase in the rural population of the Indian Union during 1941-1951 is about 36 million³, it is clear that migration to urban areas has absorbed about 28 per cent of the natural increase of rural population. Urbanization is, therefore, a significant factor in relieving the pressure of population from rural areas. All urban places, however, do not have the same pull. Some have attracted more migrants than others. Among the vital factors which determine the nature and magnitude of this pull, the type and number of functions and the size of area an urban place is serving, are by far the most important. An examination of the available data on place-of-birth for individual urban-places reveals that the size of an urban place in itself is not an important influencing factor.

In India, as a whole, the movement from rural areas to rural areas has been extremely slight, probably because cultivation has already been extended almost to the maximum limit under existing techniques of farming and economy and few other activities have been started on any appreciable scale which could encourage migration. The magnitude of movement which has taken place to a few new farm lands and areas of plantation agriculture, though significant, is far smaller than that of urban places. In a large majority of the districts of India over 95 per cent of the rural population is that "born within-the-district-of-enumeration". Much of the inter-district migration that does take place is due to marriages. The marriage migration in rural areas is reflected to a degree in the excess of females over males among the immigrants.

The third component of internal migration in India is that of marriage migration. However, in the absence of precise studies it is impossible to know exactly what proportion of the total inter-district movement is caused by the marriage factor. According to the estimates prepared by Kingsley Davis 8.5% of the total movement into the district is by marriage.⁴

Though impressive in absolute numbers, the magnitude of internal migration in India is very small as compared to the total population of the country. The extent of lack of mobility of Indian people can be seen on comparison with other countries. Such a comparison is, however, difficult to make, because the population and the areas of the countries and their sub-units are not comparable. Nevertheless, it does bring out the fundamental difference. In 1940 no less than 22.5% of the native population of the U.S.A. (as compared to 5.5% in India in 1951) lived outside the State in which they were born. In Australia in 1934 the persons living outside the Province of birth formed 24 per cent of the total population.⁵

CAUSES OF MEAGRE INTERNAL MIGRATION IN INDIA:—

The general lack of mobility in the Indian population is related to a number of factors of which the following are the more basic:—(a) In view of the very old settlement of the country and an overwhelmingly agrarian type of economy throughout the past, almost all the better lands have been under cultivation for hundreds of years and now few cultivable areas are available for settlement under existing technology. However, whenever and wherever facilities of irrigation and reclamation of land have become

3. Nath, V. *Urbanization in India with special reference to the growth of cities*: Published in the Proceedings of World Population Conference at Rome, 1954.

4. Davis, Kingsley, Op., cit., p. 113.

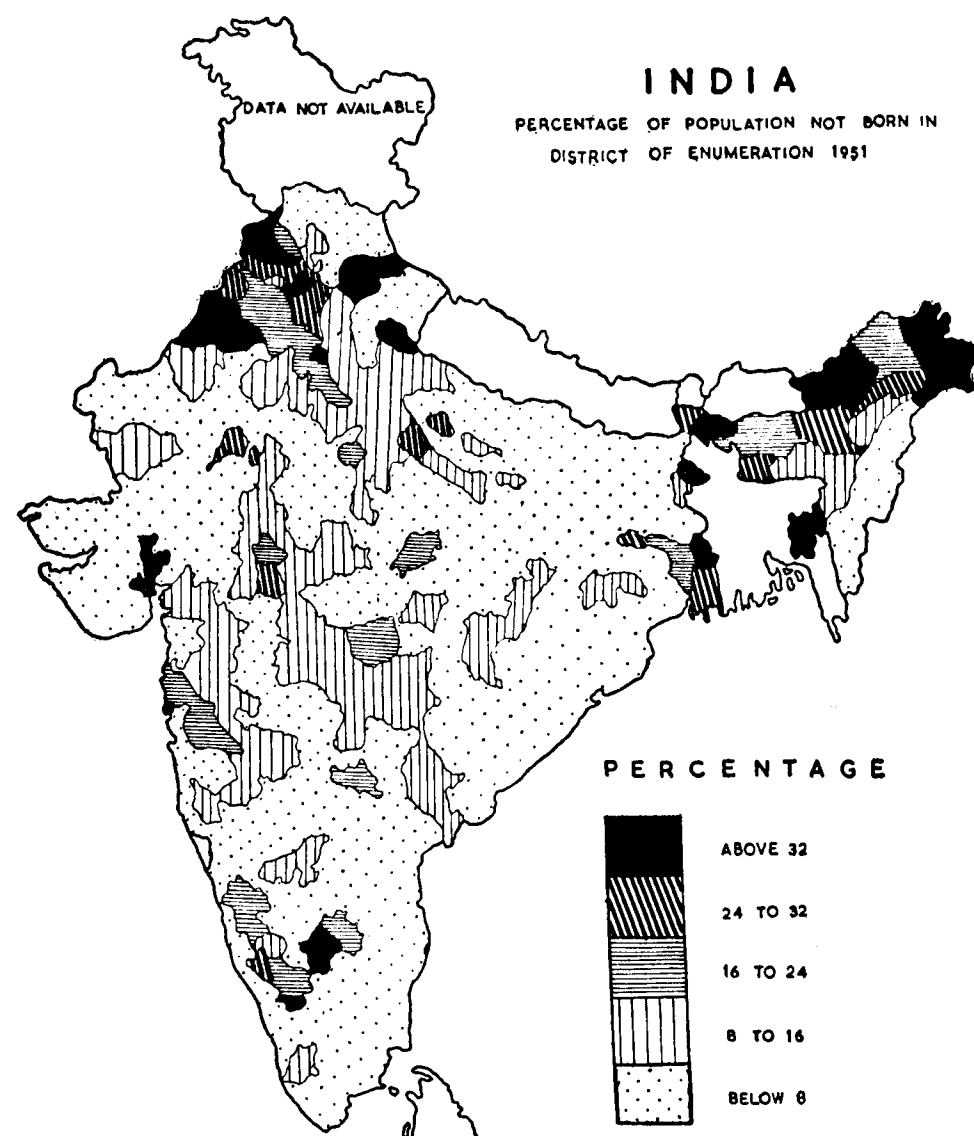
5. Davis, Kingsley, Op., cit., p. 107.

available, and new crops introduced into areas earlier considered unsuitable for food and other crops, new settlement has taken place attracting streams of immigrants. (b) The Indian economy has been oriented around a single activity-subsistence agriculture. The diversification of economic activity and urbanization, the two forces which shake the population from their original places of residence in favour of new ones, have been utterly lacking from the Indian scene till very recently and thus most of the people have remained where they were born. Naturally there is little internal movement in a static economy. But in dynamic economics people have moved across numerous boundaries and barriers. Most of the internal migration that has taken place in India in the last 30 years is generally coincident with the period of urbanization which is so intimately related to the development of communications, modern industry, commerce and services occupation (including public administration). (c) Early marriage and assumption of adult responsibility in the village community have tended to act as discouragements to migration. The caste system and the joint-family tradition are generally considered to have operated in a similar direction. (d) The linguistic diversity has also been a great barrier to spatial movement. This is especially true of S. India where the numerous languages are very different from each other. Migration from one linguistic area to another is, therefore, full of handicaps. That is why inspite of increasing urbanization, most of the migration in South India is overwhelmingly short range. (e) The prevailing illiteracy among a very large section of the Indian population, and their ignorance of the existing economic opportunities in areas outside the narrow circle of their contacts, have contributed to their general lack of mobility.

It must, however, be pointed out that although the social and cultural factors have somewhat discouraged migration from original homes, yet their influences must not be over-emphasized and they must not be singled out as the all potent factors. The most pressing reason on immobility among the people seems to have been the lack of better economic opportunities. Whenever and wherever such opportunities are available and have become known, the people, even the most illiterate among them, have ignored linguistic, social and other boundaries and have moved to new frontiers to earn a better living. Of course there are always people in every society who are not prone to make any change and do not avail themselves of new opportunities. Yet with changing times and improving economies, the attitudes of the people change. The recent decades have seen the beginning of local and regional movements of the people, and the future promises more in view of the proposed improvements in the means of communication, the accelerating rate of industrial development and urbanization, reclamation of cultivable land and the extension of irrigation to dry areas. Apart from being an effective means to achieve a balanced population distribution among the States, the future long-run or inter-State migration would help in the consolidation of national unity and the achievement of integrated planned development of the country.

REGIONAL ANALYSIS OF INTERNAL MIGRATION:—

Marked regional contrasts in the degree of mobility are characteristic of India's population. Three types of regions may be observed on Map No. 1 (a) Regions of low degree of mobility, with less than 8 per cent of the population born outside the district of enumeration. If allowance is made for marriage migration, and birth of children in villages of their mothers' parents these regions are left without any signs of immigration and thus



SOURCE: CENSUS OF INDIA 1951
DATA BY DISTRICTS

MILES 0 50 100 150 200 250 300 350

MAP. 1

show an almost completely 'born-in-the-district' population; (b) Regions of relatively high degree of mobility with more than 16 per cent of the population born outside the district of enumeration; and (c) Regions of intermediate mobility with 8 to 16 per cent of the people born outside the district in which they were enumerated.

(a) REGIONS OF LOW DEGREE OF MOBILITY:—

With only less than 8 per cent of the population born outside the district of enumeration, the degree of mobility in this class of regions is very low — lower than the national average of 10·8 per cent. Obviously these are regions of static and meagre economy, and have offered few economic opportunities to prospect migrants from other parts of India. There has been no significant intra-regional movement in them either. They include two types of areas: (i) those which are densely populated and overwhelmingly agricultural such as the middle and the lower Ganges Plain (excepting the Calcutta conurbation districts), the eastern and western littorals, and (ii) the less densely populated areas of the Himalayan region of north western India, the eastern Assam Hills and a large part of Peninsular India.

In the first type of regions, almost all the available cultivable land is already under the plough and there are virtually no possibilities of further extension in cultivated area and hence of new settlement. In all these areas the nutritional density is very high, ranging mostly between 1200 and 2000 persons per sq. mile of cultivated land. In the Malabar coastal lowlands it exceeds even 3000. The density seems to be approaching the saturation level under existing economy and technology. During 1921-1951 the cultivated area per capita has declined by more than 25 per cent in almost all the areas belonging to this category. In North Bihar Plain it has declined from 0·65 to 0·43 acre per capita⁶. In recent decades, compelled by the acute pressure of population, there has, therefore, been out-migration from all these areas.

In the second type of regions although the population is relatively sparse and there is considerable amount of unused land there has been little in-migration because of the poor quality of the land for agriculture (hilly terrain, thin and infertile soils for the most part). The small and scattered valley plains that do exist in these areas are already well-occupied.

Secondly, coincident with the lack of mobility of the people is the low degree of urbanization (less than 8 per cent of the total population living in urban places) in most areas of both types mentioned above. It has often been found that large growing cities performing a variety of functions attract people from far and wide, whereas the small service towns, in general, involve only local migration. With the exception of South Madras Division, the urban settlements, which do exist in the areas under consideration, are such as lack the multiplicity of functions and dynamicism of growth. There is little of large-scale industry and commerce which could attract people from other areas. The only significant movement that does take place is the extremely local rural-urban migration, largely from within the districts of enumeration. In South Madras Division and Andhra littoral, the situation is rather anomalous. There has been a relatively high degree of urbanization with numerous large towns and cities and fairly widespread

6. National Council of Applied Economic Research, New Delhi: *Techno economic Survey of Bihar, Vol. I*, Asia Publishing House, Bombay, 1960, p. 14.

industrial development. And yet the proportion of population born outside the districts of enumeration is very small. The labour-supply for the industries comes mainly from the local rural areas where the pressure of population is very heavy for the quality of land for agriculture. Under the circumstances, therefore, cheap labour is available to the growing industries from within the districts of enumeration.

However, the establishment of the steel plants and other industries in Orissa, Madhya Pradesh, South Bihar and West Bengal, and the completion of various multipurpose river-valley projects under construction, will certainly open up numerous economic opportunities and will bring migrants both from local and distant areas.

(b) REGIONS OF RELATIVELY HIGH DEGREE OF MOBILITY :—

With more than 16 per cent of the total population as immigrant, regions belonging to this category represent either areas of new agricultural settlement (for estate or general farming) or those of high degree of urbanisation stimulated by large-scale industrial and/or commercial development. The partition of the subcontinent in 1947 also caused considerable shifts of population across the new borders. These regions include (i) the Assam Valley and the adjoining hilly tracts and Tripura, (ii) Calcutta conurbation districts and the Damodar Valley region, (iii) north western India including Panjab, Pepsu, Delhi and Ganganagar (Rajasthan) areas, (iv) Southern and Western Mysore State and Coorg, (v) the industrial districts of Bombay State and (vi) scattered individual districts.

(i) *The Assam Valley and the Adjoining Areas :*

This is a unique region of in-migration. The sparsity of population in the valley with its rich agricultural land, inspite of fearful crowding in the neighbouring Bengal Plain, is highly anomalous. The valley is still partly covered with jungles and awaits development. In the valley as a whole, about 19 per cent of the total population is immigrant, in the upper half of the valley the proportion being as high as 25 per cent⁷. In actual numbers the immigrants are about 1·5 million of whom as many as 1·31 million have come from outside the State of Assam, indicating large long-run in-migration and only small inter district migration within the valley. The lack of inter-district migration in the valley is partly attributable to the availability of space for extension of settlement within the local areas and partly to the difficulty of transport. Urban development is extremely meagre. Moreover, the indigenous Assamese showed complete reluctance to leave their farms and villages to work on the tea plantations and there were few landless labourers in the province who could be induced to migrate to new areas."

Over 60 per cent of the immigrants in the Assam Plains came from East Bengal area which is now East Pakistan, and another 15 per cent from Bihar with Orissa, Nepal, Uttar Pradesh, Madhya Bharat, West Bengal,

7. The available information about the language situation in 1931 and immigration indicates that a little less than one half of the people of the Assam valley to-day are immigrants or descendants of immigrants. (Tor. Fr. Rasmussen, *Population and Land Utilization in the Assam Valley*, The Journal of Tropical Geography, Vol. 14, July 1960, p. 61).

8. Davis, Kingsley, Op. cit. p. 116.

Rajasthan and Madras next in order of importance (See table 3). Of the 796,000 immigrants, from East Pakistan as many as 536,000 had come to settle in the Assam Plains much earlier than the partition. The displaced persons from East Pakistan who came to the Assam Plains subsequent to the partition in 1947 were only 260,000.⁹ In Tripura State about 36 per cent of the people are immigrants, 90 per cent of whom came from East Pakistan. Half of them were already in Tripura much before the partition and settled on new lands for rice cultivation. It may be noted that most of the areas from where the migrants came are those of heavy pressure of population. The two more important forces which have attracted migrants to the Assam Plains are: (i) development of tea plantations and (ii) extension of general farming in the rich areas of the valley still awaiting settlement. The development of tea plantations started much earlier than extension in general farming. Whereas the migrants who have come to settle as farmers are mostly Bengalis, labour for the tea gardens is furnished by those from Bihar, Orissa, Uttar Pradesh, Madhya Bharat and Madhya Pradesh—areas where the population was economically less secure and more accustomed to working for wages.¹⁰ A large majority of these immigrants were landless labourers in their original areas. In due course of time, however, numerous tea-garden labourers have left the estates and have settled on farms growing rice for the most part.

TABLE 3
IMMIGRATION TO THE ASSAM PLAINS, 1951.

Birth place of immigrants	Number of immigrants	Birth place of immigrants	Number of immigrants
East Pakistan	... 796,413	West Bengal	... 21,337
Nepal	... 39,523	Rajasthan	... 15,976
Bihar	... 200,102	Tripura	... 14,449
Orissa	... 86,013	Madras	... 12,379
Uttar Pradesh	... 29,394	Madhya Pradesh	... 10,533
Madhya Bharat	... 22,842		

Source:—Census of India, 1951, Vol. XII, Part II-A, pp. 118-135.

For a long time the movement to the tea-gardens and to the unused but rich valley plains in Assam was the second strongest current of internal migration in India—second only to the movement to cities. As the valley is fast filling up, this current is bound to diminish rapidly. Already quite a few estates have not recorded any additional recruitment of labourers from outside areas for some decades. The trend of recruitment is downward. The natural increase of the estate population makes it increasingly possible to secure local labour. The migration to farm lands has also slowed down although there are still vast areas in the valley which are covered with jungles and are awaiting settlement.

9. Vaghaiwalla, R. B. Census of India, 1951, Vol. XII, Part I-A Report p. 74.

10. Davis, Kingsley : Op. cit., p. 116.

It is remarkable that economic opportunities in the Assam Plains -- development of tea plantations and extension in general farming -- have attracted people from distant States as well as from diverse linguistic regions. Knowing that a vast majority of the migrant labourers and farmers are illiterate, it is amazing how they have assimilated in a new culture where the native language is Assamese.

(ii) *Calcutta Conurbation Districts and the Damodar Valley Region :—*

In this region about 33 per cent of the population consists of immigrants who number nearly 4.5 million. Much unlike the Assam Valley, the inter-district movement is quite considerable in this region. It is mostly rural-urban migration. But as may be seen from Table No. 4, the industrial, commercial, transport and other important economic enterprises of Calcutta conurbation have attracted large number of migrants from the adjoining and distant States of India. In general, there is an inverse relation between the number of immigrants and the distance of migration. The number of persons born in East Pakistan but enumerated in this region is considerable indeed, but the statistics do not throw any light on how many of them were in the region before the partition and how many came as a consequence of the partition in 1947.

Of the States which have contributed most to this immigration, Bihar, Uttar Pradesh and Orissa rank highest in the order listed.¹¹

TABLE 4
SOURCES OF MIGRATION INTO THE CALCUTTA
CONURBATION DISTRICTS AND THE
DAMODAR VALLEY AREA.

District where enumerated	Immigration from			
	Other districts within the same State	Adjacent States	Other States of India	Pakistan
Burdwan	154,542	204,992	29,656	108,850
Hooghly	125,885	96,097	13,148	72,034
24-Parganas	252,056	233,360	116,541	621,227
Calcutta	313,154	430,320	256,751	685,672
Nadia	43,587	18,010	4,284	441,871

Sources :—Census of India, 1951, Vol. VI, Part I-C, p. 101.

As in the case of the Assam Valley, so here, the immigrants have come from areas of high nutritional density. The development of industry and commerce in the Calcutta conurbation and mining and industry in the Damodar Valley area have been the major forces attracting the people from outside. This is in marked contrast to the migration to rural areas for agricultural settlement in Assam.

11. A Mitra : Census of India, 1951, Vol. VI, Part I-A Report, pp. 304-5.

(iii) *North-western India (including Panjab, Pepsu, Delhi and Ganganagar (Rajasthan) :—*

Here about 30 per cent of the total population was born outside the districts of enumeration, in actual numbers about 5 million. A large proportion of the immigrant population in this region is due to the influx of displaced persons from West Pakistan subsequent to India's partition in 1947. Of those born outside the districts of enumeration 60 per cent are displaced persons from Pakistan. Of the remaining 40 per cent, one third represent inter-district migration, whereas two-third came from the adjoining States and other parts of India both for economic and marriage reasons. Of the displaced persons from West Pakistan about 50 per cent have settled in rural areas, mostly as farmers on the land abandoned by the out-going Muslims, and the other 50 per cent in urban areas¹². The Panjab Government built 17 "model towns", in all cases as suburbs of existing cities in the State, for the rehabilitation of displaced persons.

The introduction of canal irrigation in southern and south-eastern Panjab and in Ganganagar district of Rajasthan has brought a large number of agricultural settlers both from within the Panjab and the adjoining areas. Since the opening of the Ganga Canal there has been a regular stream of migration from the Panjab to Ganganagar district in Rajasthan. Summarising, the three factors contributing to the immigrant population in north-western India have been : (a) the influx of displaced persons subsequent to the partition in 1947, (b) increasing degree of urbanization and the development of industry and commerce, and (c) extension of agricultural settlement with the introduction of canal irrigation in the arid and semi-arid parts of the region.

(iv) *Southern and Western Mysore and Coorg :—*

In southern Mysore 20 to 40 per cent of the total population is immigrant, a large proportion of it having come from the adjoining districts of Madras state. This migration is largely to the urban areas, especially to the cities of Bangalore (778, 977), Mysore (254, 323) and Kolar Gold Fields (159, 087). The proportion of immigrant population in these cities in 1951 was 36.6, 38.9 and 21.4% respectively. While the movement to the two former cities has been motivated by possibilities of employment in industry and commerce, migration to the city of Kolar Gold Fields is attributable to employment in gold mining there.

In Western Mysore, Coorg and Nilgiri Hills, on the other hand, a large part of the total immigrant population has come to rural areas for employment in the rubber, coffee, tea or cardamom plantations. This migration is almost exclusively from among the land-less labourers of the adjoining densely populated areas, particularly those of Madras State. Plantation agriculture has made considerable progress in the Highland Division of Travancore also. The immigrants to these plantations are from the Lowland division of Travancore and the adjoining districts of Madras State. The increasing use of the upland areas in southern India for tree crops is a significant departure from the usual type of Indian agriculture.

12. L. C. Vashishta : Census of India, 1951, Vol. VIII, Part I-A, Report, p. 87.

(v) *Main Industrial Districts of Bombay :—*

Included in these are the districts of Greater Bombay, Thana, Poona, and Ahmedabad. In Greater Bombay as much as 73 per cent of the population is immigrant, in Ahmedabad over 32 per cent, in Thana 22.5 per cent and in Poona 18 per cent. As in Calcutta, a study of the composition of the immigrant population of Greater Bombay establishes an inverse relation between the number of immigrants and the distance of migration. See Table 5. About 51% of the migrant population in Greater Bombay is from districts within Bombay State, 24 per cent from the neighbouring states 14 per cent from farther parts of India. The coastal districts of Surat, Kolaba and Ratnagiri have been the major sources for Greater Bombay's immigrant population. Immigrants from Ratnagiri district alone constitute 14.5 per cent of the total population of this metropolitan city¹³. The decade 1941-50 has seen the greatest immigration into Greater Bombay and this is mainly connected with the increasing degree of industrialization and commerce.

TABLE 5

COMPOSITION OF GREATER BOMBAY'S POPULATION, 1951

Total population	...	2,839,270
Born in district of enumeration	...	791,706
Born in other parts of the State	...	1,060,048
Born in adjacent States	...	492,021
Born in other States of India	...	289,054
Born Abroad	...	128,021
Other territories	...	78,420

Sources :—Census of India, 1951, Vol. IV, Part I, pp. 198-99.

Immigration into Poona district is largely from local areas within the State. In the highly industrialized district of Ahmedabad, on the other hand, where a third of the total population is ascribed to immigration, the movement is mostly from the adjoining areas of Saurashtra and Kutch.

(vi) There are several isolated individual districts in which the proportion of population not born within the district of enumeration ranges between 16 and 32 per cent. These are Madras, Hyderabad, Nagpur, Jabalpur, Indore, Ujjain, Gwalior, Kanpur, Lucknow, and Dehra Dun. In each case a major part of the immigrant population is in the large city of the district, attracted in most cases by the expanding industry, commerce, administrative and other functions.

(c) *REGIONS OF MEDIUM DEGREE OF MOBILITY :—*

With 8 to 16 per cent of the population as immigrant this class of regions is closer to the national average in the matter of mobility.

(i) *The Upper Ganges Plain :—*

In the Upper Ganges Plain and the lower Jamna-Ganges Doab about 12 per cent of the population was born outside the enumeration districts, in

13. Bowman, J. B. Census of India, 1951, Vol. IV, Part I-A, Report, p. 10.

actual numbers approximately 3.7 millions, of whom two-thirds were born in the adjoining districts within the same region. The number of immigrants coming from other parts of India varies inversely with distance of migration indicating the importance of short-run movement. The only significant long-distance migration to this region was that of displaced persons from Pakistan. In general, there are five factors which have contributed to the mobility of population in this region : (1) Influx of displaced persons from Pakistan, (2) increasing degree of industrialization and urbanization ; (3) the development of irrigation, (4) reclamation of land in the Terai region and (5) Inter-district and inter-State marriages.

Of the immigrants from the adjacent States 47 per cent have taken to agriculture and the remaining 53 per cent derive their livelihood from non-agricultural occupations, particularly industry and commerce. Of the immigrants from farther States 86 per cent have settled in urban areas. Only about 11 to 12 per cent of the total immigrant population in the upper Ganges Plain consists of displaced persons from Pakistan two-third of whom settled in the Jamna-Ganges Doab. Significantly, only 4.5 per cent of these displaced persons took to agriculture, while the remaining 95.5 per cent are largely in urban areas deriving livelihood from non-agricultural pursuits¹⁴.

(ii) *Rajasthan areas bordering the States of Uttar Pradesh and Panjab :—*

Here 10 to 15 per cent of the total population consists of immigrants, 60 to 75 per cent of whom came from the adjoining States of Panjab and Uttar Pradesh and from Pakistan. Local inter-district migration in these areas is rather unimportant. About 70 to 90 per cent of the immigrants, especially in the districts of Alwar, Bharatpur and Jhunjhunu, are agriculturalists who have settled on the fertile lands where possibilities for well or tank irrigation existed¹⁵.

(iii) In southwest Madhya Bharat, Bhopal and south west Madhya Pradesh Division 12 to 15 per cent of the people were not born in the districts in which they were enumerated. The immigrants to these areas have been attracted mostly by the opportunities of employment in the growing industries. This movement is largely local.

(iv) *The Eastern Section of the Deccan Division of Bombay State :—*

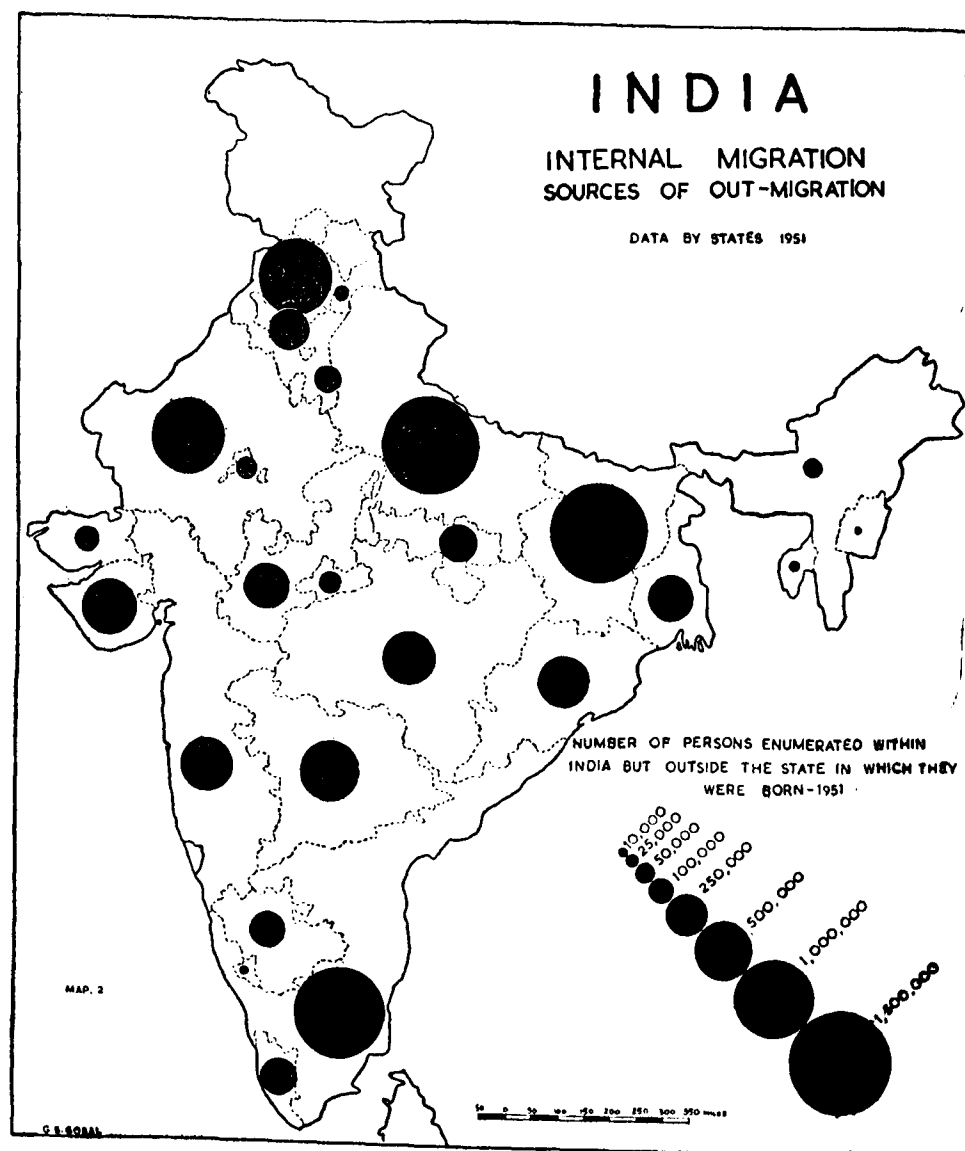
Here about 10 percent of the total population is immigrant — 60 per cent of the migrants having come from local districts within the State of Bombay and most of the remaining 40 per cent from the adjoining States. The movement is largely the inducement of growing industry and increasing urbanization, specially since World War II. The number of migrants has doubled between 1931 and 1951.

REGION OF EMIGRATION :—

The preceding analysis of internal migration was based on district-wise data on persons enumerated in districts in which they were not born. Unfortunately the census data do not reveal the names of districts in which such persons were born. Only names of States are given. Thus it becomes impossible to delimit the actual regions of emigration. Even the State-wise data do not go too far. No information is available about the number of such persons who were born in Indian States but were enumerated abroad,

14. Prasad, Rajeshwar : Census of India, 1951, Vol. II, Part I-A, Report, p. 55.

15. Dashora, Y. L. Census of India 1951, Vol. X, Part I-A Report, p. 52.



thus ruling out any possibility of measuring total emigration. Our information is restricted, therefore, to emigration to Indian areas only.

Interestingly, the States of largest emigration are those of least immigration. In absolute numbers, Bihar, Uttar Pradesh, Madras and Rajasthan are the leading states of emigration (Map No. 2). Emigrants from Bihar, U.P. and Rajasthan are mostly labourers. If, however, emigrant population as percentage of the total original population is calculated, Kutch, Saurashtra and Panjab come out as most significant — each sending out over 10 per cent of its native population. Emigrants from Panjab, in contrast to those from Bihar, U. P., and Rajasthan, mostly go out for better jobs to earn a better living. For obvious reasons, among all the Indian States Assam is the least important for emigration.

SUMMARY :—

Though impressive in absolute numbers, the proportion of migrant population to the total population is indeed small. In the balance-sheet of factors stimulating or discouraging internal migration in India, the economic factors emerge as the most significant. In the face of economic opportunities, the social, linguistic and cultural factors come down in significance. Regions with lowest proportion of immigrant population are those where : (i) the density of agricultural population has approached the saturation level and there is now little space for new agricultural settlement, (ii) the population is sparse but there is little possibility of extending the cultivated area because of meagre potentiality of land for agriculture, (iii) the degree of urbanization is low and the urban places are prevailingly small size, (iv) the development of industry and commerce is lacking and (v) the economy is overwhelmingly of subsistence type. By contrast the areas with highest proportion of immigrant population are those where : (i) new agricultural settlement has been taking place in recent decades, either for plantation crops or for general farming or both, (ii) where, stimulated by the development of industry, commerce and other important functions the process of urbanization has been quick and large cities are emerging attracting people from across long distances. India's partition in 1947 resulting in the great influx of displaced persons from Pakistan has somewhat confounded the pattern of internal mobility in India. Excepting migration resulting from inter-district and inter-State marriages, and the partition of the country, the movement thus far has largely been from the densely populated agricultural lands.

Another feature of internal migration in India is that it is largely short-run. Although large cities have attracted migrants from far and wide, in general there is an inverse relation between the number of immigrants to these cities and the distance of migration.

The tempo of internal migration in India is bound to increase in future in view of the growing diversification of economic activity. The increasing degree of industrialization and urbanization, the expanding commercial activities, the improving means of transport and the extension of irrigation to arid and semi-arid areas under the various plans of economic development will all contribute greatly to make the people move from their original homes to places of promise. The spread of education, both general and technical, will also play its part in breaking the general immobility of India's population.

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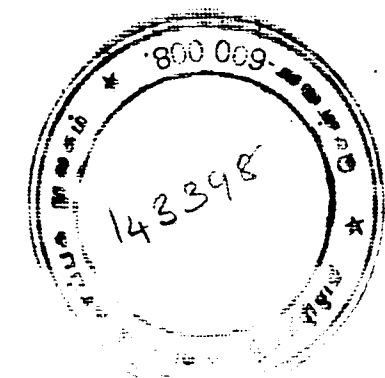
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