A Survey of Research in Geography

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A Survey of Research in Geography

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Foreword

THE IDEA of carrying out a survey of research done so far in the field of social sciences was first put forward by the late Dr. D. R. Gadgil, the first Chairman of the Council. In the very first meeting of the ICSSR, he emphasized the need to formulate priorities and significant programmes in promoting social science research in the country and argued that this task would be greatly facilitated if a survey of all social science research conducted so far is quickly carried out. These proposals were accepted by the Council and the ICSSR Research Survey Scheme, 1970, was formulated.

Under this scheme, the entire area of social sciences was divided into seven major fields, viz., (1) economics, commerce and demography, (2) political science, including international relations, (3) public administration, (4) management, (5) sociology, anthropology, social work and criminology, (6) psychology and (7) economic, human and political geography. For each of these major fields, an Advisory Committee was appointed to plan and implement the programme. Each major field was also divided into a number of subfields, the total number of subfields numbering more than 125. The work of preparing the survey report in each subfield was entrusted to a social scientist selected by the Council on the recommendations of the Advisory Committee. By and large, the focus of the survey was on research carried out by Indians and on Indian problems and each trend report was to be accompanied by a selective bibliography. Subject to this general consideration, each Advisory Committee was allowed to decide the content and format of the survey in keeping with the needs of the discipline concerned.

The work on the programme started early in 1970. The first survey reports were received in June 1970 while some of the last are yet to come. When about 8 or 10 reports in a major field were ready, a seminar was convened to discuss them and the authors of the research reports were requested to revise and finalise them in the light of the discussions. It is these revised reports that were finally edited and sent to the press.

It has been decided that all these research survey reports should be published in a series of fairly uniform volumes. The present

volume of research survey reports in geography is the second to be published in the series.

On behalf of the ICSSR and myself, I take this opportunity to thank Dr. S. P. Chatterjee and his colleagues on the Advisory Committee for the labour of love they voluntarily undertook in preparing these research survey reports and in revising and editing them. But for their willing and enthusiastic cooperation, this enterprise would not have been either feasible or successful. I have also no doubt that the entire academic community of teachers and students in social sciences will remain ever grateful to them for this great service they have rendered to the cause of social science research in India.

The ICSSR is considering proposals to keep up this project on a continuing basis by undertaking similar periodical surveys. It is hoped that these proposals will soon be approved and implemented. In these subsequent programmes also, I am sure that the ICSSR will continue to receive the same willing and enthusiastic cooperation of the academic community.

M. S. Gore
Chairman
Indian Council of Social Science Research

New Delhi
1st August 1972

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Geography As A Social Science

By

Moonis Raza

INDIAN GEOGRAPHERS have, by and large, shown little interest in theoretical discussions on the nature of Geography. The reasons are partly historical. When the controversy between the exponents of environmental determinism and possibilism was raging in the West, modern Indian Geography had not been born. It did not get involved in the ideological turmoil through which modern Geography acquired its philosophical foundations and its intellectual rigour. By the time Geography emerged on the Indian campuses, the storm had already passed. Having "imported" and uncritically accepted a complete system of ideas without participating in the making of it, Indian Geography tended to develop at best, as a *dinosaur*, with a huge body, a long tail and a tiny little head. The tradition continues. Concern for theory is still considered futile pedantry; search for logical systems is equated with esoteric casuistry. Once in a while, the demands of a Presidential Address to a learned society forces on a learned scholar the choice of a theoretical theme, but generally the ritual ends with nobody becoming very much the wiser for it.

This had led to a situation where new developments do not grow inside the organism as the inevitable consequence of an evolutionary process in the realm of ideas. They are just mechanically aggregated to the amorphous mass in response to the latest intellectual fashion in the West. This has given to Indian Geography a highly fragmented character. Thus layers after layers of academic work, related not only to different decades but different centuries of geographical thought, co-exist in the invertebrate system of Indian Geography—this spongy organism without a theoretical spine. As long as departments are expanding, research grants are increasing, international

"contacts" are developing, not many seem to be worried about it. It is time we did!

A Historical Perspective

The taxonomy of knowledge has been evolved to aid the understanding of its sectors and facets and their inter-relationships. But, not very rarely, the rigidities of its hierarchy tend to stifle and distort understanding. In such situations, it is better to modify and transform the system, rather than attempt "to fit" elements in a given framework through logical quibblings and semantic drills.

Any discussion of the role of Geography as a social science assumes the validity of a taxonomical scheme, wherein the categories of the first order are the natural and the social sciences. This premise has been at the root of the confusion inherent in and the relative sterility of the theoretical discussions on the nature of Geography during the recent years. This dichotomy is unreal for the geographer. Objectively, it is so; but Geography, perhaps alone among the natural and social sciences, recognises it to be so. Such a recognition is the *raison d'etre* of Geography. "The separation of the whole into man and his environment is a murderous act", said Herbertson as early as in 1916.

This false dichotomy has not been and is still not being adequately resisted by geographers because it is an important element of the deterministic scheme, which has kept Geography within its octopus-like grip. Ideas die hard. The search for the active and the passive, the determinant and the determined or the cause and the effect in the "environment-man relationship" is based on the recognition of the objective existence of this duality. It is genetically related to the teleological approach of Ritter which was rooted in theology; and later got sustenance from Darwinism and its philosophical derivatives. It is not entirely accidental that this concept of causal relationship was developed at a time when the geographical division of the globe between the temperate lands and the tropics roughly corresponded with the political division between the Imperialist haves and the Colonial have-nots. Viewed thus, determinism appears to be the projection of political realities of the era of Imperialism in the realm of the theory of Geography. It was rejected not only under the pressure of its internal inconsistencies but also because the regional differentiation on the globe was acquiring a qualitatively new character. The onward march of humanity had rendered it obsolete.

The "possibilist" alternative was based on a different understanding of causal relationship. But it, nevertheless, operated within the old framework of essential duality. The challenge of neo-determinism

has emerged recently due to this essential limitation of the possibilist framework. It is necessary, therefore, to recognise the holistic nature of the man-environment complex as of the essence and to search for a new philosophical basis for geographical studies.

An Attempt at Definition

It is only natural that, in this search for new philosophical moorings, geographers have turned to Immanuel Kant — the basic clue to a scientific understanding of the nature of Geography being provided by his equation:

"History : Time : : Geography : Space"

The theoretical discussions, reflected in and initiated by Hartshorne's *magnum opus*, constitute in their essential features, but the elaboration of the Kantian dictum, which had unfortunately been lost sight of in the deterministic verbiage.

That which objectively exists does so along the time-space continuum. Academic disciplines have been developed to study aspects of this complex — whether they be Physics or Botany, Economics or Political Science. Disciplines, therefore, by definition, concern themselves with sectors or facets of this multi-dimensional reality. History and Geography are, however, a category by themselves. In both cases, the involvement is not with the *aspectual* but with the *total*. Viewed thus, they constitute complementary principles of organisation of knowledge.

The complex nature of the continuum renders it very difficult to study phenomena both along the time and space scales simultaneously. Hence, the need for two complementary principles—that which studies variations essentially along the time scale is History; that which studies variations essentially along the space scale is Geography.

It may be argued whether the organisation of knowledge according to these principles is capable of producing a defined sphere of academic work with a methodology of its own, which is characteristic of a discipline in the taxonomical hierarchy. It is suggested that it can, and that, both in the case of History and Geography, it already has. The operation of the principle of spatial variation has determined the content of Geography and has contributed to the evolution of its methodology. This *essential concern* of Geography has been buttressed by its holistic *approach* and its recognition of social man as its *focus*. Viewed thus, Geography, as a social science, is concerned with the analysis of the spatial dimension of social phenomena

and with the synthesis of natural as well as social variables within a regional frame.

Classification

With such a definition of Geography as the starting point, the problem of classifying its branches and sub-branches acquires great complexity. The semantic exercise of adding an adjective to the noun "Geography" is increasingly becoming a popular pastime; and as a consequence, a plethora of sub-disciplines are emerging on the scene—some just to make a bow on the academic stage and fade out. In order to introduce a system in the scheme of classification, it is necessary, as a first step, to recognise the distinction between, on the one hand, the topical sub-disciplines, concerned with the spatial *analysis* of *aspects* of social phenomenon, and on the other, with the sub-disciplines concerned with the *synthesis* of the *multiplicity or totality* of variables within a regional frame.

In order to understand the true nature of the topical sub-disciplines, it would be useful, at the outset, to recognise one of their essential features — that each constitutes an interface between Geography and another social science discipline, the principle of spatial variation being provided by the former and the specific aspect or facet of reality being identified in terms of the latter. This interaction of Geography (as also of History) with other disciplines is deeply rooted in its very nature. In this context the identification of

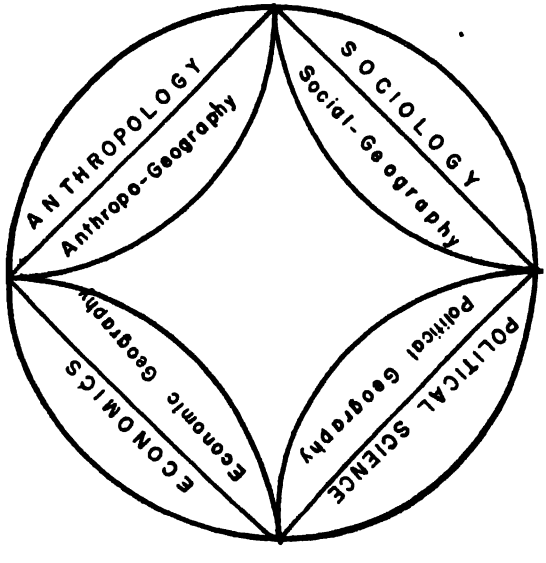

Fig. 1

the exact nature and boundaries of the subject matter of Geography loses its relevance. Geography does not operate within constraints which are alien to its system and which have been improvised by other disciplines to meet the requirements of their own development. Though Geography has an autonomous realm of its own, it is organically linked to the other social science disciplines with every fibre of its being. Following Taylor, the topical sub-disciplines of Geography, as a social science, may be diagrammatically presented in relation to other social science disciplines as in Fig. 1.

The process of differentiation within the four topical sub-disciplines mentioned above has not proceeded at a uniform rate. While Political Geography, Social Geography and Anthropo-Geography have yet not produced distinct nucleated spheres within their own subsystems, the interface between Geography and Economics—Economic Geography—has reached a comparatively advanced stage of development. Since differentiation is a function of development, branches of the second order in the taxonomical hierarchy have emerged within the sub-discipline of Economic Geography. At this level as well, differentiation and the consequent nucleation have developed as a result of intimate interaction with corresponding specialisations in the field of Economics. This relationship is represented diagrammatically in Fig. 2.

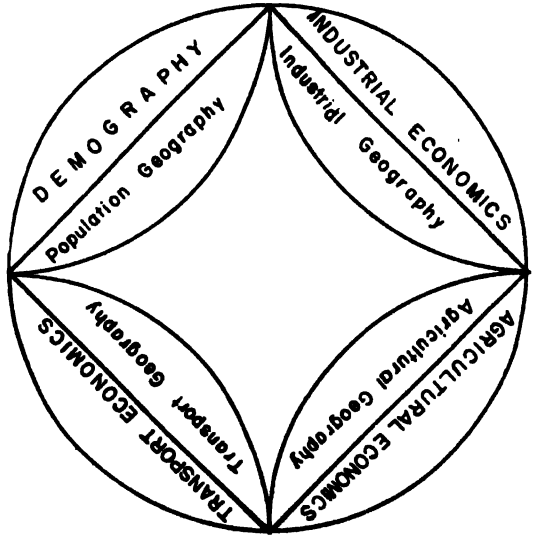

Fig. 2

Regional Geography

The sub-discipline of Geography, concerned with the synthesis of

natural and social variables within a regional frame has been traditionally known as Regional Geography. The nomenclature is apt and correctly reflects the recognition of the region—the central concern of Geography—as the spatial unit within which the process of synthesis proceeds on the basis of the inherent inter-relationships between different variables and as a consequence of their interaction with one another. This implies that regions, though dynamic and changing and not rigid and fixed entities, nevertheless *objectively* exist and are not just theoretical constructs. This distinction is of significance on two counts. Firstly, in terms of philosophical implications it makes it possible to develop Regional Geography as a *science* and prevent it from getting bogged down in idealism. Secondly, in terms of academic work in this sphere, it helps us to distinguish between a sub-discipline, on the one hand, and one of its tools, on the other.

With the development of Regional Geography in India, the process of differentiation within it has already advanced considerably. The essential basis of this differentiation lies neither in differing principles nor in different aspects of reality chosen for study. It lies in differing approaches which are, in the final analysis, complementary to one another. The distinction between the formal and the functional or the uniform and the nodal regions acquires decisive significance in identifying the sub-divisions of this category. While the term Regional Geography has been generally referred to in a generic sense to cover the entire field, it may be useful to restrict its use specifically for studies within the framework of uniform or formal regions. Another variant of Regional Geography, which focuses attention on functional or nodal regions with the aid of sophisticated quantitative tools and techniques, has emerged on the scene in recent years and lies along the advancing frontiers of geographical research. It aims at the study of the spatial integration of settlements, through linkages into a hierarchical organism of nodes and sub-nodes. It may be useful to identify sub-disciplines of this category in terms of the new emerging system of ideas, irrespective of connotations attached to them in the earlier phase. It is a welcome feature that the sub-disciplines of Settlement and Urban Geography are tending to acquire a definitive orientation in this context.

Historical Geography

The problem of properly locating Historical Geography on the map of geographical studies poses problems, peculiar to itself. By definition, its primary concern lies in the study of spatial *variation* of temporal *change*. The historical geographer, for example, is

primarily interested in the study of the varying rates of growth of agricultural production in different regions rather than in the rate of growth itself. This distinction is significant because it clearly demarcates the area of geographic study and, at the same time, brings the study of temporal change within its purview. Viewed thus, the sub-discipline of Historical Geography is an element of a binary scheme of classification, the other being Contemporary Geography.

Tools, Techniques and Methods

Each discipline develops its own tools, techniques and methodology, which arise in response to the problems within its field of study. Geography is no exception. It is, however, open to question whether all these tools, techniques and methods, can be brought, with equal validity, within the purview of Geography by designating them as its sub-disciplines. Mapping techniques, for example, are essentially specific to Geography, and Cartography can rightly be so designated. The same cannot, however, be said about the use of quantitative techniques in Geography. The emergence of "Quantitative" Geography on the academic scene in the recent past, reflects the growing realization among geographers that the use of sophisticated tools developed in the field of Mathematics and Statistics gives greater precision to their understanding and interpretation of social phenomena and makes it possible to analyse processes which could not be studied with the help of traditional tools. This is a welcome development, but does not provide adequate justification for developing a new sub-discipline called "Quantitative" Geography. The term implies, firstly, that there is a geography which is not quantitative and secondly, that this sub-discipline eschews qualitative interpretation altogether. Both the positions are untenable. It should be recognised without any ambiguity that geographers, like other scientists, are using the tools provided by other disciplines—Mathematics and Statistics. It cannot legitimately be considered to be the case of interaction between two disciplines along an interface.

The increasing use of sophisticated quantitative methods in geographical studies is a healthy development, provided that the dangers inherent in their use are guarded against. These, according to Spate are mainly, "(i) a tendency to confuse ends and means; (ii) a correlative naivete which sometimes fails to distinguish between the trivial and the significant; and (iii) a natural youthful ambition which to a point is innocent, or even laudable, but which beyond that point—hardly to be determined quantitatively—may be excessive and lead to the Original Sin of academic life—exclusivism or obscurantism."

It may be noted in the end that a scheme of classification is, by

its very nature, approximate and tends to fragment the essential unity of Geography as a principle and as a discipline. While discussing problems related to the taxonomy of knowledge in any sphere, the following words of Hartshorne should be kept in view as a necessary corrective:

"The organisation of knowledge does not require a neat division into compartments, which would in fact be in violation of the essential unity of reality, but rather the recognition of coherent and manageable but *preferably* overlapping divisions."

I

Economic Geography

1

Agricultural Geography

A Trend Report

By

M. Shafi

THE WORK of the Indian geographers in the field of agriculture can be reviewed under the following sub-heads:

(a) Regional Agriculture
(b) Food and Commercial Crops
(c) Agricultural Problems and Planning; and
(d) Food Supply and Population.*

Regional Agriculture

Geographical writings for almost two decades prior to independence have been mostly confined to regional agriculture. Ramakrishnan (22, 1930), Sourirajan (26, 1931), Rajamanikkam (19, 1933; 20, 1937), Garu (9, 1934), Srinivasan (27, 1935), and Gopalan (10, 1937) studied the agricultural geography of Coimbatore, Malabar, Madurai and Trichinopoly, Vishakhapatnam, Anantpur and Tanjore districts. All these studies brought out the importance of the principal crops of the respective districts and also attempted to analyse the influence of physical environment on agricultural practices and the distribution of the main crops. Ayyar (1, 1939) considered the major cultivated crops of the Coimbatore district. Deshpande (8, 1942) made a study of the agricultural geography of the districts of Belgaum, Bijapur and Dharwar with special reference to the cultivation of cotton. Rajagopal (21, 1942) studied agricultural geography of Tanjore district.

* The problem of livestock or animal resources is dealt with in the section on 'Resources Geography'.

Mukerjee (15, 1942) made a study of the agricultural geography of Uttar Pradesh (then United Provinces) at the Edinburgh University. He divided the state into four agricultural regions based on relief and ten sub-regions on the basis of irrigation facilities. Dayal (7, 1950) made a detailed study of the agricultural regions and harvests of Bihar.

Waring and Parida (29, 1953) discussed the influence of land holding system and agricultural wages on agricultural practices in the Barpali area. Kulkarni (12, 1955) discussed the agricultural patterns of Dharwar district, analysed the influence of physical factors on the distribution of crops and attempted to demarcate the geographical regions of Dharwar. Bhat (4, 1956) studied some aspects of agriculture in the Lower Khumbi Valley in the district of Kolhapur in Maharashtra. His study is restricted to representative village Bhamte in the valley. He has suggested four classes of land in the village depending on local slope, thickness of soils and the distance from the rivers.

Mukerjee (14, 1956) examined the agricultural geography of the Upper Ganga-Yamuna Doab of Uttar Pradesh with special reference to the Jat economy. He studied four typical villages of the region in the Meerut district and made a careful appraisal of the technique of cultivation, crop rotation, mixed cropping and cropping pattern of the area. Assessing the importance of food and commercial crops and the tenure system, he pointed out that the balance between food and cash crop farming explained the comparative prosperity of the region. Sen (24, 1957) discussed the evolution of agriculture in the Andamans and the production and distribution of food crops in relation to the physical, economic and social conditions of the island. He considered in detail the plantation crops like coconuts, rubber, coffee and tin and also some of the agricultural problems facing the island. Pande (18, 1961) discussed the factors influencing the cultivation and distribution of important food and cash crops of the piedmont plain of Uttar Pradesh, known as *Tarai* and *Bhabar*. He also analysed some of the problems facing agriculture in this area. Kaushik (11, 1962) discussed the influence of physical factors on the development of agriculture in the Himalayan Ganga Basin. He divided the area into ecological sub-regions with respect to altitude and considered crop associations, crop rotation, manuring methods and irrigation techniques of each sub-region. Misra (13,1963) studied the agricultural geography of Himachal Pradesh with special reference to agricultural operations and rotation of crops. Singh (25, 1963) brought out the significance of soil conditions, precipitation and irrigation facilities in determining crop diversification in the Malva tract of the Punjab and emphasised that the degree

of diversification of crops in the area was related to the extent of the availability of favourable physical factors. Dayal (6, 1963) presented crop association, crop patterns and relative importance of crops in the first, second and third ranks in the Punjab plains and attempted a correlation between physical, social and economic factors. Chaturvedi and Reddi (5,1963) considered the distribution of crops in the light of physical factors in the Telangana region, the technique of cultivation and modes of irrigation. They also referred to the influence of Hyderabad in bringing about a shift from the production of food crops to the production of grapes on a large scale within a radius of 40 Kms. from the city. Vasantha Devi (28, 1964) studied the influence of physical factors on crop distribution and crop association in South India and further discussed nutritional problems on the basis of the availability of food grains and dietary habits. Mukerjee (16, 1967) discussed the agricultural production in the Vidarbha region of Maharashtra by dividing the area into three cropping zones and examined the problems of increasing the yield in each of these regions. Sen (23, 1968) discussed the cartographic techniques employed to show, on a map of Rajasthan on a scale 1:2 M, the yield of major crops and their variations from year to year. Nigam (17, 1969) examined the trends of agricultural developments in Uttar Pradesh by taking into account the cropping pattern, crop distribution, and food production in different regions. In view of the existing food requirements, he made suggestions for increasing food production.

The Department of Agriculture, West Bengal, published a monograph on the *Agricultural Geography of West Bengal,* 1956. It considered the physical setting of the state, soil erosion and forest land use including the distribution and production of major crops and livestock.

Randhawa (31, 1959; 32, 1964; 33, 1964; 34, 1968) has written four volumes under the title *Farmers of India.* They deal in detail with physical setting, distribution of crops and agricultural practices, horticulture, irrigation projects, farming communities and typical villages. Vol. I deals with Punjab, Himachal Pradesh, Jammu and Kashmir; Vol. II considers Tamil Nadu, Andhra Pradesh, Mysore, and Kerala; Vol. III discusses Assam, Orissa, West Bengal, Andaman and Nicobar Islands, Manipur, NEFA and Tripura; and Vol. IV considers Madhya Pradesh, Rajasthan, Gujarat and Maharashtra.

Venkateswaran (35, 1961) is the author of a monograph which deals with *Agriculture in South India.* He has considered in detail soil and soil management, the distribution of food and cash crops, the system of irrigation, land tenure, and farm management.

Food and Commercial Crops

Geographers have given considerable attention to important food and commercial crops.

Rice: Menon (37, 1939) discussed the methods of paddy cultivation on lands submerged under fresh water known as 'Cole Lands' in Cochin. Pillai (38, 1940) studied paddy cultivation in Tirunelveli district. Kuriyan (36, 1945) made an exhaustive study of the factors affecting the cultivation of rice, its regional distribution and production and the tillage practices in its cultivation. He analysed the yield figures for the four quinquennia beginning from 1911-12 to 1931-32 in the major rice producing areas of India and discussed the factors helpful in increasing its production. He also considered its export and import and finally made a comparison of the conditions of rice cultivation in the neighbouring monsoon lands of Burma, China and Japan.

Wheat: Ahmad (39, 1942-43) discussed the influence of geographical factors in the production and distribution of wheat in the Punjab and attempted to correlate the variations in the yield with variations in the climatic elements, particularly rainfall.

Jute: Basak (41, 1948) made a survey of the cultivation of Jute in India and posed the problem of ensuring an adequate supply of jute to the Mills. He made some practical suggestions for stepping up production and proper distribution of all available supply of good seeds. Banerjee (40, 1955) made a study of jute cultivation in West Bengal and considered methods for the attainment of self-sufficiency in jute production. Sengupta (42, 1955) made a detailed study of the jute problem in India. She first considered the important jute growing centres in India and suggested a large scale expansion of jute cultivation in the regions of optimum conditions of climate, soil and relief and corresponding measures to check further growth in the areas of unfavourable environment. In a subsequent paper (43, 1961) she focused attention on the regional trends in the expansion of jute acreages in the first two Five-Year Plans and the expected trend in the Third Five-Year Plan.

Oil Seeds: Castor, groundnut, linseed, sunflower, rape, mustard and sesamum are the major oil seed crops in India. Menon (44, 1938) discussed oil seeds in South Kanara and suggested that if the cultivation of oil seeds was extended, it may be possible to set up small factories for recovering essential oils for soap factories. He further suggested that it would be possible to extract edible oil on a commercial scale from a very useful oil seed locally known as 'dhupa' obtained from the *Vareria indica*. Velayudhan (45, 1946) made a detailed study of groundnut in the Madras state and examined the

geographical distribution of the crop in various districts, crop association, and some aspects of ground-nut production, cultivation and trade.

Tobacco: Tobacco is an important crop in Andhra Pradesh, West Bengal and Uttar Pradesh. Banerji (46, 1956) examined the soil and climatic requirements for its growth in West Bengal. He discussed the methods of cultivation in different parts of the state, marketing factors and local industries associated with it.

Cotton: The material written by Indian geographers on the production and distribution of cotton in India is not adequate. Natarajan (48, 1940) analysed the influence of soil and rainfall on the distribution of cotton in Tirunelveli district of Madras. He also traced the influences of the cotton crop on the economic life of the farmers of the district. An interesting study was made by Khandwa (47, 1957) who tried to establish a correlation between rainfall and yield of cotton in Akola district.

Sugarcane: Galatgekar (49, 1933) described the progress of sugarcane harvesting in a typical Maharashtra village and presented a bright prospect for the sugar industry. Kuriyan (50, 1940) made a detailed study of sugarcane cultivation and felt that the lack of sugarcane cultivation in peninsular India was due to the presence of rival food crops and the greater cost of growing the tropical canes in terms of manure and irrigation water. Mathur (52, 1943) dealt with sugarcane in Western Uttar Pradesh and pointed out that the acreage under cane cultivation was limited by the inadequate supply of cheap irrigation water by canals and tube-wells. Lahiri (51, 1952) investigated the relationship between soil nutrients and the yield of sugar for successive cropping of the same seed cane based on the soil samples of a village in West Bengal and found a definite depletion of the soil in respect of essential nutrients such as potassium, phosphorous and calcium after the first year's harvest.

Tea, Coffee, Coconut and Rubber: Banerji (53, 1954) studied the influence of relief and slope on the location of tea gardens in West Bengal and their concentration in the northern districts of Darjeeling and Jalpaiguri. In a subsequent paper (54, 1957) he analysed the landscape of tea growing areas in West Bengal and traced the growth of the industry since the middle of the last century. Ghori (55, 1952) discussed the distribution and production of coffee in Mysore in relation to the physical factors and made practical suggestions for increasing the yield of the crop. Kuriyan (56, 1937) analysed the physical factors influencing the distribution of coffee, tea, and rubber plantations in Kerala. He also considered other plantation crops of this region like coconut, pepper, and cardamom and discussed the industries based on these crops like coir ropes and

copra. Panikar (57, 1943) considered the geographical factors affecting the distribution of coconut palm trees. Pasupathi (58, 1939) examined cinchona cultivation in India and discussed its regional distribution. Ramakrishnan (59, 1931-32) considered the distribution of pepper cultivation in Malabar and discussed the reasons for the high yield of Malabar pepper. Saxena (60, 1960) considered the method of cultivation of Soyabeans and discussed the area and production under soyabeans in different states.

Pal (63, 1966), under the auspices of the Indian Council of Agricultural Research, wrote a monograph on wheat and considered soils of wheat-growing areas in India. He also discussed the application of manures and fertilizers in wheat cultivation.

Ghosh, Ghatge and Subramanyan (61, 1956), also under the auspices of the Indian Council of Agricultural Research, published a monograph on *Rice in India*. They divided this book in three parts: Part I deals with physical setting of rice culture, physiology and agronomy, diseases and pests, application and distribution of fertilizers and plant protection methods. Part II considers marketing with reference to supply and demand, transportation and distribution of rice and rice products. Part III considers some aspects of the technology of rice-processing. Nutrition value of rice and rice diets and their nutritional improvements are also considered.

Sengupta's doctoral thesis (64, 1959) on the Indian Jute Belt gives an exhaustive account of the physical setting of jute cultivation, its regional distribution, geographic variation in production cost, and the future land utilization of jute in India.

The Indian Central Cotton Committee (1960) published *The Indian Cotton Atlas* which shows the acreage under cotton in different varieties and the distribution and production of cotton. The monograph on *Cotton in India* published by Indian Central Cotton Committee in four volumes is also very valuable.

Agricultural Problems and Planning

Ghosh (68, 1945) considered agricultural planning in India with special reference to soil conservation. Kuriyan (69, 1956) made a detailed study of agricultural planning in India. He made a survey of the existing irrigation facilities and the progress achieved in the field of agriculture during the First Five-Year Plan. Outlining the various problems facing agriculture, he made practical suggestions for its planning. Srivastava (75, 1958) made a general survey of the development of agriculture in India from 1947 to 1957. Chakervarti (66, 1960) considered the influence of microclimatology and its application in the development of agriculture of the arid regions of Rajas-

than and suggested methods as to how the micro-climates can be modified to raise agricultural productivity. Mrs. Sita (74, 1960) discussed dry farming in peninsular India. She pointed out that there was a lower limit of rainfall beyond 375 mm where even dry farming was not effective for the growth of crops; but in peninsular India there were no extensive tracts receiving rainfall less than 375 mm and about 40 million acres could be benefitted by dry farming methods.

The problem of the measurement of agricultural efficiency for a region of India was discussed by Shafi (71, 1960). He attempted to determine agricultural efficiency on the basis of acre yields of eight selected crops of each district of Uttar Pradesh and delineated agricultural efficiency regions of Uttar Pradesh. In a subsequent paper (72, 1962) he attempted to study the agricultural developments in Uttar Pradesh and tried to correlate production in different years with the level of agricultural efficiency at the district level. Agricultural planning with special reference to Eastern India was discussed in a comprehensive manner by Chatterjee (67, 1962). He referred to the considerable water resources which needed full utilization for the agricultural development of the country. Mukerjee (70, 1962) discussed the factors which should be taken into account for the delimitation of agricultural regions and the utility of such regions in the planning of Indian agriculture. Amani (65, 1966) considered the variability of rainfall in the central Ganga-Yamuna Doab and pointed out that the rainfall in the Doab is more variable in those months when it is needed most and such a variability in those areas where there is no provision for irrigation leads to uncertainties in agricultural operations. Sinha (73, 1968) discussed the problem of agricultural efficiency and adopted a common standard deviation formula to determine agricultural efficiency in the country. On the basis of his study, he concluded that the lowest agricultural efficiency is found in Rajasthan and Gujarat and the areas indicated in these states need greater attention for agricultural development.

Irrigation: Ayyar (76, 1931) discussed field irrigation in Malabar and suggested the utilization of water flowing down the hills for the production of some forms of cheap and effective energy, either before or after the requirements of irrigation are satisfied, and its use for the establishment of cottage industries. Ayyar (77, 1933) considered the development of irrigation in Trichinopoly district and felt that the area under irrigation in that district from Mettur Reservoir could not be extended due to steep gradient. Krishnaswami (85, 1939) attempted to survey the Grand Anicut Canal region in the Tanjore district and noted the effects of the canal on the

irrigated areas in all its varied aspects. He suggested that canal development should take place in a manner which would eliminate the subsequent formation of alkalies in the soil of the irrigated areas and the outbreak of malaria. Yunus (92, 1951) reviewed the effect to state tube-well irrigation scheme in the western districts of U.P and pointed out the effects of irrigation on the extension of area and the cropping pattern.

Mukherjee (88, 1943) studied the effect of irrigation on the pressure of population of Uttar Pradesh. He pointed out that irrigation became the main limiting factor for the density of population in districts having rainfall below 800 mm. and that irrigation ceased to be the determining factor for agricultural productivity and rural density in districts having rainfall above 800 mm. Dutt (80, 1948) discussed the impact of the Ganga Canal Hydro-electric Scheme on the development of agriculture in Western Uttar Pradesh. He discussed the objective of the grid scheme and analysed the extension that had taken place in irrigation and consequent increase in agricultural lands and agricultural security of the region. Siddiqi (89, 1949) discussed the potentialities of tube-well irrigation in the Budaun district in Uttar Pradesh in India. He considered in detail the number of tube-wells in the district in relation to the soil and the effect of tube-well irrigation in the extension of the cultivated area and the cropping pattern. Ghori (83, 1951) reviewed the progress of irrigation in Mysore state and pointed out that, owing to stagnation in the development of tank and well irrigation, irrigated area of canal increased substantially in the state.

Food Supply and Population

Bagchi (93, 1942) suggested that measures for increasing the food production of the country should be related to its geographical framework. Rajalakshman (106, 1945) considered the regional distribution and requirements of food grains in Tamil Nadu. He attempted to prepare a kind of balance sheet to show the availability and requirements of food grains in the state. Basak (94, 1949) made a general survey of the relationship between food and population. He outlined the size and nature of the food problem in its relation to the population of the country. Chatterjee (96, 1952) discussed the problem of food shortage in India; and in a subsequent paper (97, 1952), made a comparative assessment of the position of food supply in India and the world. He also made some concrete suggestions for evolving a good policy for India and for increasing food production in the country. Another important study on the food problem was made by Kuriyan (103, 1952) who suggested

methods for increasing the acreage as well as yield per hectare. He further suggested the cultivation of subsidiary food crops, co-operative farming, and land reform measures in providing a solution to the problem. Mathur (104, 1956) considered food resources and population growth in India. Ghori (99, 1956) considered the position of food supply in greater Mysore. He studied the distribution of crops, agricultural practices and the causes of low yield and made suggestions for the improvement of agriculture. Smt. Krishnan (102, 1960) discussed problems of self sufficiency of Tamil Nadu in food grains. After discussing the composition of the diet of the people and its nutritive value, she pointed out that the diet of the average South Indian peasant was deficient from the viewpoint of both quality and quantity. She considered in detail the production of rice and millet, the main diet of the people in different parts of the state and correlated the consumption of food with the population. Chaturvedi (98, 1962) considered the production of food crops in Andhra Pradesh. He made an analysis of the production statistics of cereals and pulses for Andhra Pradesh and for the whole of India and made a comparative study of the food position of the state in the context of shortage in the country as a whole. Kayastha (100, 1967) made an appraisal of population and food resources and pointed out that the main increase in food production must come from increased yield per acre. Besides, he referred to the prospects of tapping immense resources of organic material of the sea and the manufacturing of artificial food. Bhattacharya (95, 1968) studied the increase in population and cereal production in West Bengal and concluded that it was possible to eliminate the deficiency in cereals if a more intensive and coordinated drive was made by the state as well as by the individual farmer. He also suggested a change in the dietary habits of the people.

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2

Land Use Studies

A Trend Report

By

M. Shafi

INDIAN GEOGRAPHERS have long been attracted to study the problems of land use in the country with a view to finding out ways and means for scientific utilization of land. Such studies range from inventories of land use surveys to isolated topical or regional descriptive accounts of land use variations, both in space and time. Recently the studies are shifting towards the application of quantitative techniques in the analysis of various land use components.

Planning and Methodology

Chatterjee (4, 1941) drew the attention of geographers to undertake a land use survey in India. Sensing its necessity, the present author (22, 1951) made a strong plea to carry out a land utilization survey which would, in itself, combine with land capability survey in order to determine the measures for using land to the best advantage in relation to its intrinsic qualities. He also submitted an elaborate scheme of a model land use survey. The work on the lines of this model has continuously been done by the students of the Department of Geography, Aligarh Muslim University, who go out to complete a land use survey each year in typical areas of the country. The Departments of Geography of Madras and Calcutta Universities have also been sending similar parties of students to carry out land use studies.

The problem of covering the whole of India by land use surveys was discussed by Chatterjee (5, 1953; 6, 1956; 7, 1962) who does not favour much reliance on sample surveys in a country where numerous variations in physical conditions occur from place to place.

In order to cover the whole of India within a reasonable time, he recommends the conduct of rapid surveys and mapping of only marginal areas of different categories of land use with the help of a generalized map.

Prakasa Rao (20, 1956) doubts the feasibility of a total survey for such a large country with atomistic structure of land use. In his opinion sampling is imperative and he emphasises the need to carry out pilot studies in typical land use regions. He has also evolved a scheme of land use classification and its mapping.

Indian Society of Agricultural Economics brought out *Readings in Land Utilization* (1957) as one of its publications. It discusses varying approaches to the problems of land utilization, its scope and methods and describes some important projects which have been carried out on land utilization in the world. The extent of land misuse in India has also been discussed and problems that may arise in the formulation and execution of a National Land Policy have been enumerated.

The significance of mapping correctly all the land use information gathered by geographers has been felt by Sen and Chakerborty (21, 1958) who have given a colour scheme for land use maps.

A note by Gupta (16, 1959) explains the methods of rapid land use survey which have been adopted by the National Atlas Organization under the Directorship of S. P. Chatterjee.

Deshpande, Bhatt and Mavinkarve (13, 1959) have emphasised the influence of morphological features on land use and have suggested a micro-regional approach to land planning. In this connection, Rao and Bhat (19, 1959) have pointed out that geographers can contribute significantly to land use planning as they are well trained for regional synthesis through map interpretation. Singh (28, 1960) suggests the need for proper land classification for better land use planning.

This author (22, 1961) again touched the problem of field research in Indian conditions and advocated the adoption of a purposive sampling technique to select areas for special study. In another study (24, 1962) he suggested the measurement of efficiency of existing production throughout the region to focus attention on the underdeveloped areas and to carry out a careful, objective and detailed land use survey as a pre-requisite for all long range planning of Uttar Pradesh.

The significance and objectives of land use studies in a predominantly agricultural country like India are highlighted by Amani (2, 1964) who has chalked out a tentative plan to carry on such surveys. In another study of the significance of land use surveys, Ganguli (17, 1964) considered them to be essential for agricultural

planning and for solving the food problem of India.

Shafi (25, 1966) presented a paper to the 20th International Geographical Congress in London giving concrete suggestions regarding the techniques which should be adopted for conducting land use surveys in India. After briefly reviewing various techniques adopted in different countries, he opines that any technique which is adopted for rural land use planning in India should aim at recording the existing use of land in the first instance followed by mapping of land capability or land potential at the next stage. In view of the vastness of the country, the paucity of trained personnel and the extent of time and expenditure involved, it will not be possible to cover the whole of India by a total survey. In order to avoid this difficulty, he has advocated the use of systematic purposive cluster sampling as most suitable for land use surveys in India. The colour scheme recommended by the World Land Use Survey Commission may be adopted with some modification for mapping land use in sample villages. A brief resumé of the work being carried under his supervision in the Department of Geography, Aligarh Muslim University, since 1956 has also been given. It is his endeavour to cover ultimately the whole of Uttar Pradesh by similar surveys.

Another important work highlighting the objects and concepts of land use is a monograph on studies in utilization of agricultural land by Dr. Chauhan (8, 1966). In parts I to III, he has discussed the subject matter, scope, concepts, principles and patterns of land utilization, while in parts IV and V, some pressing land use problems are emphasised and land use policy to help a national plan of economic growth is presented. Although the work suffers from lack of comprehensiveness and coherence and inadequacy of analysis at some places, it is nevertheless a good attempt to present the problems of land use in relation to economic development of the country.

Case Studies

Many geographers have come forward with descriptive studies which range from local case studies to regional evaluation of land use problems. Chatterjee (44, 1945) has selected a small area to study the influence of physical environment and socio-economic factors on the utilization of land in the district of 24 Parganas. Another systematic study of a region was made by Siddiqi (87, 1946) who submitted to the Aligarh Muslim University a thesis on Land Utilization in the Central Ghaggar Plain. He has analysed the physical setting of the plain and studied its utilization to bring

out a real distribution of natural and cultural features in the light of physical factors. An over-optimistic micro-study has come from Karimi (59, 1950) who thinks that the yield of crops in village Dinapur Ghusabra (Bihar) may be doubled by proper utilization of land. Lahiri (61, 1950) has analysed agricultural problems in four selected villages near Jasidih Deoghar. His investigations have brought to notice the fast deterioration of agriculture due to soil depletion.

Damodar Valley Corporation (50, 1951) has attempted an outline plan of improved land use for the Corporation's area to promote agricultural, industrial, economic and general well-being of the region. It was believed that the Upper Damodar Valley urgently needed improved land use and a comprehensive land use plan was thought to be the safest way of assuring a higher rural economy on a permanent footing. In the Corporation's opinion, such a plan will be useful as a pilot scheme for the spread of scientific agriculture.

Chatterjee (45, 1952) has tried to find out the location of idle land after studying the nature of utilization of each holding in Howrah district. Honrao (54, 1953; 55, 1962) has discussed the problems of land use in village Halge and also assessed the influence of physical elements on land use in the lower Kali basin of North Kanara district, Mysore. Ganguli (51, 1953) conducted a sample survey in a village of Banaras district and after studying five types of land uses, pointed out the scarcity of irrigation water as the main problem of the village. Singh (92, 1955) has surveyed five villages near Banaras to assess the influence of physical and socio-economic conditions on land use and a comparison of land use between 1883-84 and 1951-52 has also been made. In his opinion, only consolidation of holdings may bring success to the development schemes of these villages.

The only study dealing with the rural areas of Delhi was presented by Ameen (33, 1956) who divided the whole rural area into six circles and carried out an intensive field work in a selected village of Bangar circle. Another study of existing land use pattern was completed by Sen (80, 1957)* in Matpalsa Union of district Birbhum, West Bengal. On the basis of manurial trials, relation of soils with the distribution of crops, and the condition of the people, a five-point programme has been suggested for the agricultural improvement of the area. Singh (93, 1958; 94, 1959) has found that the southern part of Mirzapur district is mostly forested and that cultivation is limited to only 12 per cent of the total area along a few river valleys. In another generalized study of the revenue records of 1906 and 1956 he has pointed out

to a considerable change in rural land use around Mirzapur town (95, 1964).

Ahmad (31, 1959) has presented an important case study dealing with one village. He has analysed in detail all the physical elements and various land use types and concluded that the slope factor cannot be ignored in any development scheme of the village. The problem of water supply is of utmost importance in the village and in fact in the whole region where the village is situated. This systematic study may form a suitable basis for similar studies in future. In another case study of a south Indian village, Arunachalam (35, 1959) has suggested the methods of replanning land use by firstly classifying land according to its inherent capabilities and then upgrading, wherever possible, the use of individual plots. Deshpande (48, 1959) in his reconnaissance study of land use in Pampore village of Kashmir Valley ,has brought out the influence of soil drainage and irrigation on the utilization of land. The village, under new economic forces, is showing marked influence of Jammu-Srinagar road on its land use pattern and mode of living.

The work of the present author (82, 1960) is based on strenuous field work and original research on land utilization in Eastern Uttar Pradesh. The first part of the work gives a useful account of physical conditions and part two introduces twelve villages selected from varied environments in which actual land use is plotted on maps and accurate yields ascertained. These were related to careful estimates of population and then an accurate assessment of the caloric intake per head per day was made. Part three relates to the conclusions and discusses lines of possible future developments to increase production.

Goswami (53, 1960) has highlighted the influence of physical environment of agricultural land use in a typical village near Ranchi. He shows the village as an ideal prototype for establishing the general pattern of agricultural land use for the whole of Central Ranchi Plateau by an integration of several local surveys. Relief, soil and rainfall conditions affecting the utilization of land in Bankura district have been given by Sen and Guha (81, 1960). A few detailed land use studies in villages have revealed certain micro-regional features, and it has been observed that the paucity of water for winter cropping and also poor soil conditions are the main agricultural problems of the districts.

Two important studies on land use in the lowlands of Beas and Sutlej have come from Bhardwaj (37, 1961; 38, 1964). The two sample villages selected from Hoshiarpur district represent the lowlands of Beas where necessary safeguards against floods and the rising underground water level have been suggested. The same

problem was met with in one of the two selected villages of Jullundur district in the lowlands of Sutlej. In the other village, it was found necessary to extend facilities of irrigation and to encourage market gardening near the town.

A compact area occupied by five villages in Ballia district was selected by Roy (73, 1961) to study the physical conditions of occupational structures and the changes in general land use patterns by comparing the Khasra records of 1882-83 and 1955-56. He has pointed out the acute pressure of population on land and has suggested the provision of irrigation and drainage facilities and improvement in agricultural practices for the development of the region. In another study of the same year (74), he has presented the utilization of land in a sample village of Ganga-Ghaghara Doab. Duggal (49, 1961) has emphasised the contribution of historical factors to the existing land use patterns in Moradabad district. Joshi (58, 1961) after analysing topography, rock types, soils, water supply and climatic conditions in Ratnagiri taluka has pointed to their marked influence on the type of land use and settlement in the region.

Chandrashekar and Sundaram (43, 1962) have recommended the study of all the problems of arid and semi-arid regions together with the necessary changes that may possibly be made in land utilization before chalking out any scheme of irrigation in the Rajasthan Canal area. Sharan (83, 1962) has found that it was possible to increase agricultural production in Salgawan village in the Upper Damodar basin by practising soil conservation, consolidation of holdings and providing irrigation facilities.

Various aspects of land utilization in Kashmir Valley have been studied by Raina (69, 1962; 70, 1962; 71, 1963) who considers climate and soil as the two most important factors affecting the utilization of land in rural Kashmir. Floating gardens of Kashmir have also attracted his attention and he shows how a floating platform is formed to grow various vegetables. In his study of 1963, Raina examined soil formation and its influence on utilization of land in the Kashmir Valley.

Land use patterns of Mewar village were studied by Mukherjee (63, 1963) and of village Karla by Paranjape (66, 1963).

Mishra (62, 1964) presented a study of land use in Khadar and ravine tract of the lower middle Gomati valley and asked for a vigorous programme of soil conservation in this area. Singh (96, 1968) has extended the nature of his studies around Mirzapur town and has now calculated the carrying capacity of land on the basis of land fertility and output of foodgrains, potential production units and the standard nutrition units. Roy (75, 1964) has further

shown his interest in land use problems of Ballia district where he has highlighted important characteristics of Doab pargana.

The much neglected Himalayas were the subject of land use study by Kayastha (60, 1965). His study of Himalayan Beas basin has shown that only a small area in the region is given to cultivation while the major part of land is occupied by forests and other uncultivated lands. In view of the small area of good agricultural land, he has suggested that it should be saved from misuse, through a Scientific Land Utilization Act.

Tewari (98, 1965; 99, 1966) has also studied utilization of land in the Himalayan region. In a study of Jaunsar Bawar, he has suggested that the standard of living and the level of subsistence in the village may be raised only if land use planning for purposes other than agriculture is aimed at. However, in the general study of Jaunsar Bawar area, he has suggested some measures to improve agricultural production.

Land use studies from four different states have been reported in 1965. The problem of mapping land use data of rural areas in Bihar is, according to Sharan (83, 1962), a costly affair as it requires a team of local people and revenue officials. However, it is only after mapping land use data that the physical capabilities of an area can be ascertained with some reasonable accuracy. Sinha (97, 1965) has shown the existing patterns of land use in eight villages situated in an area irrigated by canals in Patna district. The decisive role of desert environment in the nature and type of land use in Rajasthan is described by Yadav (101, 1965). Another valuable study for those interested in improving the utilization of land in arid and semi-arid regions has been brought out by UNESCO (1965) as one of the Arid Zone Research series dealing with the history of land use in arid regions. In this series, Bhardwaj (39, 1965) has contributed a chapter evaluating the physical resource base and the agricultural land use in the arid zone of India and Pakistan from the earliest times. He has emphasised that the value of the physical resource base changes from time to time according to the capabilities of man to make use of these resources. In Maharashtra, Amrite (34, 1965) has seen the necessity of studying the impact of the growing urban area of Bombay on the land use of the coastal Thana district. Bose (41, 1965) has presented a descriptive account of physical conditions and related land use in Malnad region spreading over about 300 kms. from north to south along the western margin of Mysore state.

The National Council of Applied Economic Research (64, 1966) took up a pilot project to suggest, with a closer look at the agronomic and other conditions, the possible cropping patterns that would

add to the farmer's returns in Punjab. Due to varying agronomic conditions in the state, the district was selected as a proper unit of study. It was concluded that Ferozepur, Hissar and Sangrur have immense possibilities if provision of irrigation facilities and fertilizers etc. is made to develop areas under less remunerative crops.

Singh (89, 1966) has shown that the pressure of population on cropped land is increasing day by day in Eastern Uttar Pradesh. It is obvious from his study that an elaborate land use survey can help in the planning for improvement of agricultural and other material resources. Amani (32, 1966) has shown that in Aligarh district the distribution of crops is mainly controlled by the geographical factors of climate and soil and that the choice of crops grown is largely affected by traditions and economic considerations.

An intensive agricultural land use survey was conducted by Siddiqi (85, 1966; 86, 1967) in the villages of Bundelkhand. His first two studies give a general description of crop patterns in the two villages situated in an area of predominantly kabar soil in Hamirpur and Banda districts. In both the villages, it was found that 1.35 and 1.30 acres of cropped land meets the general nutritional and other requirements of one person. In the other close study of cropping pattern in a village with parna soil, he shows land use problems which could be met quickly. The important points calling for immediate attention are sub-division of holdings, poor irrigation and traditional cropping pattern. It is also calculated that in those areas of parna soil where irrigation facilities are not available, the per capita share in cropped land comes to 1.35 acre.

A micro-regional study of land use, crop patterns and their ranking has been attempted by Singh (88, 1967) in Baraut block of Meerut district. In this study he has concluded that all the villages of small size have put their land to optimum use while the large size villages may still increase their cultivated area by bringing uncultivated land under plough.

According to Ganguli and Nikhat (52, 1967) the proper utilization of arable land depends to a very great extent on the form of ownership relations. They also argue that the consolidation of holdings should be accomplished to improve agriculture. The problem of encroachment of urban area on the rural land use is discussed by Jadhav, Kulkarni and Bopegamage (57, 1967). They have studied five villages in the rural urban fringe of Poona, prepared a land classification map and showed how various land types can have better utilization for urban or agricultural purposes. Singh (91, 1967) has described general land use in Dunai village. Roy (76, 1967) selected a village from the margins of old and new alluvium soils of Ballia district for his study of cropping pattern during 1880-81

and 1960-61. Low yield of land in poor soil gives only 1,000 calories per head per day which is much below the requirement for health. In another study of the same year (77) he has analysed the land use conditions in village Chainpur Gudaura in the riverine region of Ghaghara and has indicated a continuous change in land use. Floods are the chief menace to the arable land. He has also measured the utilization of land in Azamgarh district of the middle Ganga Valley (78, 1968).

In another attempt Bose (42, 1967) has pointed out that environment, due to rapid changes in landforms, slope, altitude and degree of roughness of relief, has a strong control on land use in the Himalayas. There is still much scope for developing suitable areas for greater production.

Ahmad (30, 1968) has explained the need to resort to an intensive use of land in the arid zone of India. Besides emphasising the limitations imposed by environmental set-up, he has assessed the region's potentialities for their fullest exploitation.

The importance of land reforms for increasing agricultural productivity was emphasised by Raza (72, 1968). After enumerating various land reform legislations in Uttar Pradesh, he has shown that their implementation has resulted in changing the land use pattern and in increasing the intensity of cultivation of crops like wheat, paddy and other commercial crops.

Ayyer and Shrivastava (36, 1968) have made an elementary attempt to work out an indirect relationship between land use and nutritional state in three selected villages of Bewas basin. They have pointed out to the difficulty in collecting dietary data and have recommended conduct of such surveys on a family basis.

Another recent valuable addition to land use studies in India was made by the Indian National Committee for Geography in the form of a volume, *India-Regional Studies* (1968), presented to the delegates of the 21st International Geographical Congress. These studies deal with thirteen different regions of India and outline the regional personality by focussing attention on the synthesis of the physico-cultural environment and rural agrarian base. A detailed treatment of the distribution of land use and crop-association is given for Upper Bari Doab, Ganga-Yamuna Doab, Eastern Uttar Pradesh, the Tarai Region of Uttar Pradesh, Kangra Valley and the Mahanadi Delta.

Bhattacharya (40, 1968) draws attention to the chronic shortage of food for human consumption owing to low average of cultivated land per capita and low yield of crops. In a study on Uttar Pradesh, Chaudhary (46, 1968) also points to low productivity of land. But due to sparse population, the region is self-sufficient in

food. However, the carrying capacity of land can be enhanced by land use planning. Patterns of agricultural land use in three adjacent blocks of Patna district have been portrayed by Dayal and Sharan (47, 1968). The area was found to be characterized by highly intensive cultivation of cash crops. Niyogi *et al.* (65, 1968) have evaluated the impact of physical factors like geomorphology, soil, climate and hydrology on the utilization of land. Prasad (67, 1968) has reported that considerable changes in the nature and pattern of agricultural land use have been the outcome of a switch over to pump irrigation system. Rafiullah (68, 1968), after analysing the demographic factor and agricultural use of land in the Doab, emphasizes the need for diversification of agro-oriented cottage industries for a better and more balanced use of land in the region. The influence of physical conditions on agricultural land use in Bundelkhand were highlighted by Saxena (79, 1968) and solutions were given for better utilization of land. A model to determine the land capability has been given by Singh (96, 1968). Tewari and Chauhan (100, 1968) have laid down principles on which future land use planning in the Upper Ganga plains should be based. In their opinion, all such planning must provide the guidelines for restoration of the present disturbed ecological balance.

Husain (56, 1969) has summarized the utilisation of land in kharif and rabi seasons of 1960-61 in Meerut district. He has also given in detail two types of crop rotations that are common in the district.

Changing Land Use and Recent Trends

Geographers have recently turned their attention to assess quantitatively the changes which have been taking place in the utilization of land. In this connection, Chakerborty (109, 1962) has given a statistical method to analyse land use pattern of any region.

This author (114, 1965) has selected Ganga-Yamuna Doab, in the most fertile and thickly populated part of U.P., for his intensive study of patterns of cropland use. He has mapped and discussed crops ranking first, second and third in 150 parganas of Doab in 1945-46 and 1955-56. The total volume of change in the acreage of nine major crops between the two years selected for study has also been given. Ahmad (103, 1966) has measured the productivity and farming efficiency in district Bijnor on the basis of land utilization statistics and yield of crops in a village.

Various statistical approaches to the study of crop regions of Madhya Pradesh have been applied by Ayyer (108, 1965). Besides reviewing other methods, he has also given his own maximum

distance method to group important crops into associations.

In his study presented originally to the Autumn School in Geography, Aligarh, Singh (118, 1967) has found significant changes in cropland use pattern in Kachhwa after analysing the data of three basic years (1839-40, 1880-81 and 1959-60). Indigo, millet and barley of 1839-40 have been replaced by rice, maize, potato, tobacco and fodder crops in 1959-60. Tremendous change in the cultivated lands of Varanasi district during the past fifty years (1911-1963) have also been pointed out by Mukherjee, Singh and Mukherjee (111, 1967). There has been a sharp fall in dry crops owing to the spread of irrigation facilities while paddy and double cropping have gained an increasing popularity. Roy (113, 1967) in an attempt to study changing patterns of crop and crop associations, has selected only two base years (1880-81 and 1960-61) to show a broad picture of changes in the cultivation of crops, in the Ganga-Ghaghara Doab East and, on its basis, has made a generalisation for the whole of the Doab.

Considering the recent trends in the application of quantitative techniques to land use studies, Siddiqi (115, 1967) has reviewed methods used in forming crop-combinations and has tested their applicability in Indian conditions. In his opinion, the modified formula of Weaver as used by Doi may be utilized suitably in this connection. A successful application of Doi's formula in making crop-association has been attempted by Ahmad and Siddiqi (102, 1967) in their study of cropland use in the Luni Basin. It has been found that the procedure of combination analysis can yield some illuminating results even in areas not very positive ecologically. The scheme of regional classification that has emerged in this study can well serve as the basic framework of reference in all future micro-studies in the agricultural geography of the area.

Amani (107, 1968) has presented two studies to find out the changes that have been taking place during a period of forty years (1926-27 to 1966-67) in agricultural land use and crop production in village Narayanpur and Golgarhi of district Aligarh. He has indicated that the present patterns of land use reflect a long process of interaction between the physical and socio-economic factors. In his opinion, any study to interpret the existing land use should be based on a thorough inquiry into the various forces that have been acting over time. Ahmad (104, 1968; 105, 1969) has shown statistically the correlation of rainfall and cropland use in district Bijnor and then in Rohilkhand by using Pearson's formula of product moment coefficient of correlation. It has been brought to light by Mukherjee (112, 1968) that there is a shifting tendency in agricultural pattern for multi-culture to micro-culture in Howrah

district. Another interesting study of changing patterns of cropland use has been made by Tripathi and Agarwal (119, 1968) who have shown changes in the harvested cropland during the last four decades (1925-26 to 1965-66) in the lower Ganga-Yamuna Valley. On the basis of the calculations of total volume of change in eight major crops, it has been pointed out that wheat, rice and peas are declining in importance in the lower Ganga-Yamuna Doab.

The role of socio-economic factors like price incentive in the changing patterns of land use in Bareilly district is highlighted by Khan (110, 1968). The study is based on an analysis of five sample villages where location with respect to market has been a single important factor inducing changes in the prevalent land use patterns.

Siddiqi (116, 1968) has assessed the influence of physical, economic and social conditions on the evolution of cropping pattern from 1930-31, at ten year intervals, to 1960-61. A comparative study of land use patterns during the years 1957 and 1967, by Siddiqi (117, 1968) reveals that no major shift in land use patterns has taken place in the decade and that cereal crops have usually predominated the agricultural landscape. He suggests the necessity of a change in cropping patterns to get the maximum yield from the land.

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3

Forest Resources Geography

A Trend Report

By

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THE TOTAL forest area in our country is comparatively small and inadequate. In spite of this, there have been several encroachments on forest areas, either for agricultural use or for felling trees for commercial purposes. The Jhumming practices in the hilly areas, so liberally allowed after Independence, have also laid bare large forest tracts. It is therefore essential that proper geographical investigation regarding the spatial extent of various forest areas with locational pattern and their commercial value should be undertaken by geographers. Further, geographical studies at the regional level have also to be initiated to pinpoint the use and misuse of our forest wealth with suggestions, as the situation may warrant, for its integrated development. But, a review of the work done in this regard testifies that there has hardly been any adequate and integrated attempt toward a geographical investigation and associated spatial as well as locational analysis of the forest resources. However, such valuable work of a geographical nature has been done by non-geographers and particularly by professional forest authorities associated either with the Forest Research Institute, Dehra Dun or the forest departments of the different states. Special mention may be made, in this context, of the work done by the Madras Geographical Association and by Puri (83,1960) whose treatise on *Indian Forest Ecology* (in two volumes) may rightly be considered as the most inspiring treatise for geographical reference on forest resources of India.

The Indian geographers, particularly of the Madras Geographical Association, were very much influenced by the potentiality of this new field of research and took due note of the work of British

authors like Thomas (117, 1902), Stebbing (114, 1926) and Smythies (113, 1925) who wrote extensively on the forests of India. The pioneer attempt in this field was however made by Sabhesan (101, 1927) who dealt with the vegetation according to the types common in the area, Madras and its environs, and emphasised the relation between climate and vegetation. He was followed by Visvanathan (126, 1931-32) who discussed the ecological background of forest flora in Malabar and outlined its types on the basis of climatic variation of the locality. Agarkar (1, 1929) emphasized the various external factors which influence vegetation types and pattern. This, however, was an ecological treatment with a botanical bias.

A systematic regional study of forest wealth was probably first attempted by Hart (38, 1932) who laid stress on the utility and importance of the forest resources to man in the context of the Indian economy with a detailed analysis of the forests of the Madura district, as a case-study. Ramakrishnan (91, 1932) studied economic geography of the hill produce of Madura region. His paper was largely informative. But the papers of Kimbush (60, 1934), Visvanathan (127, 1935) and Khan (58, 1935) contained commendable systematic analysis from the geographical point of view. Kimbush's paper examines the forest resources of south India as a "whole" under one system of study. Visvanathan's paper adopts a highly systematic approach and outlines possible suggestions on the proper utilization of the forest produce. Khan's treatment of the forests of Anantpur is similar. Rao (95, 1936) studied the forests and forest products of Salem District and drew a picture of the effects of forests and forest produce on the occupational pattern and life of the people. Champion's classical work (10, 1936) on the forest types of India and Burma was a great source of inspiration to Indian geographers and botanists. He outlined a systematic classification of the forest types in the four principal climatic regions of India (tropical, sub-tropical, temperate and alpine) and 15 sub-divisions. Puri (83, 1960) summarized vegetation characters and environmental adaptability in ten botanical regions: (i) Western Himalaya, (ii) Eastern Himalaya, (iii) Assam, (iv) Ganga Plain, (v) Indus Plain, (vi) Central India, (vii) Deccan, (viii) West Coast of Malabar, (ix) Andamans, and (x) Laccadive and Minicoy Islands. He even examined critically Champion's classification in the light of additional data on the environmental factors that were collected after Champion's publication, and put forward a modified classification. He has also given an illustrated account of all types of Indian vegetation based on climatic, edaphic and biotic factors.

Four additional papers deserve notice in this context: Pillai (77, 1938); Venkatachari (123, 1940); Ponniah (78, 1940) and Mitchell

(65, 1941). The treatments of Pillai, Ponniah and Mitchell were almost similar to those of Hart (38, 1932) and Rao (95, 1936) and helped in assessing the forest potentiality and the geographical condition of forest resources in the concerned regions of South India. Venkatachari outlined the geographical distribution of Casurina, an exotic plant in South India, and pointed out the geographical conditions which determine its distribution.

Bose (9, 1948) contributed a paper on plant geography of Damodar Valley and recorded altitudinal variation in pure strands of sal (*shorea robusta*) in the upper Damodar Valley from 300 m. in the valley bottom to the plateau at an altitude of 600 metres. Shafi (107, 1950) stressed the role of forests in the national economy and focussed attention on the need for proper planning based, in the main, on problems of forest utilization. Pal (72, 1950) gave a description of the coniferous forests of the Himalayas, the sal forests of the foothills and the scrub forests of Bundel Khand.

Stracey and Das (116, 1949) dealt with the utility of forests in the economy of Assam with special emphasis on soil erosion, industry and flood control. The Ph.D. thesis of Das (26, 1954) examines the forest resources of Assam and deals with such aspects as the uneven distribution of the forests with respect to consumption centres, their classification according to climatic and edaphic factors, the present scheme of their regeneration, and the system of their exploitation, both for major and minor forest products. He has also attempted to reconstruct the history of forest conservation and timber trade since 1850.

Karnik (57, 1954; 56, 1956) contributed two papers on regional studies of the forest wealth of the Tapti Valley and Khandesh in the Deccan plateau. He has observed two types of forests, the xerophytic (dry thorn) and the dry forest (dry-mixed deciduous) in Khandesh, and teak and anjan forests in the Satpura. Sinha (111, 1958) made a systematic regional analysis of the types of forests in Orissa and their distribution, with a significant stress on the major problems confronting the forest economy such as encroachment on forest tracts for agricultural use, burning of forests for shifting cultivation, and clearing forest areas for transport lines and so on.

The work of the National Atlas Organisation (71, 1957) may be mentioned here for its forests and land use map in which the distributional pattern of the types of vegetation of India has been clearly shown. This is a good reference tool for researchers in geography to study the forest types with their spatial locations as a whole. In all, nine types of forests have been shown on the map. These are: alpine, temperate, sub-tropical, tropical semi-evergreen, tropical evergreen, tropical moist deciduous, tropical dry

deciduous, tropical moist coastal and tropical thorn. Roychoudhury (99, 1959) has dealt with the various aspects of forest and wild life in Bihar. A different aspect of research on forests was attempted by Singh (110, 1960) when he reconstructed the history of forests and woodlands in Faizabad and Sultanpur districts of U.P. from ancient times through a study of place names associated with forest areas. It is an interesting study in historical geography of forest resources. Iyppu (43, 1955; 44, 1960) described the forests of Kerala, particularly the evergreen forests and their economic exploitation for silviculture. While outlining the South Indian forest types, Begue (5, 1960) referred to the work of Champion (10, 1936) and preferred to supplement the latter's work by ecological studies taking into account various climatic considerations based on the rainfall data of the meteorological stations in South India.

Pande (73, 1961) published a systematic regional study on the Kumaon forest types and resources. He described the forest types, 21 in all, of the region and then attempted a note on the forest products, both major and minor, emphasising the possibilities for better utilization of the forest resources.

Work on Assam's forests has been done by Bor (8, 1942), Stracey and Das (116, 1949), Jacob (51, 1939; 45, 1940; 48, 1942; 46, 1952), Purkayastha (87, 1936; 86, 1946; 85, 1948), Das (27, 1958; 28, 1959), Rowntree (98, 1954), Saikia (103, 1955), Rajkhowa (90, 1961) and Rao (93, 1968). Mention has already been made of Stracey and Das (116, 1949) and Das (27, 1958). Bor has analysed the relict vegetation of Shillong plateau and Rao has dealt with the phytogeographical characteristics of the flora of the Khasi and Jaintia Hills. Saikia deals with the grasslands of Assam with ecological variations while Das (28, 1959) draws attention to the problems of forestry in Assam. Rajkhowa's contention is to recognise two main climatic formations in Assam in order to explain the two broad divisions of forests: (i) evergreen and semi-evergreen, and (ii) deciduous and semi-deciduous. Rowntree describes the variation in vegetation within the Assam Valley, giving particular attention to climatic and edaphic factors. Jacob's (45, 1940) is an authoritative treatise on the classification of forests and gives an economic assessment of the forest resources in the different parts of the state. The reports on the working plans made by him and Purkayastha for different forest divisions of Assam are undoubtedly valuable references for a framework on research in the geographical study of the forest resources in this state.

The vegetation of the Upper Doab of Uttar Pradesh has been analysed by Mukherjee (68, 1962) who has pointed out the geographical distribution of the sal forests, scattered woodlands and scrub

vegetation. Chaudhury (21, 1968) has revealed that moisture in soil and humidity in the heavy rainfall areas govern the distribution of species in the Eastern Himalayas and that soil has no bearing on the problem. His treatment is more from a botanical than a geographical angle. Ghori (33, 1968) suggests that the eastern Himalayan vegetation distributional pattern is influenced by a variety of natural conditions and that the salient features of the taxonomic distribution of the plants in this region can be explained and interpreted if one takes into account their probable past history.

This brief sketch of the geographical work done in connection with the forest resources of India clearly indicates that, in spite of the research already carried out, there is considerable scope for further study and research at the micro-regional level. Geographers should study the different aspects of our forest resources and their utilization through regional scrutiny of the types of forests and their economic value. Such a detailed research at the regional level will be of great use in assessing the economic potential of the country in this regard.

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4

Resources Geography

A Trend Report

By

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RESOURCE GEOGRAPHY is concerned with quantitative and regional surveys of natural wealth, for analysing and mapping the situation of resource utilization with reference to the overall system and organization of the economy and economic growth of a nation.

Nature has been bountiful in endowing India with abundant natural wealth. The country possesses some of the most fertile and extensive agricultural lands in the world. Its forest reserves are not only vast in volume but are also very rich in variety and possess great potential for supporting wood-chemical, timber, paper and pulp industries. Grasslands are widely spread over the country and can provide a good base for pastoral industries. The country possesses nearly one-third of the total livestock wealth of the world. Besides, there are vast resources of fish in the coastal sea waters, rivers and lakes. The mineral wealth of the country is immense, varied and, in many cases, of high grade and quality. The iron ore reserves in India constitute a quarter of the total world reserves whereas the country is among the leading countries of the world in respect of manganese, mica and coal deposits. In respect of other minerals such as refractories, bauxite and copper, the national resources are very substantial. It is, therefore, no exaggeration that the country possesses an immense store of natural wealth for all kinds of production.

Studies of Resources

The natural resource potentialities of India have been studied and recorded by the specialists of various disciplines such as geo-

logists, geographers, botanists, zoologists and economists. Besides the individual efforts and works of the scholars in different fields, various government institutes and agencies have also made extensive studies of the country's natural wealth and have collected enormous and valuable information on the quantity and quality of different categories of resource potential.

The contribution of the geographers, geographical societies and organs to the study and understanding of the resources has been both substantial and sustained.

Agricultural Resources

The subject of agricultural and food resources has drawn the attention of the geographers from the early decades of the present century. A detailed survey of the work done in this respect is given in the section on agricultural geography.

The main feature of the geographical studies upto the mid-forties was the emphasis on description of the distribution and production of various agricultural commodities in the country as a whole or in different provinces or regions. But the pioneering work of Prof. Stamp on the land use survey of British Isles gave a new orientation to the thinking of Indian geographers and studies in land use were initiated. These have also been described earlier in another section. The geographers are now giving increasing emphasis to the analysis of the factors which have affected and are affecting the patterns of agricultural land use and the levels of farming efficiency and crop productivity. Land capability is also emphasised in some of these studies and broad suggestions for improving efficiency and productivity are also put forward. The research papers, theses and monographs written in recent years clearly indicate the change from the statistical and distributional discourses of the earlier period to the investigative, enquiry-oriented and plan-based surveys of the present time.

Animal Resources

Among the resources of animal life, livestock and fish have attracted special attention of Indian geographers. Livestock occupies a unique position in Indian economy as it is not only a source of food items but also the basis of agricultural operations in the country.

The Government of Madras carried out a survey of cattle in the province as early as 1912 and it is probably because of this that majority of studies of cattle and livestock attempted in the earlier period relate to the regions of south India. A systematic account

of regional distribution of cattle in relation to the factors of environment was given by Iyer in his paper on *South Indian Cattles: Their Breeds and Distribution* (4, 1927). Three years later he published another informative paper on *Cattle Breeds of Kongunad* (5, 1930-32). A valuable study of the various breeds of cattle and the practice of cattle raising was made by Annamalai in his paper entitled *Cattle Wealth of Chittoor District* (1, 1941).

Dayal made a study of *The Distribution of Cattle and the Problem of Fodder Supply in Bihar* (3, 1950). Besides giving a systematic account of the distribution of cattle in the Chota Nagpur plateau and the Bihar plains, he has attempted an analysis of the situation of fodder supply and put forth the suggestion that reclamation of waste lands and introduction of suitable and better varieties of leguminous crops may be an effective measure for developing the cattle wealth of the area. A decade later, Sinha (8, 1960) wrote on *Livestock and their Problem in Orissa.* He emphasised the inadequacy of fodder supply and stressed the need for better breeds, control of diseases and improved transport facilities for future development of the livestock resources of the state. Kayastha (6, 1966) made a study of *Animal Husbandry in the Himalayan Beas Basin* in which he emphasized improvement in the fodder supply situation in the region. The characteristics of Alambady cattle of North Salem district were examined by Littlewood in his paper entitled *Alambady Cattle* (7, 1936). A more detailed account of the distribution of cattle in Andhra Pradesh was given by Chaturvedi in his study of *Economic Geography of Cattle-Raising in Andhra Pradesh* (2, 1961). He particularly noted the suitability of the state for raising good quality working bullocks on a large scale.

Fish Resources

India possesses abundant wealth of marine and inland fisheries but the geographic study of this important resource is rather inadequate. Sunder Raj (15, 1930) presented a description of the pearl fisheries of South India. But not being a geographer, he did not make a comprehensive geographical study of the subject. Menon (13, 1939) in his study of Fisheries of Cochin, has given an account of the distribution of marine and fresh water fisheries of Cochin State.

Banerjee (9, 1942), in his paper on Fisheries of Bengal, discussed different sources of supply of fish in Bengal. Mookerjee (14, 1946), in his study of River Fisheries of Bengal, has given a detailed account of the distribution of Fisheries emphasizing the conditions of fishermen and the need of appropriate measures for the conserva-

tion of this resource. Hora (10, 1947; 11, 1949; 12, 1951) contributed valuable papers on the geographical study of fish in India. In his *Torrential Fish and the Significance of their Distribution in Zoogeographical Studies* (*1947*), he has briefly noted the distribution of torrential fish and emphasized the importance of such studies in geography. He published an interest-provoking analysis of *Geographic Basis of Fisheries of India* in 1949. In his presidential address to the Zoological Society of India in 1951, he outlined the scope and significance of fish geography of India and in 1952, published a review paper on the *Recent Advances in Fish Geography of India* (*1952*).

The studies of livestock and fisheries made so far by geographers or published by the organs of geographical associations and societies are neither extensive nor patently problem-oriented. In view of the great value of these resources, geographers have to give greater attention to a systematic study of the subject.

Mineral Resources

About a dozen specialized studies of the distribution and occurrence of various minerals in the country have been made by the Indian geographers. Chatterjee (17, 1942-43) published a series of papers which contain a detailed account of the geographical distribution of all the important ferrous and non-ferrous mineral deposits of the country. He also attempted to analyse the problem of mineral products in India and the world at large. Basu (16, 1943) made a study of Darjeeling coal and emphasized its utilization possibilities. Sharma (28, 1944) published an account of the distribution and production of Molybdenum, Tantalum and Niobium which are mainly used in making alloy steel. Menon (23, 1945) presented a survey of the iron ore deposits of Travancore. His study is based on field work at five places in the area and contains a valuable though brief account of the occurrence of magnetic deposits in Kerala. Kar (20, 1946) brought out a detailed and highly valuable study of Indian coal and its future. He analysed, in some detail, the problems of the coal industry of India and stressed the need for a number of improvements in respect of methods of mining, marketing facilities, extraction of by-products and establishment of a complete array of by-products industries. A series of three papers on the mineral distribution in West Bengal was published by Roy (27, 1950-51). He dealt with the northern, western and south-western parts of the state separately and tried to underline the contrast between these three regions with regard to the variety of minerals and the grade and quality of the ores. Dhope (19, 1954) con-

tributed a brief paper dealing with mineral resources of Portuguese India. Karan (21, 1958) brought out a balanced account of the occurrence of mica in Bihar, traced the development of mica industry in the state, and analysed the methods of mining and the problems of the industry. He made several suggestions for improvement of the industry and stressed the need for planned methods of mining, standardised classification of ores and better transport facilities. Negi (24, 1960) described the mineral resources of Kumaon and Garhwal region of Uttar Pradesh and pointed out that the main problem regarding full utilization is the inaccessibility of the deposits. Malhotra (22, 1960) discussed the changes that had taken place in the nature and volume of demand of petroleum and petroleum products in India during the decade 1950-59 and examined the future prospects of oil industry in the country. Very recently, Pasupatinathan (25, 1965-66) attempted a brief survey of the distribution of mineral resources of India.

Soil and Soil Erosion

A more detailed survey of the work on this subject is contained in the sections on agricultural geography and land use survey and as such a brief reference to the work in this field will suffice for this review.

The soil studies may be grouped under two broad categories: (1) description of the distribution and type of soils and (2) the analysis of the problems of soil erosion and soil conservation. Thirunaranan's study of soils was probably the first geographical account of soil formation in India (51, 1936). It was, however, only after the turn of the midcentury that the subject received considerable attention and a number of studies covering different parts of the country appeared in quick succession. Among these may be mentioned papers published by S. K. Mukerji on Bengal, K. L. Khanna and B. N. Sinha on Bihar and Orissa, B. K. Roy and B. N. Mukerjee on Uttar Pradesh, J. K. Basu (in collaboration with V. D. Tagore) and R. V. Joshi on Gujarat and Maharashtra, R. S. Gupta and K. M. Mehta on Rajasthan, and O. P. Bharadwaj on Punjab. These and other similar studies made during the fifties and sixties are mainly concerned with the classification of soils into different types and their regional distribution, underlining the relationship with features of structure, topography and climate on the one hand and with the aspects of agricultural system and products on the other.

Works on the problem of soil erosion and need for conservation are comparatively less numerous. For the eastern regions of India, the studies made by Bhattacharya (35, 1956), Pathak and Verma

(46, 1958), Acharya (29, 1958) and Roy (49, 1942) deserve mention. The works of Puri (47, 1956), Bharadwaj (34, 1961) and Nigam (45, 1968) deal with the north-western region of the country. The problem of soil erosion in Uttar Pradesh has been studied by Khan (40, 1955) and Mukherjee and Mukherjee (43, 1957). Reddy (48, 1965) and Verma (52, 1966) examined the extent and causes of soil erosion in Madras State and Sagar district respectively. Kayastha (39, 1965) attempted a survey of soil erosion menace in India as a whole. All these studies have analysed the factors and causes of soil erosion such as unplanned deforestation, steep gradient, torrential rains, faulty agricultural practices, and overgrazing and have emphasized various remedial measures such as gully reclamation, terracing of slopes and highlands, control of cultivation, construction of reservoirs and levees, control and regulation of water in catchment areas, check on indiscriminate felling of trees and planned afforestation.

Water Resources

India is rich in water resources for irrigation and generation of power. Both these aspects of water resources have been a subject of special interest and attention to Indian geographers who have also studied the problem of floods and flood control and river projects.

During the forties of the present century, a number of papers on various aspects of hydro-electric power were published. Krishnamurty (63, 1940) discussed the Papanasam Hydro-electric Project and analysed its significance. He also pointed out the potential of the Western Ghats for the development of hydro-electric power in South India. A good account of water resources is contained in Majumdar's book, *Rivers of the Bengal Delta* (66, 1943). Banerjee (54, 1943) published an outline of the devastations caused by floods in the Damodar Basin and discussed briefly the ways of controlling the floods. Mukherjee (67, 1943) attempted a survey of the electric installations in pre-independence Bengal. Kuriyan and Nair (65, 1946) examined the Development of Hydro-electric Power in South India. Two years later, Kuriyan (64, 1948) made a detailed and thorough study of the distribution and development of hydel power in different parts of the country and put forth some suggestions for future planning. Mention should also be made of Siddiqi's paper (69, 1949) on *Potentialities of Tube-well Irrigation in the Budaun District* in which the programme of tube-well construction is examined and a regional analysis of irrigation is attempted with special reference to certain crops.

During the next decade also, a good number of studies on the subject were made and published by geographers. Jha (62, 1955) gave a detailed account of the behaviour of rivers of Bihar, emphasizing the problems posed by them. He also discussed some schemes and projects. Goirala (59, 1955) studied the flood problems of the Ganga Drainage Basin and suggested certain methods of control such as improvement of channels or construction of dams to reduce floods. Jauhari (61, 1956) published a detailed study of the regional distribution of various schemes of electric power development in north-west India comprising the states of U.P., Punjab, PEPSU, Delhi, Rajasthan, Madhya Pradesh and Jammu and Kashmir. The survey covers both the pre-partition and the post-partition periods. Raina (68, 1956) gave a brief description of the water power of Jammu and Kashmir State. Chakravarty (56, 1949) dealt with some measures to control the floods of the Himalayan rivers of the Ganga Plain. Banerjee (55, 1964) discussed the regional pattern of power development in relation to geographical distribution of different power resources and the power requirements of various regions of the country. Chaudhuri (57, 1965) has attempted a survey of the power zones of West Bengal with reference to the sources of power and the power requirements of the state. Jain (60, 1967) described the surface and underground water resources of Rajasthan. Sinha (70, 1968) examined the installed capacity of electric power in Bihar and the total demand for electricity by the end of the Fourth Plan and suggested the construction of a number of thermal and hydro-electric power stations.

Conclusion

The most outstanding feature brought out by the examination of the work done in the field of resources geography is that the majority of the studies are informative in character and contain useful data on the amount of resource potential and their regional distribution. Plan oriented studies of resources suited to the economic needs of the country and focussed on the objective analysis of the whole process of resource creation and utilization are strikingly absent. A second feature that emerges from the report is the absence of any systematic regional coverage. Some provinces, states, or regions have received sufficient attention whereas others have been almost totally neglected. A third feature is the relatively inadequate emphasis on the problems of conservation. Casual references to such problems are not infrequent; but systematic and planned analysis of the problem is still far from being adequate. It is, therefore, obvious that there is still a lot to be done to promote the study

and heavy chemicals industries, and was critical of the uneven distribution of industry in the country. However, the first serious attempt to understand the role of geographical factors in the location of industries was made by Prakasa Rao (28, 1942) who rightly disagreed with Alfred Weber who had given all importance to economic factors only and had discarded geographical factors as merely subsidiary. The attention of the geographer was again diverted to the field of industrial geography when Thomas (34, 1943), in his presidential address to the Calcutta Geographical Society, strongly pleaded for a careful planning of industries in India. He insisted that in a task like this, the geographer's help would be of fundamental value and should be sought at once.

Ghosh (13, 1946) felt that decentralization and a regional development of manufacturing industries, rather than their indiscriminate concentration in a few favoured pockets, such as Bombay and Bengal, were of fundamental importance in the balanced development of resources. He stressed the need of planning for the spatial distribution of industries and suggested a dispersal of industries for balanced economic growth. Ganguli (49, 1949) presented his survey of the Bengal-Bihar industrial region where a marked concentration of mining and metallurgical industries was a significant aspect of India's industrial growth. Karan (16, 1952) identified the main patterns of the industrial landscape of Jamshedpur, one of the main centres of iron and steel industry in the country. Krishnan (18, 1952), taking the example of iron and steel industry emphasized the role of geographical factors such as proximity to raw materials and sources of power in the location of mineral based industries. Ahmad (1, 1956) worked out the bases of delimiting industrial zones in the country. In a comprehensive study of the industrial zones of India, Ahmad recognized their main distributional patterns and discussed their future prospects. He studied the distribution of major industries and employment in each factory included in the *Large Industrial Establishments in 1949* and identified 18 chief industrial zones in the country. He also critically examined the industrial policy of Government as envisaged in the First Five Year Plan, and suggested that future industrial development should be planned in conformity with the main regional divisions of the country. He disapproved of the current trends of concentration of industries and thought that, without a regional bias, all planning would be haphazard. Deb (10, 1957) discussed the prospects and possibilities of industrialization in Baltikari (Howrah) Region. In view of the growing population and the consequent unemployment, Deb suggested the establishment of an Industrial Estate at Howrah. In his study of the aspects of urban planning, especially those related

to the problems of employment of the city-dwellers, Shreevastava (29, 1958) assessed the employment-potential of the major industries of India. Kuriyan (19, 1958) presented a survey of the industrial development of the country, correlating it with the programme envisaged in the first two plans of national reconstruction. Sinha (32, 1959) highlighted the present problems and future possibilities of heavy industries in Orissa, mainly in the context of the state's agrarian economy and the prospects of the availability of cheap hydel power from Hirakud and Machkund projects. He assessed the major locational factors such as raw materials, power and labour in the establishment of cement, iron and steel, ferro-manganese, aluminium, galvanized pipes and refrigerator industries. He also analysed the plan of the proposed steel plant at Rourkela and presented a critical appraisal of the state's industrial policy and expressed his disappointment over the envisaged programmes for industrial growth. In her study of the Maikal plateau, Banerjee (3, 1960) referred to the problems and prospects of industrial growth in this part of India.

In a subsequent study, Kuriyan (20, 1962) drew attention to the uneven distribution of industrial activity in the country, as this caused regional economic imbalances. He analysed the present structure of cotton and jute textiles and iron and steel industries and suggested expansion in many other fields of industry. Chaudhuri (6, 1962) published his interesting study of Indian industries, tracing the history of industrialization in India, and its development during the first two decades of planning. He critically assessed various theories of industrial location which failed to highlight the role of the geographical factors which influence industrial location so basically.

Hameed (15, 1962) focussed attention on the causes of Telangana's industrial backwardness and suggested measures for removing the existing regional imbalances in economic development in Andhra Pradesh. In this connection he also attempted an appraisal of some of the main industries of the Telangana region. Gananathan and Bhanumati (12, 1963) presented their survey of the manufacturing industries in and around Poona.

In his presidential address to the Indian Council of Geographers, Dayal (9, 1964) analysed the role of geographical factors in the location of iron and steel and cement industries of India. He made a strong plea for the geographical studies of industrial location and assessed the relative merits of the newly proposed sites—Salem, Hospet, Vishakapatnam—for locating an iron and steel plant in South India, favouring Salem as a preferable site for such a location.

Durrani (11, 1965) examined the locational factors in his study of the industrial development of Rajasthan. The state has a fairly

sound base for establishing chemicals, fertilizer and woollen and cotton textile industries, but is seriously handicapped by the paucity of power resources. In a subsequent study, Tiwari (35, 1965) brought out the significance of vast population and sound resource base in Uttar Pradesh which should be duly appreciated in assessing the prospects of industrial development in this otherwise backward state.

In north India, Delhi region has made remarkable progress in the industrial field. It has now a concentration of cotton textile, minor engineering, food, chemicals, ceramics, and metal industries. Singh (30, 1966) traced its historical evolution and identified the major patterns in the spatial distribution of industries.

Tripathi (37, 1968) studied the dominant features of the industrial landscape of the Central Ganga Valley in U.P. which he described as the Kanpur region and included in it the districts of Kanpur, Farrukhabad, Etawah, Unnao, Jalaun, Hamirpur and parts of Banda and Fatehpur. He stressed the fact that rational planning for industrial location was vital for balanced economic development. Verma (38, 1968) examined the locational factors of primary, secondary and tertiary industries of Madhya Pradesh.

The changing spatial patterns of industries in the Howrah region were studied by Chatterjee (5, 1968) who concluded that, from an initial concentration on the Hooghly river bank, considerable shifting has taken place inland with the development of rail and road transport and that the industrial region has gradually assumed a bead-like structure. The industrial landscape of Bhadravati, the second largest industrial centre of Mysore, with a unique concentration of iron and steel, cement, paper and other allied industries, was studied by Karannavar (17, 1968). Lal (21, 1968) analysed the process of industrialization in the lower Ghaghar-Gandak Doab and traced its impact on the development of the transport system, employment structure and the general economy of the region. Mishra (25, 1968) investigated into the industrial prospects of U.P. and found that lack of dynamism among the people and complexities of social, political and economic vicissitudes have been mainly responsible for the industrial backwardness of the state. Pathak (26, 1968) studied the dynamics of industrial growth in the Damodar Valley and Ram (27, 1968) analysed the role of regional factors in the industrialization of the south-eastern part of the Chhota Nagpur plateau. Sinha (33, 1968) attempted a survey of the recent trends in the distribution of industries in the Ranchi industrial complex and traced the role of geographical conditions in the industrial setting. Giadhubli (14, 1968) compared the role of iron and steel industry in economic regionalization in India and in the Soviet Union.

In the volume *India-Regional Studies* published on the occasion of the 21st International Geographical Congress held in India (1963) a number of Indian geographers contributed their studies of the various regions of India, touching briefly on the existing set-up and the future prospects of industrialization. The regions studied included Upper Bari Doab by G. S. Gosal and G. I. Krishna; Ganga-Yamuna Doab by M. Shafi; Eastern U.P. by R. L. Singh and K. N. Singh; Tarai region of U.P. by L. R. Singh; Kangra valley by S. L. Kayastha; South Bihar by J. Singh; Chhatisgarh Basin by P. C. Agarwal; Telangana by M. Alam; and the Calcutta Conurbation by N. R. Kar. The spatial distribution of industries in Maharashtra, the leading industrial state of India was studied by Bhasin (4, 1969). He surveyed the existing structure of leading industries and delimited the main regions of industrial concentration.

Industrial Growth

A number of geographers have undertaken studies of recent industrial growth in some of the important industrial regions of the country. Sengupta (41, 1958) presented her valuable study of the industrial growth in the Hoogly region of West Bengal, where a concentration of industries has been stimulated, among other factors, by a high aglomeration of population, a monopoloy in jute and proximity to the rich mineral-bearing belt in Bihar and Orissa. She used a modified version of the Tress' formula to measure the industrial diversification in the area and computed and ranked employment percentages of the 29 major groups of industries. The study revealed that although jute manufacturing dominated the scene, the region exhibited a slight trend towards diversification. Gupta (40, 1967) traced the industrial growth of Faridabad which has made remarkable progress during the first decade, mostly because of government encouragement. He listed a number of problems, including shortage of labour, poor power supply and inadequate transport, which have proved detrimental to a steady growth. Bharadwaj (39, 1968) reviewed the industrial growth of the state of Punjab since 1947. He attributed the industrial progress of the state to the initiative and enterprise of the people of Punjab who, starting from minor industries such as hosiery and sports goods, have achieved distinction in the manufacture of sewing machines, bicycles, agricultural implements, machine-tools and a number of agriculture-based industries. He linked the state's future industrial development with farm products. Sinha (42, 1968) surveyed the industrial growth of Bihar, viewing it in the context of the state's share in the country's industrial income (which was 7 per cent at that time).

Mineral-Based Industries

Iron and Steel: The first attempt to understand the geographical bases favouring the development of the iron and steel industry in India was made by Kalyanasundaram (50, 1934). He examined the various aspects of the problem including the availability of raw materials, especially the high-grade iron ore deposits of the country, and found that a rapid growth of the industry seemed certain in the near future. Ganguli (49, 1949) attempted a useful study of the Bengal-Bihar industrial belt, in which all the three steel centres of free India were located. He worked out the volume of exploitation of the three important raw materials of the iron and steel industry, viz. iron-ore, coal and limestone, and showed cartographically their flow from the mines to the steel works located at Jamshedpur, Hirapur and Kulti. A geographical analysis of the proposals of the State Governments of West Bengal, Bihar, Orissa and Madhya Pradesh for the establishment of the first iron and steel mills in the public sector was made by Deb (10, 1957). He assessed the merits of Rourkela in Orissa for the location of a steel plant and analysed the locational factors which strengthened its case for this choice. Singh (55, 1961) surveyed the prospects of Bokaro, the growing centre of iron and steel industry. He studied in greater detail the problems associated with the evolution of the steel town in its initial and penultimate stages and analysed the elements of its site which would define the main features of its industrial landscape.

Andhra Pradesh, with its vast reserves of iron-ore in the districts of Anantapur, Kurnool, Cuddapah, Khammam, Krishna, East Godavari and Vishakapatnam districts, can provide a sound base for the location of an iron and steel industry. In the absence of such an industry, large quantities of iron-ore are exported to foreign countries. Vidyanath (57, 1962) explored the possibilities of the establishment of such an undertaking. He observed that the shortage of coal in the state could be no handicap as an alternative to the usual blast furnace method could be found out. He was convinced that the state could well support a medium-sized steel plant producing about 300,000 tons of steel per year. Karimi (51, 1963) attempted a geographical evaluation of the setting of Bhilai and assessed the merit of its location, where an important centre of steel manufacture has been established. In a separate study Chaudhuri (44, 1964) presented his assessment of the growth of iron and steel industry in India.

Non-ferrous Metallurgical: Among the non-ferrous metallurgical industries, only two have attracted the geographer's attention, viz.,

the copper and the aluminium industries. Majid (53, 1956) presented his survey of the copper industry of Bihar. Copper occurs in Bihar in a 80-mile long continuous belt. As full prospecting of the ore has not yet taken place, Majid recommended that, in the interests of the industry, any production outside the lease of the Corporation should be sold to it for smelting. Dayal (46, 1958) noted the new trends in the development of India's aluminium industry which should be further strengthened in view of the rich resources which are available in the country. He presented a geographical survey of the raw materials and analysed their role in the location of the industry. The study revealed that the inadequate supply of cheap power, was the main factor which hampered the full utilization and growth of the existing capacity of the plants. Yet the industry was a highly capital-intensive one, requiring an investment about ten times as great as that of steel per ton of installed capacity. He took a serious view of the present high cost of production and recommended a number of measures including reduction in protective duties to bring down the cost of manufacture. Dayal thought that the home market possessed great possibilities for stimulating the rapid growth of the industry which should be exploited.

Other Industries: Prakasa Rao (54, 1941) presented an appraisal of the role of geographical factors in the location of the ship-building industry. He listed the major problems, especially the deficiency of power, which hampered its growth in India.

I. N. Chawla (45, 1955) attempted a survey of the chemical fertilizers industry in India. He drew attention to the problem of depleting soil resources of the country and the necessity of their replenishment by adding suitable quantities of chemical fertilisers. Chawla traced the evolution of the chemical fertilizers industry in India, giving the geographical distribution of the essential raw materials—sulphur and gypsum—and power resources. He studied the spatial distribution of main manufacturing units, such as that of Sindri, Nangal and other centres, their existing production and plans for their future development. He also analysed the prospects of Suratgarh for the establishment of a fertilizers plant. Tiwari (56, 1962) brought out the role of the geographical factors in the location of glass industry in Uttar Pradesh. Khan (52, 1966) surveyed the recent progress of the glass industry in the country as a whole. Bhat and Mathur (43, 1967) described the main trends of the cement industry in India during the period 1951-66. Durrani (48, 1967) made a detailed study of the cement industry of Rajasthan. It revealed that, in preferring present sites, the factories have followed a simple economic law. They are located close to the limestone deposits

and the market centres, but away from the coal fields.

Agriculture-Based Industries

The cotton textiles industry is among the oldest and the most developed of the agriculture-based manufacturing industries in India. Iyengar (61, 1930) studied the growing cotton mill industry of Coimbatore in all its aspects from the supply of raw materials to the disposal of the finished goods. Lokanathan (63, 1936) presented a more comprehensive study of the prevailing trends of growth and the spatial distribution of the cotton mill industry in the country. He investigated into the causes of its heavy concentration in a few areas, like Bombay and Calcutta, in the nineteenth century. He also reviewed the theory of industrial location in order to know the reasons of Bombay's pre-eminence in this field and concluded that the transportation cost was the predominant factor in location. He analysed the transport relations of Bombay and the other factors responsible for the concentration of mills and noted that the industry was now migrating north-wards. Another study of the Coimbatore cotton mill industry was made by Narayanaswami (66, 1941). He traced its history dividing it into three phases; pre-war, post-war and post-pykara development; described the main features of the industry such as yarn and cloth production, location of mills and the labour problems; and assessed Coimbatore's position in the cotton textiles industry of the country.

Basu (59, 1961) made a comprehensive study of the problems of the jute industry. He considered the price fluctuations of raw jute as the greatest deterrent to stability and suggested that economic prices to jute growers would be a major incentive to the industry.

Tiwari (68, 1961) worked out the operation of economic factors such as freight charges, distance from the cane supply centres and the mode of transport, in the selection of a site for the sugar factory. He found the proximity to the supply zone as the major attractive force in location.

Khan (62, 1961) studied the tea industry of India in all its aspects. He dealt with its history of development, areas of tea cultivation, volume of production and the share of the tea industry in India's foreign trade. Singh (69, 1963) explored the prospects of the textile industry in Punjab and observed a rich agricultural resource base which could support a large number of industries in the region. In a recent appraisal of the cotton mill industry of Coimbatore district, Mahadev (64, 1966) focussed attention on its trends of growth.

Banerji and Basu (58, 1968) traced the evolution of the cotton

textile industry. They recognized it as the largest single organized branch of industry in India, employing about one-third of the total industrial labour and accounting for about one-fourth of the total industrial output in terms of value. The authors also linked the growth of the cotton mill industry with the development of the railways and the two world wars which have given incentives to the industry. Dayal (60, 1968) in his study of the major trends in the development of sugar industry, listed the main problems from which the industry suffered, including the irregular supply of cane, low yields, low sucrose content and a short crushing season. Majid (65, 1968) devoted his attention exclusively to the problems of sugar industry in Bihar. He thought that the industry could prosper if the prices of cane are regulated in relation to the needs at home and the competitive prices abroad. Tewari (67, 1968) discussed the sugar industry's problems in Eastern Uttar Pradesh. He thought that the dispersal of sugar mills was essential for striking an economic balance in the region.

Forest-Based Industries

Bihar leads in the production of lac contributing about 60 per cent of the total national production. While making a detailed study of the lac and shellac industry of Bihar, Majid (71, 1960) emphasized the need for implementing the recommendations of the various enquiry committees for ensuring a smooth development of the industry. Dixit (70, 1963) traced the growth of the paper industry, analysing the role of the supply of raw materials and water in the location of factories. He critically assessed recent progress of the industry, and recognized main patterns of its spatial distribution. The study highlighted some of the major problems from which the industry suffered, such as inadequate foreign exchange for the import of machinery and absence of a rational policy of forest conservation.

Small Scale and Cottage Industries

In the predominantly agrarian setting of the country, small scale and cottage industries assume significance as they absorb the surplus rural population, provide it with dependable means of livelihood and support it in years of calamity. Rao (73, 1930) presented his comprehensive survey of the common 'home' (cottage) industries of the Coimbatore district, which included hand-spinning, handloom weaving, *khadi*, sericulture, silk weaving, carpets and metal industry. The problems of the cottage industries of Malabar were

studied by Rao (74, 1932). Among the major problems which handicapped development, Rao listed lack of capital and disorganized marketing. He dealt in greater detail with the coconut fibre industry, handloom weaving, mat-making, bell-metal bronze, cabinet and soap industries. Rangappa (72, 1957) examined the structure of small scale and cottage industries in Mysore state, and observed that the state offered vast scope for their development. He criticised the lack of comprehensive surveys which were so necessary for an identification of the major problems of these industries and for suggesting measures for their future growth. He also carried out a detailed study of the state's two main cottage industries—handloom weaving and *khadi*.

The *tasar* silk industry is a fairly developed one in the Chotanagpur districts of Bihar, including Palamau, Dhanbad, Hazaribagh, Ranchi and Santal Parganas. Majid (71, 1960) surveyed the existing position of the production and weaving of *tasar* silk and expressed his satisfaction over the measures adopted by the Government to stimulate the industry. He recommended that they should be further strengthened and urged the widening of the fields of present organisation of research and training and the evolution of a better system of seed distribution. These measures would be instrumental in accelerating the growth of the industry which already earned foreign exchange for the country.

Small scale and medium-sized industries of Orissa were studied by Sinha (75, 1960) in his general analysis of the problems and prospects of industrialization in that state. He analysed the total employment, present structure and the prospects of growth of a large number of industries including glass, paper, sugar, rice and pulses mills, ceramics, jute pressing, bailing and weaving, and leather. He also attempted a critical assessment of the official policy regarding small scale and cottage industries. Tewari (76, 1967) took stock of the current trends of the small scale industries in East Uttar Pradesh. Exploring the possibilities of future development in the context of the available raw materials and a ready market, he suggested the establishment of a large number of small scale industries in the region.

Conclusion

The above review of the work done by Indian geographers in the field of industrial geography reveals that few geographers have been able to free themselves from the economic theories of industrial location and produce a really geographical analysis of locational aspects. However, the contributions of some Indian geographers pleading

for a careful planning of industrial location with a distinct regional bias provide refreshing exceptions.

A dominant trend of research in this field in the post-independent period has been to analyse the different aspects of concentration and dispersal of industries on a regional basis and to recognize the outstanding features of industrial landscape in the major industrial zones of the country. Among the regions which have received serious attention, mention may be made of Bihar, West Bengal (especially the Hoogly-side industrial zone), Orissa, Eastern Madhya Pradesh, Maharashtra and the industrial zones around Poona, Kanpur and Delhi. A number of geographers have reviewed, in a generalized way, the present industrial structure, problems of growth and prospects of development in a number of states such as Madhya Pradesh, Punjab, Rajasthan and Andhra Pradesh (Telangana Region). Geographical studies with emphasis on factors which have promoted industrial development in different regions of the country and in which main stages of industrial evolution have been identified are few. Of the 18 major industrial zones of the country, only 4 have received detailed treatment. In only one of these studies—that pertaining to the Hoogly-side industrial complex—have statistical methods been employed for a quantitative assessment of industrial diversification. It is evident that a quantitative assessment of the country's industrial structure would yield valuable results.

Among the metallurgical industries of India studied by geographers, the iron and steel industry has attracted most concerted attention. In most of these studies, an assessment of the geographical bases favouring the location and development of iron and steel industry has been made. The south-eastern part of the country consisting of portions of West Bengal, Bihar, Orissa and Madhya Pradesh, where four of the country's public sector steel plants are located, has received detailed treatment and is by far the most well known industrial zone of India. So far, Bokaro and Rourkela have received separate treatment also. Obviously there are still many gaps in this frequently trodden, yet promising field of research. An overall geographical assessment of the problems and prospects of the iron and steel industry of India must be an essential prerequisite in all future planning. No quantitative assessment of the degree of concentration has so far been made. An up-to-date statistical analysis of the inflow of the raw materials from the mines and the outflow of the finished goods from the mills to the market which would provide the basis for remodelling and enhancing the existing capacity of the transportation not serving the industry would be another field which deserves immediate attention.

Among the non-ferrous metallurgical industries only two indus-

tries—the copper and the aluminium—have received attention. Only one—the aluminium industry—has been dealt with on an all-India basis. Other mineral-based industries so far studied include chemical fertilizers, glass and cement. Many of these studies are only too sketchy to produce fruitful premises for future research. Of course, many areas of research in this field remain untouched by the Indian geographers.

While the cotton textile industry has been studied in greater detail on a regional as well as national basis, jute, woollen and other textile industries have so far failed to inspire an equal share of interest. Of the tea, coffee, rubber plantation and processing industries, only the distributional patterns and problems of the tea industry have been analysed in detail. Only a few geographers have devoted attention to the problems of sugar industry, both on a regional as well as a country-wide basis. The problems of the forest-based industries such as lac and shellac and paper, have been studied by geographers in some detail.

Studies in which problems of the small scale and cottage industries have been analysed are mostly topical in nature and do not correlate the location and distribution of these industries with the geographical setting of the regions concerned.

All in all, it may be said that there are large and serious gaps in the study of industrial geography. A large programme of research, based on new techniques, will have to be promoted to highlight the contribution of geography to the planning of industries in India.

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6

Industrial Complexes

A Trend Report

By

M. R. Chaudhury

A SYSTEMATIC study of the growth pattern and problems of industrial complexes in India is an important programme of industrial geography.

An industrial complex may be defined as a set of activities occurring at a given location and belonging to a group of industries that reap external economies as a result of production, marketing and such other linkages. Thus, there are steel complexes which encompass a chain of activities from raw materials to finished goods or a petrochemical complex where several products are produced from a single class of raw materials. Development of industrial activities based on varied types of raw materials also helps in the emergence of an industrial complex.

Ganguli (5, 1949) analysed the growth of mining and metallurgical industries in the Bengal-Bihar Industrial Belt of the Chotanagpur plateau. In a map produced for the purpose, the author has shown the heavy concentration of industrial activities in the region.

In an illuminating paper, Ahmed (1, 1956), attempted to delimit the major industrial zones and centres of India, numbering 18, based on his study of the existing and projected industrial distribution. The industrial map produced by him showed three types of industrial zones: (i) industrial regions proper like the Hooghly side industrial area; (ii) large areas of agriculture-based industry like the Ganga Valley Sugar Factory Belt extending from the Kosi to the Jamuna; and (iii) industrial centres of limited geographical extent around cities like Bombay and Calcutta.

Sen Gupta (6, 1958) studied the concentration of industrial activities in the Hooghly side around Calcutta with particular refe-

rence to the jute industry and also examined the trend toward diversification of industries.

The present author (2, 1964) studied the development of the steel complexes at Burnpur, Jamshedpur, Bhadravati, Rourkela, Bhilai and Durgapur in a monograph on the iron and steel industry. He also studied (3, 1967), the growth and problems of the Kulti-Burnpur industrial complex. The author traced the causes of development of the iron and steel and related industries in Kulti-Burnpur and adjacent areas. The occupational structure in the industrial complex—the role of coal mining in promoting various industrial activities, development of aluminium industry at Jaykaynagore, locomotive industry at Chittaranjan, the cable factory at Rupnarayanpur and various ancillary and small industries at Barakar and Raniganj were discussed by the author in some detail. He also analysed the problems relating to development of ancillary industries, transport and dispersal of industrial activities and prevention of agricultural decay for economic regeneration of the area.

Another study by the author (4, 1969) identified the growth pattern of Durgapur industrial complex. He analysed the various aspects of the development of this steel complex. The steel industry at Durgapur is under the management of the Hindusthan Steel Ltd. The Durgapur Projects Ltd., a West Bengal Government undertaking manages a number of industries including coke oven and by-products plant consisting of two batteries, a number of thermal units, a tar-distillation plant, a cyclone type coal washery and a chemical plant based on the by-products of the coke oven plant at Durgapur. The author has suggested a careful study of inter-industrial dependence and also the dependence of various industries on common raw materials and infrastructure in order to shape policies to secure economy in production.

With the successful implementation of the various projects under the Five Year Plans, industrial complexes have emerged in different parts of India. These may be classified into five groups: (1) the steel complex like that at Kulti-Burnpur, Jamshedpur, Rourkela, Bhilai, Durgapur and Bhadravati; (ii) the coal complex like the one at Talcher, Orissa or at South Arcot, Tamil Nadu; (iii) the petrochemical complex like that at Digboi, Trombay, Koyali, Cochin and the one to be commissioned at Haldia; (iv) the heavy engineering complexes like those at Ranchi and Bhopal; (v) the industrial complexes that have emerged due to growth of varied types of industrial activities (e.g., those at Calcutta, Bombay, Madras, Kanpur, Delhi, Vishakhapatnam, Salem-Tinnevelly and other areas). These names of complexes are given only as examples. The list is therefore not exhaustive.

The structure of an industrial complex in broad outline can be determined by a general knowledge of technical and marketing relationships. Again, an industrial complex cannot be considered to have a fixed structure regardless of location, its composition, and the complex changes between regions with varying factor proportions, scale economies and differences in urbanisation.

Regional planning is industrial planning in its resource-activity-product aspect. In the great task of progressively reducing the disparities in the levels of development between different regions, effort should be directed as stated in the Industrial Policy Resolution, to analyse the *raison d'etre* and problems of growth of the industrially advanced areas on the one hand and the causes of lack of industries in different parts of the country on the other.

The industrial complexes as the most advanced centres of industrial activity must be studied with particular reference to inter-industry dependence, resource-base, input-output ratio, infrastructure and marketing relationships for effecting economy in production and regional growth. In the days ahead, re-development and re-location of industries in India would form the cornerstone in regional planning. The advantages obtained or the disadvantages accruing from the location of a particular industry have to be carefully analysed for suggesting new locations of industries. A study of the co-efficient of linkages of different industries in a particular industrial complex may help to obtain a correct picture of locational advantages of different industries there. The aim of scientific location is to maximise profit by minimum investment. The development of industries within an industrial complex may help to maximise gains provided such industries are located after a careful consideration of their relative advantages and disadvantages in regard to site, resource-base, transport cost, labour supply and market.

The success attained or the problems raised by the existing industrial complexes would provide future guidelines for the development of new industrial complexes in India.

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7

Geography Of Transport And Marketing

A Trend Report

By

M. Shafi

Transport

GEOGRAPHICAL STUDIES of the transport system of the country have been mainly attempted on a regional basis. There are only a few overall assessments of the country's transport needs, and Indian geographers have yet to analyse the role of modern air transport as an inter-regional force of economic development and modernization.

Sourirajan's study of the Buckingham Canal (24, 1929) represents the first systematic attempt to understand the navigational problems of an inland water-ways system in India. He traced the history of its construction, analysed the role of relief and other natural factors and correlated its future with the economic progress of the region. Subramanyam (25, 1930) devoted his exclusive attention to a study of the transport network in differeent parts of South India. His studies carried out during the period of 10 years (1930-40) pertained to the districts of Coimbatore, Malabar, Madurai, Ramnad, Trichinopoly, Anantpur, Salem, Tanjore, South Kanara and Tinnevelly. In all these attempts, Subramanyam described the general transport pattern formed by roads, railways and inland water-ways and emphasized regional transport requirements.

In the regional studies of transport geography in which a single state has been selected for an appraisal of the transport system, Majid (10, 1950) made the first contribution. He assessed the relative density of transport lines in different parts of the state and found that a thick net of unmetalled roads served the sugarcane producing zone of north Bihar and that the density of the transport lines

... where all transverse links terminated at ... but the mica zone awfully lacked transport facilities which was a hindrance in the economic exploitation of this mineral resource. Majid also correlated the state's transport system with market accessibility. Kulkarni (6, 1955) focussed attention on the communication problems of Bombay State. The study brought out the role of railways in breaking caste barriers and linking isolated parts of the state which used to suffer from famines and other calamities. Kulkarni assessed the importance of the transport system in boosting agricultural produce, locating industrial centres, raising the cultural status of the people and evolving a closely woven community by facilitating the communication of ideas and goods.

Guha (4, 1955) presented her valuable study of the traffic flow in the greater Calcutta area. While all the relevant aspects of the problem were treated satisfactorily, Guha's study lacked suitable maps which could have far enhanced the value of her work.

Sinha's study of the transport problems of Orissa (23, 1957) indicated the inadequate development of road transport in that state. Mukherjee (11, 1958) emphasised the need of a new rail link between Calcutta and Bishnupur in view of the inadequate transport facilities available to the agricultural population in this part of West Bengal. Singh (21, 1959) assessed the transport requirements of Allahabad, situated on the confluence of the Ganga and the Yamuna and attracting a large inflow of traffic. He found the transport system of the town thoroughly inadequate and outmoded, and urged an early modernization of the modes of transport. Subsequently, he studied (22, 1960) the impact of the railway network of India on the location, growth and industrialization of the Kaval towns of U.P., viz., Allahabad, Varanasi, Agra, Kanpur and Lucknow. The study brought out the extent of railway utilization in these towns and pointed out the limitations of the system.

Kayastha (5, 1960) referred to the problems of construction of communication lines in the sub-Himalayan Beas Basin, and linked the existing transport facilities with the development of the area. Singh (14, 1961) worked out the railway traffic densities and identified their main patterns in south Bihar. The study revealed that the passenger traffic mainly moves along the main line of the Eastern Railway, while the bulk of the freight is transported by the Grand Chord Line.

Singh (18, 1963) studied the road traffic flow in U.P. and depicted his results on suitable maps. The study showed the state's transport relations with other parts of India and assessed the regional position of various traffic divisions in respect of inter-state movement of vehicles. It also noted the recent growth in road traffic, especially

during the first decade of independence, and attributed it to the state's economic development. Singh and Singh (20, 1963) conducted a useful survey of road traffic in Varanasi. The survey, carried out in December 1960, revealed that, in Varanasi, the chief modes of transport were still the cycle and the cycle-rickshaw, that the southern and eastern parts of the city were highly congested, and that an early diversion of traffic to alternative routes was needed. He also proposed the construction of a second bridge on the Ganga and a few wider link roads.

Singh (15, 1964) published his useful study of the transport system of south Bihar, focussing attention on some of its major problems and suggesting measures for their solution. Singh (19, 1966) presented a study of U.P.'s transport system in the context of the state's geographical setting and analysed its evolution.

Singh (16, 1966) attempted a detailed analysis of the patterns and problems of coal movement in India in the long-term perspective. The study provided a much-needed basis for planning the projected traffic demands of this commodity in the country.

Patterns of railway traffic flow in Madhya Pradesh were identified by Lakshmi (8, 1967) who correlated the state's railway system with its economy and worked out the density of passenger and freight traffic flows illustrating her results on suitable maps.

Analysing the existing road network of Mysore State, Adrashannawar (1, 1968) assessed the state's transportation needs. He calculated ranking co-efficients of the surfaced roads for each district and suggested useful measures for future development. Prasad (12, 1968) investigated into the factors, both physical and economic, which have retarded the development of roads in the Chota Nagpur region of Bihar. Lal (9, 1968) selected Lower Ghaghara-Gandak Doab for ascertaining the degree of accessibility and identified places, situated at a distance of 6.5 Km. from a road or 13 Km. from a railway station, and categorised them as suffering from poor accessibility. In another study, Singh (13, 1968) traced the evolution of transport network in North Bihar and determined regional accessibility. He concluded that only 7.9 per cent of the total area of north Bihar remained inaccessible.

Ports and Harbours

The six major ports of India—Calcutta, Bombay, Kandla, Vishakapatnam and Cochin—have attracted geographers' attention from time to time; but a systematic study of the problems of these ports in relation to the geographical setting of their hinterlands on a country-wide basis is yet to be attempted.

Armstrong (33, 1930) was the first to draw attention to the Madras harbour and the history of its development. Ash (35, 1933) referred to the construction of the Vizagapatnam (Vishakapatnam) harbour and discussed some of its problems including the indrift of the sand. The export and import trade of Negapatnam was studied by Pandyan (39, 1937) who dealt, in some detail, with the outstanding features of the port's hinterland. In a subsequent study, Armstrong (34, 1939) analysed the locational factors of the port of Madras and discussed its present features and prospects of future development. The study indicated that while the port did not enjoy any great geographical advantage—it has a small harbour and its hinterland is not remarkably rich—yet it had flourished on trade and its future was linked with our efforts of fostering overseas trade. Thyagarajan (43, 1940) attempted a comprehensive study of the port of Tuticorin dealing with all the aspects of its development and relations with the hinterland. Master (38, 1953) reviewed the major problems of Indian shipping. Ramanadham and Krishnamurthi (40, 1955) emphasized the maritime opening of Andhra which has 600 miles of coastline. They highlighted its significance in the international trade of India, especially of those land-locked states which could use Andhra coast for this purpose. The study brought out the characteristic features and the potentialities of the Andhra coast and explored the possibilities of its development as more ports could be established for handling the growing volume of trade. Analysing the data of India's coastal trade and the trade which the existing ports of Andhra handled, the authors elaborated the principles involved in the demarcation of hinterlands, especially those of the three ports of Andhra—Vishakapatnam, Kakinada and Masulipatnam. The study revealed that, even 50 years ago, exports from these ports predominated over imports. Deb (36, 1957) urged the construction of a new port in West Bengal, south of Calcutta, which could handle greater traffic than Calcutta does at present, and have an access to the vessels of higher draught for the greater part of a month than is possible at present at Calcutta. He referred to the existing problems of the port of Calcutta including congestion to justify his proposal. Deb suggested the construction of a new port at Geonkhali in Midnapur district. The Government of India, however, favoured Haldia, at the mouth of Sabarnarekha, for port construction.

Kandla which has emerged as an important port in West India replacing Karachi, serves a vast hinterland. Kayastha (37, 1963) presented a detailed geographical study of its site, location, transport linkages and the inward and outward traffic. It revealed that, although Kandla possessed all the advantages of becoming an im-

Marketing

Indian studies which may be classed under the name of marketing geography fall broadly into three categories. The first category includes those studies which deal with the local and regional markets, in a general manner and describe the commodities—agricultural produce or consumer goods—which are exchanged in these markets, or those which bring out the significance of weekly or bi-weekly rural markets to the rural economy and society. The second category includes those studies which deal with market villages and describe their functions; such studies should be classed under settlement, and not under marketing geography; and the third category includes those studies in which the characteristic features of the internal and external trade of a market centre or a port have been described.

In the studies of the first group may be listed works of a number of Indian geographers who selected different regions of the country for a description of the local markets and surveyed the forces which had helped the emergence of the larger market centres. Areas which received special attention included the districts of Madurai, Ramnad and Tinnevelly in south India (48, 1932; 49, 1940) and the agricultural markets of western U.P. in north India (50, 1941). In the case of the Tinnevelly district (49, 1940) special emphasis was laid on the cotton markets. A study of the agricultural markets of western U.P. revealed that while the region had a large number of market centres which traded in agricultural produce, specialized markets were conspicuous by their absence. Studies have also been made of the weekly markets taking place at Modinagar (52, 1957), Bamnia in Manbhum district (60, 1951), Sagar-Damoh plateau region of Madhya Pradesh (61, 1966) and at Barpali in Sambhalpur district of Orissa (53, 1953).

The internal structure of the markets of Hyderabad and Howrah city also attracted geographer's attention. In the case of Hyderabad (59, 1961), it was observed that location with reference to the potential consumer areas was decisive in the dispersal of retail vegetable markets, while wholesale vegetable trading had no such connection and emerged as isolated nodes far away from each other. A study of the daily shopping in Howrah city (46, 1966) indicated that its pattern was largely determined by community composition, urban functional structure, economic status of the people and the transport reticule of the city.

Studies in which the location and other characteristics of markets specializing in export trade that have been discussed have so far been concerned with the Malabar products (56, 1931) dealing in pepper,

ginger and copra, Mangalore which has a flourishing trade in coffee (55, 1938), import and export trade structure of Madras port (57, 1938) and the relations of Vishakapatnam ports with its hinterland (58, 1966).

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II

Geography and Planning

8

Metropolitan Planning

A Trend Report

By

S. Manzoor Alam

Introduction

THE PROBLEM of metropolitan planning has grown in magnitude and complexity on account of the explosive growth of large cities and concentration of population in them. It has attracted the attention of scholars from diverse fields, and the contribution of geographers on problems of metropolitan planning and development has been quite significant. The geographers' viewpoint regarding the formulation of corresponding spatial strategy to implement the economic strategy for metropolitan development effectively has been widely accepted by scholars in cognate disciplines, and the geographical emphasis on regional approach to metropolitan planning has now been adopted as a national policy. Moreover, the importance of a centering policy and particularly that of the creation of growth poles as instruments for economic development at the regional level are essentially geographical concepts.

In this review, it is proposed

(a) to summarise the approaches to metropolitan planning, as adopted by the metropolitan planning agencies in India, and

(b) to highlight the contribution of geographers in metropolitan studies.

This, it is hoped, will bring out clearly the role of geography in metropolitan planning.

Research Studies on Indian Metropolises

There are a large number of studies on Indian metropolises. Of

these, only four which have given new direction to metropolitan research and planning in India, and where the contribution of geographers has been notable, are discussed below. These include (1) Master Plan for Delhi (1961); (2) Basic Development Plan—Calcutta Metropolitan District; (3) Regional Perspective of Industrial and Urban Growth—the Case of Kanpur (1969); and (4) Hyderabad Metropolitan Region: A Strategy for Development (1969).

Master Plan for Delhi

The master plan for Delhi was issued in 1961 by the Delhi Development Authority. It examines comprehensively the development and planning problems of the national capital at three levels, *viz*; (a) the Central City; (b) the Delhi Metropolitan Region; and (c) National Capital Region.

This is basically a sound approach because the problem of Delhi has been viewed within the framework of regional hierarchies. The master plan further stresses the fact that the economic growth or decline of Delhi will have countrywide repercussion. In order to arrest the haphazard growth of Delhi and to prevent overcrowding in the Central City, the plan has suggested the growth of satellite settlements within the metropolitan region. It further envisages that the magnetic pull of metropolitan Delhi and its region may lead to a greater concentration of economic, social and administrative functions within them. The master plan therefore, recognises the need to stimulate the development of counter-magnets (which have also been identified) within the National Capital Region. The master plan for Delhi is however silent as to how spatial integration will be accomplished down to the lowest rural level within either the Metropolitan Region or the National Capital Region.

Basic Development Plan—Calcutta Metropolitan District 1966-86

The authors of the Basic Development Plan for Calcutta Metropolitan District (CMD) have stressed that "the progress of the City, of its extensive hinterland, and of India as a whole are intimately and inseparably linked," and hence "the planned development of Calcutta with the strengthening of its metropolitan functions, will make a significant contribution to India's economic development." Although the basic development plan of CMD essentially concerns itself with its delimited area, it certainly takes into cognisance its regional setting, i.e., the hinterland of the port of Calcutta (West Bengal, Assam, and Bihar, 24 districts of U.P., six districts of Orissa,

and the smaller territories of Manipur and Orissa). As the entire state of West Bengal falls within the Metropolitan Region of Calcutta, the State Government has already initiated a move for integrated regional planning of the state. Regional development plans have already been prepared for such growing regional centres as Asansol-Durgapur, Siliguri and Haldia, and are to be "harmoniously balanced with the economic growth of CMD. The development of these four centres has been viewed as an entity. These centres together, through economic growth, can facilitate a rural-urban shift that will not necessitate massive movements of people from one part of the state to another".

For the CMD, a two-centred growth (Calcutta-Kalyani) has been proposed, and a detailed land use plan, projected upto 1986, has been drawn up. This is a unique feature of the Basic Development Plan of the CMD: no other study has proposed a detailed parcelling out of land, for different functions, at the Metropolitan District level.

Regional Perspective of Industrial and Urban Growth—The Case of Kanpur

This study presents a set of technical papers which were presented in a seminar jointly sponsored by the Directorate of Industries, the Government of Uttar Pradesh, the I.I.T., Kanpur and the USAID—India. The two principal objectives of the seminar were:

(i) to ensure, through regional development, the optimum spatial distribution of the population and the productive activities among the various villages, towns and cities within the region and a desirable interaction among these different sized centres; and

(ii) to examine the opportunities for implementing a desirable spatial policy and consider specifically the extent to which the government can create incentives and disincentives to influence the distribution of activities among different sized centres.

The geographers made significant contribution in three of the five panels for discussion into which the seminar was divided. These three panels were:

Panel II: Optimum Spatial Pattern of Growth Points in the Kanpur Region.

Panel IV: On Problems of Urbanization and Industrial Diversification of Kanpur Region.

Panel V: Techniques of Regional Analysis.

In its specific recommendations, Panel II emphasised the need "to

promote integration of city and countryside by spreading urbanisation and securing adoption of non-traditional modes of thought by villagers. In order to achieve this spatial integration, the panel suggested that "the economic, administrative and urban hierarchy should ultimately have four levels: (a) Kanpur city—a first order growth centre; (b) Seven district headquarters as sub-regional centres; (c) Forty-two centres of the level of Tehsil headquarters providing local services; and (d) a set of sub yards of regulated markets with a minima of package opportunities.

In Panel IV the problem of spatial integration was strongly stressed and it was pointed out that the development of metropolitan Kanpur cannot be isolated from its region. Hence that Panel recommended:

(i) that planning in the metropolitan area of Kanpur must be so oriented as to generate the economic development of its region;

(ii) that there is an urgent need for the formulation of an integrated rural-urban land development policy; and

(iii) that the development of Kanpur Region has also to be related to the regional development of four other cities—Lucknow, Allahabad, Agra and Jhansi.

These panel recommendations were eventually adopted and incorporated in the policy recommendations of the seminar.

This seminar brought out the significant impact of geographical researches and techniques of analysis on problems of metropolitan planning. The points relating to the delimitation of the metropolitan region, spatial integration of the region, the hierarchical pattern of regional development, and adoption of a meaningful land use development policy, were emphasised by the geographers and were well received by the participants from the allied disciplines.

Metropolitan Hyderabad and its Region — A Strategy for Development (1969)

This was an inter-disciplinary research project sponsored jointly by the Osmania University and the Institute of Asian Studies and financed jointly by the Asia Foundation and the University Grants Commission. This was a problem-oriented research project and it has made practical recommendations with regard to the planning and development of metropolitan Hyderabad and its region.

Although metropolitan development has a strong physical expression, it has essentially been viewed as an economic phenomenon capable of acting as a powerful stimulus to transform the regional economy. It is in this context that the strategy for spatial integration of the regional economy through "growth centres" and "rural service centres" has to be seen. This strategy, it is hoped,

will make the "trickle down" mechanism function more effectively. It has been noted in this study that the spread effect of metropolitan economy has been weak due to poor interaction between metropolitan Hyderabad and its rural hinterland.

In order to obtain the optimal use of land socially, economically and functionally, the study has strongly stressed the need for an integrated rural-urban detailed land use development plan for the Hyderabad Metropolitan District, covering an area of approximately 400 sq. miles. The administrative integration of this politically fragmented area by the creation of a Metropolitan District and a Metropolitan Development Authority to administer and organise its social and economic activities has also been suggested.

The central city or the incorporated area has been examined in its historical context and also as a socio-economic phenomenon. Striking imbalances and contrasting trends have been noticed in the diverse social and economic areas of the city. This is causing physical disintegration of the metropolis. Hence in order to prevent disintegration and to induce organic development of metropolitan Hyderabad it has been proposed that its activities may be organised around three, spatially separated but strongly interlinked, functional nodes.

Besides the above institutional research studies, there are hardly any studies on metropolitan planning by individuals. Sudhir Wanmali's work on Regional Planning for Social Facilities which deals with the Nagpur Metropolitan Region is a solitary exception. In this study he has examined in detail the level of social facilities available in all the settlements of the Nagpur Metropolitan Region. A sharp decline in the level of social facilities between the metropolitan city of Nagpur and its rural hinterland is highlighted. This "developmental dualism" between the centre and its periphery is due to a high degree of "functional friction" and can be reduced by creating intermediate centres of varying importance. In order to accomplish an integrated development of the metropolis and its region the author has suggested the creation of seventeen service centres with their complementary regions. These service centres, if appropriately linked with the metropolis, can transmit efficiently, developmental impulses down to the lowest settlement unit within their respective complementary regions.

Approach of Indian Geographers to Problems of Metropolitan Planning

Traditionally, geographers look upon the metropolis as a physical space both in its local and regional dimension. Hence we are used

to the concept of banal space, and not the topological space of economic and social relationship. Consequently our studies of metropolitan cities are primarily static morphological analyses. Most of the studies fail to recognise that the physical growth of the metropolis is an expression of certain basic economic and sociological factors. Economically the metropolis has to be viewed as a "growth pole" which, if spatially integrated with its complementary region, can bring about structural improvements in the regional economy. The degree of interaction of the metropolis with its region will depend more on time and cost dimension rather than on mere physical distance measured in miles or any other linear unit of measurement.

It has been noted in a study of the market settlements of the Hyderabad Metropolitan Region that settlements located 40 miles away but well linked with Hyderabad were better integrated than those located only half the distance from Hyderabad but accessible only by bullock carts.

The metropolis and its region form a unified field of social and economic relationship which has to be interpreted in terms of service-production-consumption relationships in order to make metropolitan studies more meaningful, dynamic and action-oriented. There is no point in undertaking metropolitan studies unless we can make a positive contribution in the strategy of their development.

Geographers can make a significant contribution in the spatial and ecological patterning of metropolitan cities. Most of the morphological studies on Indian cities have failed to appreciate the evolutionary processes of morphological development. Besides other factors, its evolution is strongly influenced by its history and political development. Each major event in the history of the city gives a new social and cultural dimension which is invariably reflected in its morphology. An understanding of the cultural layers and social stratification is important in resolving the planning and development problems of the metropolis. Even the slums in India are of divergent character, if viewed in their historical context; and without historical perspective their problems cannot be perceived correctly. An analysis of the social areas of the metropolitan cities can be very useful in identifying some of their basic planning problems.

Despite an enormous turnover of research in urban geography, we have failed to evolve a theory of urban growth or even test the validity of the western theories of urban growth. Most of the researches in urban geography make us feel that the Indian cities are carbon copies of the western cities and therefore, the theories of growth for the latter are applicable to our cities as well. This is simply ignoring the fact that our cities are the product of a

vastly different natural, social and cultural environment and are the outcome of historical circumstances which have no parallel in European or American history. This intellectual following of the western scholars has prevented the development of our own theoretical formulation of the processes of growth of Indian cities. This is a sad reflection on the merit of our work in urban geography and calls for a concerted intellectual effort on our part to rectify the situation. We can make positive contributions to the complex problems of our metropolises, only if we have perceived correctly the theoretical bases and the underlying processes of metropolitan growth in India.

Suggestions for Further Researches

The following are some of the more important areas in which research should be promoted on a priority basis:

(a) Theoretical determination of metropolitan regions and their empirical testing;
(b) Empirical study of the "spread effect" of metropolitan economy over the region;
(c) Formulating a theoretical scheme for the division of each state into its metropolitan regions and analysis of inter-regional and intra-regional commodity and passenger flows;
(d) Analysis of the impact of the growth of urbanised areas on the general land use within the Metropolitan District (the underlying assumption is that good agricultural lands are being taken over by the rapidly expanding urban area);
(e) A critical study to determine the minimum population for an urban settlement to be designated a metropolis;
(f) A critical study of the factors influencing land values in a metropolis and their impact on metropolitan land uses;
(g) A critical study of the social areas of metropolitan cities using factor analysis. (For this study, data on religion and language by the smallest reporting unit (such as a block) will be required).
(h) Morphological evolution of cities and ecological patterning of functions; and
(i) A study of the processes and patterns of urbanisation in India by regions.

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9

Regionalization And Regional Planning

A Trend Report

By

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and
L. S. Bhat

Scope

THE SCOPE of this survey report is (i) to review the work done by geographers in the field of geography and planning, (ii) to examine the trends of research and (iii) to identify significant areas of research to be developed in the years ahead.

The comprehensive and a systematic review of the progress of geography prepared by Professor Chatterjee (31, 1963-68) provides a valuable base for this survey report. For convenience, it is divided into the following sections:

I. Regional Surveys for Planning;
II. Regionalization for Planning;
III. Sectoral (topical) Studies for Planning;
IV. Quantitative Geography and Planning; and
V. Suggested Fields of Research.

I. REGIONAL SURVEYS FOR PLANNING

Regional surveys for planning include resource inventories, reconnaissance and sample surveys. They are conducted at different regional scales, macro, meso and micro. It is also important to note that ever since the beginning of the Second Five Year Plan, the geographers' contributions to regional survey have been specifically oriented to planning.*

*Systematic regional studies and land utilization surveys have been carried out by geographers even as early as in the 1940's.

Pilot Regional Survey of the Mysore State

The Indian Statistical Institute conducted a Pilot Regional Survey of the Mysore State during 1956-58 (63, 1961). Its objective was primarily to analyse the patterns and variations in the distribution of resources, patterns of development and problems in planning the development of different regions within the state as an integral part of the state's development programmes. The survey also employed selected quantitative techniques in regional survey and synthesis. Though the project was to apply geographical techniques in regional survey, analysis and synthesis, it was explicit from the beginning that it was to be interdisciplinary in character, the disciplines involved being geography, economics and statistics. By analysing the information contained in the Survey of India topographical maps and mapping other published and unpublished data supplemented by sample surveys of land-use, commodity and passenger flow, the survey brought out the distinct regional structure and patterns within the Mysore State which provided the basis for the preparation of generalised regional plans and their coordination in the State Plans. Other contributions of this survey were (i) a framework of planning regions and (ii) estimation of land-use potential in one of the less-developed regions of the State (17, 1965).

Macro-regional Survey of South India

On a less intensive scale, a macro-regional survey of South India comprising the states of Mysore, Kerala, Madras (Tamil Nadu) and Andhra Pradesh was carried out by the Regional Survey Unit. The Regional Survey of Mysore State had revealed that the spatial patterns of physical resources and the spheres of influence of urban industrial centres extended beyond the boundaries of the linguistic States to include parts of the adjoining States. This necessitated the extension of the survey to analyse the problems in regional planning of inter-state magnitude. The study revealed that inter-state disparities do merit detailed investigation. Core and peripheral areas of major crop-associations and selected industries were identified and by analysing the distributional patterns of several variables, a regional synthesis was attempted. Since balanced regional development was stressed in the Third Five Year Plan, one of the specific objectives of this survey was to study disparities in levels of development between regions by quantitative techniques combined with map analysis (51, 1962).

Relatively developed and less developed areas were thus identified and a framework of regions for the compilation of regional statistics

for planning was also suggested. The macro and meso levels of regional surveys were followed by studies of the broad regional dimensions of the national development plan and micro-regional studies at the Tehsil level with a view to illustrating the hierarchic nature of the problems.

Damodar Valley Survey

A diagnostic survey of the Damodar Valley Region was conducted in 1957 (52, 1968) by the Geography Department of Calcutta University, Patna University and the Department of Architecture and Regional Planning of the Institute of Technology, Kharagpur. The objective of the survey was to provide a basis for integrated regional development. The region included the command area of the project and the adjoining areas coming under the impact of development programmes of the valley. Surveys of land-use, socio-economic characteristics, hierarchy of central places, sub-regional disparities in development and resource potential were carried out for this purpose. In this context intensive land-use studies and mapping were undertaken in selected villages. Some specific problems like flooding, soil erosion and inadequacies of rural and urban infrastructure were analysed in the regional setting. Based on the survey, a detailed Atlas, inventorying the resource structure, potential and problems has been prepared.

The South-East Resource Regional Survey

The Damodar Valley and the Dandakaranya regions were amongst the five resource regions proposed for the preparation of regional development plans during the Third Five Year Plan period. These regions are parts of a single resource region and hence need to be treated as one region for planning. A study of the South-East Resource Region is now in progress at the Town and Country Planning Organisation. A preliminary report setting out the basic resources, potential and problems has been prepared (50, 1968).

Techno-economic Surveys of States and Selected Areas

In the techno-economic surveys of all the states and selected areas conducted by the National Council of Applied Economic Research, geographers have contributed to the analysis of physical resource base and economic structure of the states by cartographic analysis. For one of the states, a detailed Atlas has also been prepared to bring out the spatial patterns of resource use and problems (80, 1962).

Regional Transport Surveys

The Joint Technical Group on Transport, Government of India, conducted, during 1963-68, detailed studies on the movement of some 15 commodities. These were supplemented by Regional Transport Surveys for all the states. Geographers contributed to these studies in the design and preparation of flow-maps to facilitate the study of inter-regional linkages and interaction (48, 1969).

Locational and spatial aspects of development of selected commodities have been studied by geographers by using the commodity-flow data which hitherto were not available for a detailed analysis of space relations (48, 1969).

II. Regionalisation for Planning

Regionalisation is an exercise of dividing regions of higher order into sub-regions or aggregating regions of lower order into those of higher order based on homogeneity in the selected characteristics or functional interdependence between the nodal centre and its hinterland or between the different functional centres of different hierarchic levels.

It was during the decades 1920-1940 that regionalisation of India was attempted on a scientific basis. Much of the work was on regionalisation based on natural factors, and the main purpose of dividing the country into a system of regions was to provide a rational basis for the study of the regional geography of India (19, 1958). These studies were based largely on qualitative analysis of the spatial patterns by cartographic exercises supplemented by regional description with the help of secondary data. It was, however, during the decades 1940-1960 that the main objective of regionalisation was oriented to planning (33, 1968). In a systematic study of regional geography of Western India (former Bombay Province) an attempt was made to identify a scheme of 15 planning regions of both formal and functional type and to analyse their problems in planning (37, 1948). The anomaly between regional and administrative boundaries was stressed as early as in 1920. In all the schemes of regionalisation the emphasis was more on natural and formal regions and the techniques employed were mostly qualitative. In the later studies, the trend has been towards the application of both qualitative and quantitative techniques.

There have been several attempts in the delineation of planning regions of different scales—national, state and district levels. In all these efforts, there has been a shift in the approach from the identification of formal or functional regions to an integrated approach

based on the concept of regional and locational hierarchy. The pilot regional survey of the Mysore State suggested a scheme of 21 planning districts grouped into 6 divisions for the purposes of preparation of plans from below and in preparing the state plan according to the physical resource-structure and problems of development (109, 1960). With the emphasis on regional development in national planning, a number of studies have been conducted in the delineation of planning regions for the country as a whole. Principles of regional delineation were formulated to facilitate adopting an uniform approach and to minimise subjective judgment. As a first step a tentative scheme of 11 major resource regions and 51 sub-regions of India was worked out (108, 1964). These regions comprising groups of districts revealed the distinctive character of the resource base and problems of development which otherwise are concealed in the study of districts in isolation or in treating the sub-national areas like the linguistic states as regions. In 1964, the Planning Commission worked out a scheme of 15 resource development regions and 61 divisions after a study of physical factors, agricultural land use and cropping patterns (49, 1965). The question of delineation of economic regions by a combination of diversified resource base and the development of major power metallurgical bases was further elaborated. In these studies the role of physical complexes in the delineation of agricultural regions and economic regions of India has been discussed. Likewise a scheme of six macro-economic regions of India was suggested by combining linguistic states on the basis of a broad analysis of the development possibility of major industrial complexes for those regions (8, 18, 56 and 98).

In a joint Indo-Soviet research project, study on the approaches to the problems of economic regionalisation in India was undertaken by the Census Organisation. This study enunciated the theoretical and conceptual aspects of formation of economic regions and analysed the essential components of region formation. A tentative framework of economic regions was suggested on the basis of the Soviet concept of economic regions and production specialisation. Under this scheme, seven macro-regions and 42 meso regions were proposed (120, 1968). In 1968, the Town and Country Planning Organisation in collaboration with the National Atlas Organisation suggested a scheme of 13 macro and 36 meso regions for the country (133, 1968). The principles of regional delineation were economic viability, self-sufficiency, and ecological balance at the macro and meso levels.

There have been several studies on the identification of areas with different levels of economic development using district and state level data for South India and India. In these studies, indices were

constructed on the basis of physical characteristics, resource base, urban-industrial patterns and occupational patterns. Areas with relatively low, intermediary and high levels of development were identified and their characteristics and problems of development were analysed (51, 76, 82 and 94).

Regionalisation has also been attempted by studies of the patterns of fundamental linkage structure in the pattern of commodity flows. Multiple factor analysis was carried out for the analysis of inter-relationship among several variables. In the all-India study, the analysis of the flow of patterns of 63 commodities for 36 trade blocks revealed that "the Indian economic system consisted of interacting set of economic activities based upon major resource complexes together with disaggregation into a set of regional economies oriented to major metropolitan complexes like Calcutta, Bombay and Madras" (5, 1966). This all-India study was followed up by a detailed commodity flow study of the Bengal-Bihar Industrial Area (113, 1967). As a follow-up to these studies, a study on inter-city flows of commodities and communications was completed in 1967.

III. Sectoral (Topical) Studies for Planning

Sectoral components of a plan have distinct regional dimensions. Geographers have made a specific contribution in the analysis of the regional dimensions of sectoral plans.

Urban Studies

The scope of urban surveys for planning has three distinct levels (i) national, in terms of an overall urban-industrialisation policy relating to concentration *vs* dispersal of economic activities, (ii) regional, in terms of integrated development and (iii) local, in terms of urban functions within the town (intra-urban) and the town and its hinterland. These studies in the context of planning are distinct from systematic surveys of each town treating each town as unique.

Growth Centres and Growth Tracts: It is in this context, that the urban surveys of Mysore and Telangana, were designed and the composition of the survey teams was inter-disciplinary (100, 102, 107). Least urbanised areas and regional imbalances in urban-infrastructure were identified and a model of urban hierarchy was suggested as part of the framework of a regional development plan. The urban framework suggested for Mysore State, urban Telangana and Muzaffarnagar district, should be considered as a first step in the identification of growth-centres and growth-tracts.

Town and Country Planning: The region as a conceptual frame-

work for town and country planning is being employed in the context of the planning of new industrial townships (like the Heavy Engineering Township near Ranchi, or the Steel Township of Bhilai) or new settlements in an area of pioneer peasant colonisation (as in the area extending beyond the canal command area and including all those areas coming under the impact of such development). Among such studies, particular mention may be made of land capability surveys' and studies for evolving a settlement hierarchy for Rajasthan Canal Area (28, 29, 131 and 47). The Rural-urban Relationship Committee set up by the Government of India recognised the need for integrated rural-urban development through expanded local government areas to include both municipal areas and their adjoining rural areas (35, 1961). Geographers' contribution was in formulating the approach to problems in rural-urban integration. Among the micro-level surveys, the study of Wardha District conducted by the Institute of Regional Development Planning represents an experiment in integrated development of the district (96, 1968). A hierarchy of settlements focussing on 'Mandi Centres' (market places) was conceived for this purpose.

Metropolitan Planning: Among the surveys for planning urban centres mention must be made of the survey of the Calcutta Metropolitan Region, the Delhi Metropolitan Region and the Kanpur Region. These are dealt with elsewhere.

Industries

Study of industrial location in the context of regional development is becoming increasingly important. A study of the cement industry in relation to national and regional perspectives (1967) was made to illustrate the geographers' approach to problems in industrial planning (20, 1967). Maps of location and capacities of cement factories spatially analysed for 1951-56 brought out the gradual emergence of distinct areas of concentration of the cement industry in and around important areas of limestone reserves. The spatial patterns of production and consumption were chronologically studied by using the data on the flow of cement to major consumers during 1961, 1965-66 and for 1971. Taking into consideration the raw material reserves in different parts of the country and the patterns of regional development, the study attempted a generalised regional location pattern for 1976 in relation to the production target worked out for the year for the country as a whole. The study provides a spatial framework of locations of production and consumption that could be used in objective assessment of the per-

spective locational pattern using linear programming and other related techniques of analysis.

Similar studies are now in progress for several industries such as steel, fertilizers, heavy engineering and petroleum for which locational information and technological coefficients are now available.

In an attempt to relate the problem of location of industries of national importance with the growth of regional economics, geographers have applied the concept of the development of power-metallurgical complexes to the macro-economic regions of the country using the Iron and Steel industry as an example (44, 1966). In this study the states of India were grouped into six macro-economic regions and their consumption and supply of steel were analysed. In arriving at the rational sequence of regionwise location of steel mills in India, linear programming technique was used taking nine locations of Steel Plants (existing and coordinate point) and twelve important consuming centres within the six macro-economic regions. This study was further improved by increasing the number of locations of demand and supply and allowing for phased expansion of production and demand (43, 45 and 46). The limitations of data regarding total cost of production and supply and the choice of only a few locations of major consumers are obvious and hence there is a need for further refinement of the study looking at the locational problems from a regional angle.

Agriculture

Agriculture (both broad land-use and cropping pattern) has been the subject of study at various area levels and also in terms of individual crops. In most studies, regional diversities in natural environment and cropping pattern have been noted and problems in agricultural land-use planning qualitatively described.

Regional approach would be needed for the preparation of agricultural production plans and in their implementation because the States are too large and heterogenous in terms of the natural environment and cropping patterns and there are distinct regional cropping patterns or crop-associations which could provide a basis for evaluating crop-production potentials and in estimating the requirements of major inputs and other infrastructural investments.

Physiographic division of the country in greater detail is a good beginning but only the beginning for areal delimitation of the land system which could be of practical use in the analysis of regional land-use structure and in planning both broad regional specialisation and integrated development of different land uses. The major work of mapping and delineation of physiographic regions of different

scales has been in progress in the National Atlas Organisation. Pending the preparation of comprehensive land system maps by the use of air-photographs and adequate information on soil fertility, one interim approach is to attempt the best possible physiographic characterisation of administrative units like the Tehsil or Development Block and the District for the study of regional aspects of agricultural land-use planning from a national and state angle. Regional physical complexes for agricultural land use planning at the national and macro-regional scale are being studied (18-19). Core and peripheral areas of major crop-associations have been identified at different area levels by ranking crops on the basis of their relative importance—local, regional and national. The concept of core areas in regional analysis provides a basis for the evaluation of crop production potentials and for disaggregation of national targets of production and investment. These studies need to be followed up by interdisciplinary studies in which geographers, agricultural economists, agricultural scientists and planners should participate. Macro-regional studies of land form and land use carried out by geographers could be of use in the preparation of a geographic framework as a basis in area development at the District and Block levels.

A study of the 'Indian Jute Belt' has been made by analysing the character of the land form, soils and climate in the Ganges-Brahmaputra-Meghna Delta areas of jute concentration. This study indicated areas potentially suited to jute cultivation in other parts of India (119, 1959). The study also provides data regarding economic aspects of jute cultivation and the extension of jute cultivation in other areas. Problems of land utilization in the jute growing area are also analysed in the context of the anticipated changes in land use in favour of jute under the compelling need for increasing the area of jute cultivation to sustain the industry.

IV. Quantitative Geography and Planning

A review of research in Geography and Planning would be incomplete without the consideration of recent developments in research techniques and tools employed by regional planners. The cartographic techniques used by geographers are still very important and there has been considerable improvement in the cartographical analysis by blending together the qualitative aspects of regional structure with the quantitative aspects. These improvements are seen in the maps prepared for the Regional Survey of the Mysore State and the Atlases prepared by the National Atlas Organisation and the Census Organisation. These techniques are being supplemented by sophisticated quantitative analysis in planning. Quantitative ana-

lysis has significantly contributed to improved methods of synthesis of complex regional patterns, and in enhancing the ability of planners, through model simulation, in predicting the future and in evaluating alternative strategies in planning.

Three distinct sub-areas of research in geography and planning have benefited most from the recent development of quantitative geography. These are:

(i) Quantitative analysis of regional structure, which provides the base and the initial framework for planning.
(ii) Regionalization and regional delimitation for planning.
(iii) Quantitative study of growth processes in planning.

Quantitative Analysis of Regional Structure

Planning involves a detailed analysis of existing regional structure. This is best expressed in the spatial arrangement of individual phenomena, the spatial association among phenomena, the spatial interaction or movement of people, goods, and services, and the hierarchical ordering of places and their relationships to other places.

The techniques now employed in the study of regional structure are: centrographic methods, nearest neighbour analysis, correlation and regression, and more recently multivariate techniques. In addition, a variety of theoretical constructs are also used, such as the gravity and potential models, network models and graph theory, and distance decay functions.

The approaches and techniques outlined above formed the basis of two major studies of the spatial structure of the Indian economy; one is a study of commodity flows of the Bengal-Bihar industrial area (113, 1967) and the second is a study of commodity flows and spatial structure of the Indian economy (51, 1962). In the Bengal-Bihar area study, the potential model was used to explain commodity flows in terms of demand, supply and distance. Apart from generalisation of the flowpaths of goods from the area, the study also outlines the alternative strategies for future development of the Bengal-Bihar industrial area.

The study of commodity flows covering the whole of India is based on data covering movement of 63 major commodities among 36 trade blocks of India. The data are analysed by factor analytic methods. These revealed a division of the Indian economy into a set of regional sub-economies (5, 1966).

Quantitative Regionalisation and Regional Delimitation

The quantitative technique commonly used is the multiple factor

analytic method. This method is appropriate for identifying the nature of the relationship existing between relevant variables and to identify groups of variables that have a common underlying spatial pattern. Multiple factor analysis was first used to identify groups of similar districts in Madras State (103, 1953). In a recent study of the levels of economic development in South India, the principal components analysis has been employed to identify development regions. In these studies, the first principal component was used to construct an index of development (82 and 103). In another study, more complex procedures were used to study the spatial structure of the Indian economy to identify economic regions within the broad framework of a general field theory (5, 1966). In this study multiple factor analyses were first used to identify groups of variables and this was followed by a dimensional analysis to evaluate the degree of similarity between pairs of places and finally group-analytical methods were used to identify clusters of contiguous sets of similar places.

Quantitative Studies of Growth Processes

The study of growth processes sharply focus on such concepts as development, evaluation, improvement, and progress—all basically related to planning. In recent years, geographers have focussed on spatial growth processes that lend themselves to mathematical analysis and through such analysis for making prediction. The growth processes generally considered are diffusion processes, urban growth processes and migration processes.

Research in quantitative studies of growth processes in India is still in its initial stages. However, two major studies have been completed in this area; these relate to the spread of agricultural innovations in rural India, using essentially the Hagestrand model of innovation diffusion. The first study is concerned with the spatial spread of agricultural co-operative societies in the Mysore District (73, 1968). The second study deals with a heuristic simulation of the spread of irrigation pumps in the Coimbatore Plateau (99, 1969). Simulation studies of innovation diffusion are valuable for evaluating alternative strategies for the promotion of technological change in rural India.

V. Suggested Fields of Research

Some important fields of research in geography and planning which should be given priority are indicated in this Section. Under each field, some important research projects are also suggested. While

the research in these fields will be on their geographical aspects, there is also a strong case for an inter-disciplinary approach.

Regionalization for Planning

There are numerous ways to define and classify regions for planning; many of these are either theoretical or limited in scope. Regional coincidences and co-variations should be objectively and precisely defined in working out the regional framework for sectoral planning or integrated regional planning. In this field, research should be promoted under the following project heads:

(a) Planning Regions at the national level;
(b) Planning Regions of different States;
(c) Regional framework for the compilation and aggregation of statistical data;
(d) Case studies in regional delineation for sectoral planning: agricultural, industrial, urban and market regions; and
(d) Boundary anomalies.

Central Place Studies

Central place studies would provide the basic framework for (i) a rational distribution of market and urban infrastructure at different hierarchical levels of settlements (rural and urban), (ii) a rational organisation of flows of people, goods and services and (iii) the location of growth centres for regional development.

A central place framework could be also used to construct a regional-urban development model as a part of the regional development model.

A number of case studies at different regional levels (micro, meso and macro) should be undertaken. These studies should be carried out in different types of regions, e.g. command areas of major irrigation projects like the Tunga-Bhadra, the Deltaic plains of the Krishna-Godavari, the Mahanadi and the Cauvery deltas, the homogenous agricultural plains of the Punjab, Haryana and Western U.P. and the newly emerging industrial regions. The central place studies and the study of land use models are complementary.

Regional Spatial Development Models

There is an increasing emphasis on the formulation of a theoretical framework and of model construction and working out alternative patterns of man-environment relations. Model construction requires rigorous sorting out of significant elements in the system,

formulation of concepts and search for order, regularities and analogues, and for appropriate techniques of analysis of spatial/regional structure and inter-relationships. Here, the traditional data matrix and the map get transformed and there is an increasing emphasis on geometric analysis of the location and spacing of points, lines and areas, and the size, shape, interaction and intensity of emerging patterns.

This new approach has given rise to several new dimensions in regional research. Model building techniques could now fruitfully be applied to studies of rural and urban land use structure and planning, studies involving simulation models of spatial processes and studies focussing on models of transportation networks.

Land Use Models

Land use models attempt to specify the existing and the potential inter-relationships of spatial and non-spatial elements that contribute to the patterning of land uses in rural and urban areas. An important theoretical base for rural land use studies exists in the Von Thunen model and its later elaboration. These models emphasise such parameters of land uses as transportation costs, distances to markets, but assume a homogeneous rural landscape. The validity of Von Thunen's model of land uses has not been empirically tested, while there is every indication that the model may prove to be an appropriate base for studies of rural land use in India. However, certain of the assumptions in Von Thunen model will have to be discarded. For example, future studies of land use in India should consider the spatial variations in the physical base—particularly variations relating to land capability—and the contrasting regional structure and problems. Specific studies along these lines should emphasise any one among the several important aspects: (i) temporal change in the land utilization patterns; (ii) the impact of technological change on rural land use patterns; (iii) the impact of fragmentation and consolidation of holdings on land use patterns and (iv) the inter-relationship of land use and the spacing and functions of market centres. Priority should be given to the study of growing regions like the Tunga-Bhadra Canal irrigated area and the Rajasthan Canal area.

In the context of the rapid growth of metropolitan and sub-metropolitan centres in the decade 1951-61, and the prospects of the continued growth of these centres, it is necessary that greater attention should be given to the study of urban structure. Existing models of urban land use structure (sectoral, concentric zone and multiple nuclei models) provide a general theoretical framework for future

studies. In particular, the development of normative models—as opposed to the existing behavioural models—of city's land use structure should provide a better basis for metropolitan planning in India. More specifically, there is an urgent need to study problems relating to the land use patterns of the rural urban fringe, the patterning of residential land uses within cities, the zoning of industrial land uses in the context of the rapid growth of industries and the internal commercial structure of Indian cities.

Simulation Models of Spatial Processes

In recent years, geographers have actively contributed to building models for simulation of spatial processes—innovation diffusion processes, migration processes and urban growth-processes—stimulated by the growing realisation of the practical value of such research for purposes of prediction and planning.

The models of innovation diffusion illustrate the general approach. The general objectives of spatial simulation models are threefold: (i) to apply model building techniques heuristically to gain further insights into the relative roles of various parameters of diffusion, (ii) to evaluate alternative strategies for developmental planning and suggest optimum patterns for the distribution of various inputs and (iii) to predict the time-space path of the spread of technologies and evaluate the consequences of such technological change.

Transport Network Models

Transportation network models focus on linkages between places and involve the evaluation of the nature and intensity of the flows of goods, ideas and people, along established patterns of a given transportation network. These studies should provide a sound basis for the identification of spatial functional organisation and ultimately lead to the delimitation of nodal regions, which would provide a regional framework for planning.

Network models are based on three fundamental building blocks: origin, routes and destinations. The spatial structure of the transportation network is evaluated in terms of the locational patterns of the basic building blocks and in terms of the relation of these elements to the entire network system.

The theoretical bases of research center on the application of graph theoretical models, gravity and potential models and models based on the concept of intervening opportunities. Principles of graph theory are used to measure the accessibility of nodes in a

transportation system and the degree of connectivity of the entire system. Movements along routes of a network are analysed within the framework of gravity and potential models. Each of these emphasises the important role of urban centres in the organization of spatial systems of transportation networks.

The theoretical bases of analysis outlined above, provide the framework for research on the structure of various types of transportation network within India: the network of roads, rail roads and air routes. However, while studies of the structure of transportation networks are important, it is perhaps even more important to examine the role of transportation in the processes of economic development of various regions within the country. Future empirical research in this area should emphasise the structural characteristics of transportation networks and evaluate their adequacy/inadequacy in relation to the needs of economic growth of regions; they should also suggest alternative strategies for the development of the transportation infrastructure; and indicate potentially optimum patterns of transportation related to economic development.

Area Development

Area development studies are essentially micro-regional comparable to the size of a district or a block. The area development framework includes land type/land use structure, settlement structure, (rural and urban) and social and economic infrastructure and their inter-relationships both existing and projected. The concepts, techniques and approaches to area development have yet to be formulated and standardised. Hence, there is a need for a number of pilot studies in selected areas.

Quantitative Geography and Planning

There is a strong case for experimenting with the application of techniques like multiple factor analysis, grouping techniques such as nearest neighbour techniques and cluster analysis, simulation and network analytical techniques to problems in spatial planning.

The utility of the application of sophisticated techniques, particularly at the meso and micro regional levels is determined by the nature of the areal data and the character, size and shape of unit areas for which data are recorded. The unit areas should be small, compact, and homogeneous or at least near homogeneous.

Traditionally the multiple factor analytical approach has been used to identify homogeneous units based on a wide range of variables, spatially significant or not. In regional problems, identifica-

tion of groups of areas with similar characteristics is more relevant than the identification of groups of variables. In this exercise of grouping of areas, there are a number of problems relating to normality, linearity and equal variances of data matrix, which need to be sorted out. Further, factor analytical techniques should be applied in conjunction with the techniques of dimensional analysis, discriminatory analysis and grouping analysis to delineate a system of formal and functional regions for regional planning.

In the study of the changing character of regional structure which is basic to planning, techniques for the analysis of regional/spatial processes and the simulation of such processes for future prediction will play an important role. At present, geographers have tended to emphasize, perhaps even over-emphasize, the Monte Carlo approach to simulation. In the Monte Carlo approach, the outputs of successive simulation runs of a given model vary greatly and there is need for analysing the variance structure of simulation runs. Further alternative simulation techniques need to be explored, e.g. the Markov-chain model. Construction of models can be successful only on the basis of detailed empirical studies of spatial processes; once the basic mechanism of the spatial processes are understood simulation may be applied hueristically to gain further insight.

Another quantitative technique that is being increasingly applied is the nearest-neighbour technique. Although this type of analysis was originally developed to study the pattern of point distributions, it has now been further extended to the study of pattern of lines. The extension of the technique to higher order nearest neighbours and the sectoral arrangement of points in space, should increase its usefulness. Opportunities for empirical research along these lines have not yet been explored for example, the spacing of settlements in Deltas differs markedly from the spacing of settlements in arid areas; and both have changed over time. To be relevant to planning, future research should emphasise the factors that enter into dynamics of point distribution; here techniques, such as multiple factor analysis, may be used in conjunction with the nearest neighbour techniques. Eventually, the application of nearest-neighbour techniques should result in establishing norms of point-distributions for various regions and for predicting future patterns.

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10

River Valley Development Planning

A Trend Report

By

P. Dayal

Nature and Scope

THE GEOGRAPHY of water resources is a relatively new subject. Since times immemorial rivers and tanks have been used for drinking water supply, bathing and irrigation purposes; but there has been little understanding of their use as an economic resource. Records of canals built during the Hindu and Muslim Rules in India have been found. Of these, the western Yamuna Canal built by Feroz Shah III in A.D. 1356 near Hissar may be mentioned. It is, however, definite that the extent of land irrigated by canals was extremely limited before the British period, mainly because the Kingdoms for the most part were small and the rivers were regarded as being mainly of religious or strategic importance.

Rivers in India, even where snow fed, are dependent upon the monsoons for their peak flow. Since the monsoon is too variable, the rivers discharge either too much water inundating the plains, or are too dry to be of agricultural use. Consequently, water resource planning in the context of our agricultural economy becomes extremely important. During the last century, rivers have achieved added significance as a source of hydro-electric power. More recently, new dimensions have been added with the realisation of the importance of measures like soil reclamation, flood control and afforestation which go to make a river valley development project truly multipurpose in character. It is surprising, therefore, that very little geographical literature exists on the subject and that most of the publications relate to the period after 1950. It is the object of this review to arrange and examine the chronological development of knowledge in this important branch of geography of India.

Earlier Studies

The most important schemes relating to river valley development were conceived and executed in the 19th century itself, and may be called the forerunners of modern multipurpose river projects. The first of these was in North India where Captain Proby Cautley conceived and executed the Yamuna and Ganga Canal systems in the face of heavy odds, and freed western Uttar Pradesh of recurrent famines. This was followed by similar schemes in Maharashtra, Mysore and Tamilnadu by such renowned engineers as Sir M. Visvesvaraya. The most notable of these was the Krishnaraj sagar Project on Cauvery river in the early part of the 20th century. At the same time, hydro-electricity was introduced in India through the Sivasamudram Project (1902) in South India and a small plant near Darjeeling. Gradually the pace quickened and several new irrigation works such as the Son Irrigation in Bihar and hydro-electric projects such as Tata Hydro-electric plants of Maharashtra took shape.

Many schemes, however, continued just to remain on the anvil. The Damodar Valley Project was conceived of almost a century ago, but it was only after the devastating floods of 1943 that Government actively considered the matter. By that time, the success of the Tennessee Valley Authority in the U.S.A. had become a precedent in integrated river planning and it was therefore, decided to set up the Damodar Valley Corporation on similar lines. The objectives of this project were threefold: irrigation, power development and flood control including soil conservation and afforestation. The project, as sanctioned in 1948, has since undergone considerable transformation, and has also perhaps been overshadowed by such other great multipurpose schemes as the Bhakra-Nangal and the Hirakud Projects. Nevertheless the D.V.C. remains the forerunner of all similar projects in free India during the last two decades.

Damodar Valley

The two significant studies on the Damodar Valley made in earlier years were by Bose (9, 1948) and Kirk (28, 1950). Bose deals with all aspects of the project and has later developed his ideas in his Ph.D. thesis (Calcutta). Kirk has presented a comprehensive and balanced regional geography of the Damodar Basin and has examined the Damodar Valley Project in all its aspects as it was then conceived of. A colourful study of the Damodar Valley as well as of several other river valley development schemes in India, both during the British and the early post-Independence period,

is given by Hart in his book *New India's Rivers* (23, 1956). The book is invaluable for its literary quality, lucid treatment and deep understanding of both the land and the people involved in such projects.

Sen, in his Drainage Studies of Lower Damodar Valley (45, 1956) and (46, 1958) has examined the probable effects of D.V.C. Dam Regulation on the lower reaches of the Damodar. In a similar article, Bose (8, 1958) has drawn attention to the problem of silt deposition in reservoirs which shortens their life enormously. He suggests a greater emphasis on irrigational aspects with an attenuation in power generation as a possible remedy.

Perhaps the most important study on the Damodar Valley Region was made by a group of experts constituting the Joint Committee for the Damodar Valley Diagnostic Survey set up by the Planning Commission, Government of India, in 1958. Three institutions, namely, the Calcutta University, Indian Institute of Technology, Kharagpur, and the Patna University actively participated in this programme, and on their behalf, S. C. Chatterjee (Calcutta), V. N. Prasad (Kharagpur) and P. Dayal (Patna) set up local offices with trained officers and staff for the survey. The methodology included collection of data from the field as well as from the Government and other sources on all aspects of physical, socio-economic and cultural geography between 1959 and 1963, their analysis through statistical and cartographic techniques and interpretation in a series of reports dealing with various sub-regions as well as the region as a whole. The report on the Lower Damodar Region by S. C. Chatterjee has been published (1969) while that on Upper Damodar Region by P. Dayal is under print. This would be followed by the report on Middle Damodar Region by V. N. Prasad. A planning Atlas for the region is also being prepared under the supervision of S. C. Chatterjee. Besides the reports on these three regions, studies of different aspects of the entire valley have been made by P. Dayal on Population and Towns, by R. N. Banerjee on Power, and by S. C. Chatterjee on Physiography and Landuse. Detailed studies on micro-regional geography .of the Calcutta conurbation by S C Chatterjee, on the Durgapur Industrial Complex by V. N. Prasad, and on the Ranchi-Ramgarh-Industrial Complex and Bokaro Industrial Region by P. Dayal have also been completed and are under publication.

Studies on Other Regions

A comprehensive and very useful work on *Mountains and Rivers of India* was published by the National Committee for Geography

at the time of the International Geographical Congress held in New Delhi (32, 1968). The book contains 29 articles written by eminent Indian geographers and geologists and has been edited by B. C. Law. The second part of the book deals with the physiographic, historical and cultural aspects of various river valleys in India.

Singh (48, 1959) has dealt with the available water resources and competing demands for irrigation, flood control, power generation and need of water for domestic and industrial uses in general. Gokhale (20, 1959) has examined some aspects of the Tungbhadra Project. Another interesting study on the same project giving details of different aspects was made by Venkateswarlu (60, 1959). Naegamvala (34, 1961) has made a very useful study of the Narmada river emphasizing particularly the importance and benefits of this project. Das and Lal (16, 1969) have examined the design and economics of Gandak and Kosi river projects, and have pointed out the benefits which will accrue from these projects to Bihar and adjoining areas. The river projects of Bihar had also been examined earlier through a brief official note (1, 1962) in *Indian Journal of Power and River Valley Development* where periodic reports on Progress of River Valley Projects in India are also published regularly. Appadurai (3, 1962) studied the salient features of Annamalai Hydro-Electric Scheme from the point of view of an engineer. A similar study on Bhakra Nangal Project was made by Palta (37, 1962), who described the physical setting and the problems and potentialities of the project. Gupta (22, 1962) refers briefly to a number of power projects in Assam.

In an earlier paper, Bagchi (6, 1952) has advocated a change in the Polavaram Project on Godavari river on certain geographical considerations. Roy (42, 1951) has criticised the Hirakud Project giving the full historical perspective and a comparison with the experiences gained by the T.V.A. The problem of river water disputes between states has been considered by Chaturvedi (13, 1969) with reference to South India. Jain (24, 1968) discusses the development of water resources of the western rivers of Uttar Pradesh, and points out areas in which further development is possible. Krishnan (30, 1938) has given a balanced geographical account of the Tambraparni Basin of South India. Nagabhushanam and Rao (35, 1970) have dealt with the cost of material input and agricultural output before and after irrigation provided by the Nagarjunsagar Project. They then go on to suggest the optimal crop pattern for the area. Subramanayam and Dakshinamurti (58, 1968) have made a physiographic and hydrological study of the Godavari and Krishna basins. The question of irrigation in Mahanadi delta

has been discussed by Sinha (50, 1954) in a lucid manner.

Srinivasaraghavan (56, 1936) has made a geographical study of the Vellar Basin, while Thiruvaranati has made a similar study of the Palar basin (59, 1938). A complete project report giving historical details of scheme, resources, potentialities, and capabilities appears in an earlier issue of the Journal (2, 1934).

Irrigation may lead to problems of water logging and salinity, as in the Punjab. In one such study, Gupta (21, 1970) has examined drainage and water table in the Eastern Kosi Region. The Mahi Project of Gujarat has been discussed by Patel (38, 1961) who has pointed out its benefits in the fields of flood control and irrigation. Rivers which flow within different states often give rise to political disputes. Padmanabhan (36, 1962) has attempted an objective presentation of such disputes in the case of Mysore State.

Flood Control

The problem of floods in Brahmaputra Valley has been examined by Baruah (7, 1970) who suggests a number of alternative schemes for their control. Bannerjee (6, 1944), in a very early paper on Damodar Valley dealt with the problem of floods in this area in a very general way. In a similar article, Sirkar (51, 1954) examined the question of floods and their economic effects in Western Bengal. The historical perspective of floods and physiography of the Tista Basin have been studied by Sanyal (44, 1967). Chakravarti (10, 1959) has discussed the causes of floods in the Himalayan Rivers of the Ganga Basin and has suggested that dredging of channels and construction of inundation canals would be more effective in their case than other conventional methods. Singh (49, 1961) has studied the flood problem of the Tarai Region of Uttar Pradesh, Roy (41, 1942) investigated the causes of rapid flood water erosion of the upper Brahmaputra, Chatterjee and Bagchi (12, 1961) studied the floods affecting different parts of West Bengal and traced their causes to three different factors: precipitation, terrain and run-off. Chatterjee (11, 1943) and Bagchi (5, 1961) also investigated the causes of floods in the Damodar. Chatterjee has explained the reasons for the 1943 floods, while Bagchi has traced the early history of the Damodar and how the conditions deteriorated through the centuries. Gairola (19, 1955) has traced the successive floods in the Ganga Basin since 1894 and has concluded that a knowledge of elevation discharge curve for various stations is necessary for predicting flood flows. Floods in West Bengal, particularly in the south-west, have been discussed in successive papers by Sirkar (52, 1954; 53, 1955, 54, 1956), who has analysed the hydrological and climatic aspects and has

indicated that the extent of flooding has changed for the worst. Floods are rare in Rajasthan, but sometimes they cause extensive damage. Srivastava has discussed this with reference to the 1943 floods (57, 1943). Another useful article on flood control is by Roy (43, 1950) who has advocated construction of guide banks on all the 32 major rivers in North India based on his detailed analysis of river control of both slack water channel pattern and open river channel pattern.

The problem of silting due to heavy soil erosion in the catchment area of River Kosi was investigated by Das (14, 1968) who has recommended suitable protective measures in the upper reaches.

Power Development

Krishnamurti (29, 1940) has given a detailed account of Papanasam Hydro Electric Project of South India and has pointed out the advantages as well as the cost involved in this scheme. Shankarappa *et al.* (47, 1968) have, in an article on the west flowing rivers of Mysore State, examined their hydrology and various hydro-electric schemes proposed for them. Dutt (8, 1948) has given an account of the hydro-electric scheme on the Ganges Canal and has tried to evaluate its impact on agriculture in Western U.P. In an issue devoted entirely to the Chambal Project, Sivaprakasham (55, 1960) has examined the grid system and Mane (33, 1960) has discussed the Chambal Canal System. The question of power development in South India has been presented in its historic perspective with a brief note on different projects by Ramamoorthy (40, 1963).

An earlier but excellent geographical account of hydro-electric power development in India was given by Kuriyan (31, 1945). A more recent but brief study was made by Datta (17, 1964) which includes both hydro-electric and thermal power generation. Jauhari (25, 1956) has made a detailed regional study of electric power development in north-west India highlighting its impact on industries and irrigation.

Doctoral Theses

A good regional monograph on the Himalayan Beas Basin was published by Kayastha (26, 1964) based on his Ph.D. thesis (1957, B.H.U.). Portions of this work were published earlier in the form of papers in the *National Geographical Journal of India* (27, 1955) and elsewhere.

Two recent Ph.D. theses completed under the supervision of the author include the Subarnarekha Basin in Bihar (39, 1967) by Ram

and another on the Pattern of Changing Landuse and Population in the Kosi Region of Bihar (15, 1970) by Das. Both these studies are based on detailed field work and employ sophisticated statistical techniques for the identification of problems and correlations.

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III

Historical Geography

11

Historical Geography

A Trend Report

By

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Introduction

It is interesting to note that the earliest contributions to modern geography in India were made in the realm of historical geography. There were two motives behind this accent on the historical factor. Firstly, the urge on the part of the British to establish a stable administrative system in the country led them to encourage the study and analysis of the man-environment relationship in the preceding periods. Secondly, these studies were undertaken by Indian scholars to reach to the historical roots of contemporary phenomenon in order to develop a sense of national identity and pride.

As these extra-academic urges gradually subsided, interest in the field of historical geography withered away. In the new context, this borderline discipline could develop through its inherent academic potentialities and in close relationship with the natural and all-sided development of both history and geography. This largely explains the retarded development of the field of historical geography in India after the initial impetus had petered out. In the recent past, however, there are indications that this process is being reversed. With the stabilization of the foundations of history and geography, researches in historical geography have received encouragement because it is being increasingly realized that both the disciplines would lose much of their intellectual rigour without the contribution of historical geography. New conceptual frameworks, are, therefore, being evolved in this borderline area and new tools of analysis are being perfected.

The present review of literature in the field is based on three criteria, which are considered significant from the point of view

of the organisation of research endeavour in this field, *viz.*, (i) Nature of the Source Material; (ii) Aspects of the Natural and the Social Environment; and (iii) Spatial Differentiation and the Regional Framework.

Nature of the Source Material

In the absence of definitive geographies and maps prepared in India during the ancient and the medieval periods, the nature of the source material has posed the most serious challenge to scholars engaged in researching on the historical geography of India. It is a difficult task, indeed, to search for bits of information of geographical significance in essentially non-geographical accounts, to sift the small grains of authentic facts from the gravel of myths, bardic exaggerations and poetic fancies, and to fit them into a systematic framework so as to present the man-environment relationship in a particular historical phase. It may be stated with some justification that this difficult task has been shouldered with credit.

Religious Texts

Religious and quasi-religious texts such as the *Vedas, Brahmanas, Sutras, Upanishads,* and *Puranas* contain much useful material on the geographical character of the regions and places in which they were composed. In a number of studies this material has been organized to produce meaningful reconstructions of the geography of various regions of India at different points of time. Notable among them are the contributions of Bird (36, 1840), Wilford (183, 1822), Cunningham (54, 1871), Dey (66, 1927), Raychaudhuri (145, 1960), Sircar (166, 1960) and Ali (20, 1966). Law based his *Geography of Early Buddhism* on the fragmentary evidence lying buried in the Pali-Buddhist texts. Dey prepared a detailed index of all geographical references occurring in the ancient Sanskrit and Pali texts. Dikshitar (68, 1952) prepared a similar index for the *Puranas* to give some definiteness to their 'vague obscurity'. Raychaudhuri and Sirkar also utilized Puranic sources to sift and arrange information on the extent, topography and population of *Bharatavarsa.* Ali's monumental work on the geography of the *Puranas* broke new ground by using the tools of modern geography to understand the real significance of geographical references in the ancient texts. Fleat (73, 1899), Abbott (1, 1899), Clark (52, 1919) and Majumdar (116, 1919-1921) also drew heavily from these sources. Specifically, Stein (171, 1917), Das (56, 1921) and Bhargava (33, 1956; 34, 1964) used geographical material occurring in the *Rigveda* and Tamaskar

(175, 1956; 174, 1967-68) and Mukerji (122, 1969) used similar material from the *Upanishads* and the *Jataka* tales. Dubey (70, 1967) deserves special mention since he has utilized a variety of source material from the ancient period.

Epic and Literary Sources

The great epic *Ramayana* is rich in geographical content, which has been utilized, among others, by Das (57, 1894), Pargiter (131, 1894) and Dikshitar (67, 1935). Similarly, the geographical material in the *Mahabharata* has been painstakingly utilized in all major contributions to the historical geography of ancient India. Literary sources such as the works of Kalidasa were used for an understanding of the geography of the age by Sivaramamurthy (167, 1932), Law (107, 1954) and Gupta (77, 1963).

Travel Accounts

Travel accounts constitute an invaluable source of information for the historical geographer. These records offer the rare opportunity of having an eye-witness account of the lands and peoples visited by the traveller concerned at a given point of time. In the Indian context, most valuable among these travel records are the narratives of the Chinese pilgrims Hiuen Tsiang, and to a lesser degree, Fa-Hain and Sung-Yun; the Arab travellers Ibn Battute and Alberuni and a number of European travellers who toured the country during the sixteenth, seventeenth and eighteenth centuries.

The enormous evidence in Hiuen Tsiang was ably sifted, annotated and analysed by Beal. The latter (28, 1957-58) took great pains in identifying place-names and other geographic references mentioned by Hiuen Tsiang. This evidence was utilized by Cunningham (55, 1871) who not only cast it in the geographical mould but also compared it with the accounts of Alexander's campaign to produce a brilliant geographical account of Buddhist India.

The narrative of medieval Arab traveller Ibn Battuta was translated and edited and annotated by Gidd (76, 1929; 1962). Yule (184, 1874) arranged the geographic content on India in the *Rehla,* while Haig (81, 1887) discussed his travels in Sind, identifying place-names and assessing the geographical significance of the narrative.

Wheeler (1881, 1890) and Macmillan (1895) incorporated valuable material on Indian geography as contained in the travel accounts of some important European travellers of the seventeenth century such as Terry, Della Valle, Tavernier, Thevenot, Fryer, Hamilton,

Niebuhr, Hawkins, Roe and Careri. The extracts from the works of Wheeler and Macmillan were compiled in a volume (182, 1956) and constitute a useful source material on the geography of this period. The geographical content in the account of Peter Mundy's travels in the seventeenth century was thoroughly annotated by Temple in the Hakluyt Society's edition (177, 1919).

Classical Geographies

Classical geographies of India, such as those of the Greeks in the ancient period and of the Arabs in the medieval period, are valuable contemporary source-books for the historical geography of their time. The Greek accounts of India—among others those of Diodorus, Herodotus, Megasthenes, Arrian, Strabo, Quintus, Siculus, Justin, Plutarch, Frontinus, Nearchus, Apollonius, Pliny and Ptolemy—were extensively used in a number of studies. Cunningham's work (1871) has already been referred to; other notable contributions include Mc Crindle's studies (112, 1879; 113, 1882; 114, 1885; 115, 1926) on the geography of ancient India and Majumdar's commentary in his *Classical Accounts of India* (117, 1960). The value of Mc Crindle's work has been enhanced by the fact that he annotated the accounts on points related to geography and identified place names with their Sanskrit originals. Mc Crindle's work was later edited by Majumdar (118, 1927), who also provided detailed notes embodying later researches.

Árab geographical works on India have been similarly utilized by scholars in reconstructing the geography of early medieval India. These accounts of India came from a large number of Arab geographers, travellers, mariners and merchants—like Ibn Khurdadhbih, Ibn Haugal, Al-Masudi, Al-Maqdisi, Al-Biruni, Al-Idrisi, Abul Fida and Ibn Majid—who throw light on this otherwise little known Indian scene of the early medieval times. The geographical content of these accounts was extensively used by Ahmad (6, 1939; 7, 1947), Alavi (14, 1940; 17, 1950; 1951; 1952; 1954; 15, 1965; 16, 1966), Ahmad (8, 1953; 1954; 1955; 9, 1956-57; 10, 1955; 11, 1954), Ali (23, 1950) and Law (104, 1955). Later Ali (19, 1960) translated section II of M. Reinaud's work from the original French and enhanced the value of the work by adding annotations, comments and explanatory notes.

Classical Histories

Geographical material of immense value occurs in the Indian

classical histories. Some of the important works in this category which have been extensively utilized by scholars for reconstructing the geography of the past are *Rajatarangini, Chachnama, Tabaqat-i-Nasiri, Muntakhabat-ut-Tawarikh, Tarikh-i-Firoz Shahi, Tarikh-i-Rashidi, Akbarnama* and *Mirat-i-Ahmadi.* The geographical material in these works has been organized and made usable by the translators and editors and further utilized by those who referred to the geographical evidence contained therein to enrich and illustrate their studies on specific problems of historical geography. Notable among these contributions are those of Ali Ahmad and Lees on *Muntakhab-ut-Tawarikh* (3, 1864-69), Raverty on *Tabaqat-i-Nasiri* (143, 1970), Beveridge on *Akbarnama* (30, 1873-87), Blochmann (38, 1877), Jarrett (1891), D. C. Phillot (1927) and Sarkar (12, 1949) on *Ain-i-Akbari,* Stein (169, 1900) on *Rajatarangini,* Hasan (82, 1918) on *Khulasat-u-Tawarikh,* and Ali (18, 1927-28; 1930) on *Miraat-i-Ahmadi* and Ross (155, 1895) on *Tarikh-i-Rashidi.*

Another class of works constitutes the writings which have elaborate topographical details. Of them special mention may be made of *Haft Aqleem,* Abdul Latif's *Journey to Bengal* (1600-09) *Malumat-al Afaq, Safarnama-i-Mukhlis,* and *Chhahar Gulshan.* They have been critically examined by Ross, Harley and Haqqi (156, 1918; 1927; 1939) and Sarkar (103, 1928), besides being used by Irfan Habeeb in his *Agrarian System of Mughal India* (78, 1963) and Karimi in his urban-geographical study of Akbarnagar (99, 1970).

Dynastic Archives and Chronicles

Geographical material is available in a scattered manner in day-books, court histories, chronicles, biographies, genealogical rolls, correspondence and orders which were maintained or were issued by the various dynasties and their courtiers. The richness of *Akbarnama* as a source of geographical material has already been alluded to. Some other works of significance in this category, which have been utilized in geographical studies are *Babarnama, Tabaqat-i-Akbari* and *Tuzak-i-Jahangiri.* The commentaries and annotations on these texts, among others, by Beveridge (31, 1921; 1909-14) and Rogers (154, 1913; 1927; 1931) enhance their value as source material for researches on the Mughal period. Tod (179, 1829; 1832) used genealogical rolls of the Rathors furnished by Jain priests and preserved in the temple records, poetic histories and other bardic literature. They are rich in reference to the character of the tracts and of the peoples ruled by these royal lineages. Khan (83, 1939) has similarly utilized bardic literature for reconstructing the political geography

of the past as far as the territories of Jammu and Kashmir are concerned.

Revenue Records

For the late medieval period, Mughal documents on revenue and other agricultural statistics provide a vast treasure of useful information hitherto untraceable in Indian history for any period antecedent to the Mughals. Of these *Ain-i-Akbari* has been extensively used by economic historians such as Moreland (119, 1929) and Irfan Habeeb (78, 1963) whose works are important aids in research on the economic geography of Mughal India. Besides Irfan Habeeb's work was based on a number of contemporary sources such as *Ganj-i-Barawurd* of Amanullah Khan Husaini, *Mazhar-i-Shahjahani* of Yusuf Mirak (1634), *Char Chaman-i-Barhaman* of Rai Chandrabhan Brahman (C.1656) and a number of accountancy manuals and statistical tables of the seventeenth and eighteenth centuries, notably *Yad-dasht-i Mujmil-i-Jama* (C. 1646-7), *Dastur-ul-Amal-i-Alamgiri* (C. 1659), Nand Ram Kayastha's *Siaqnama* (1694-6) and Brij Rai's *Dastur-al Amal-i Shahanshahi* (C. 1727). Extensive information on land systems of Mughal India was also unearthed from the imperial *farmans, parwanas* and other papers related to the land grants to nobles and others issued by the various Mughal dynasties (79). Earlier Moreland had utilized historical sources of the early Muslim period in his *Agrarian System of Muslim India,* (119, 1929). Mention may be made here of new cartographic techniques evolved by Hasan, Raza and Hasan (1962) in plotting the *pargana, sarkar* and *suba* boundaries of the Mughal Empire. Raza (148-150) has presented a series of studies on the geographical interpretation of the administrative and revenue divisions of the Mughal Empire.

Military Campaigns

Narratives of the military campaigns of Alexander in the fourth century B.C. and of Timur, Babar and Akbar later in medieval times have been profitably used, among others by Cunningham (55, 1871), Raverty (140, 1892) and Qadri (97, 1947). Raza in the reconstructions of the geographical features in the works cited above has extensively used material from the military campaigns of Akbar.

Temple Records

Genealogical rolls maintained by royal priests contain rich geographical materials. Their use by Tod has already been referred to. Another study which called for theoretical initiative of a high order

was that of Chakravarti (46, 1916), who utilized the temple records of Puri to reconstruct the geography of Medieval Orissa.

Old Maps

Old maps contain enormous data so essential in all studies of the geography of the past. However, there exists no evidence of an indigenous tradition of map making in India, though classical literature otherwise contains much accurate geographical information. On the authority of Wilford (183, 1822) we come to know that crude maps prepared on the 'system of the Pauranics' did exist in the country—one of which Wilford himself had seen—but they lacked basic cartographic requirements, and, for reasons of obscurity, they may be conveniently described as diagrammatic representations of the Puranic knowledge of the then-known world.

Earliest maps of India were made by Greek geographers, particularly Eratosthenes who based them on the knowledge gathered during Alexander's campaign in the fourth century B.C. The later contributions include maps of Herodotus, Ptolemy and other Greek geographers. Ptolemy's map of India remained by far the most authentic till the late eighteenth century when it was replaced by refined maps with more accurate information based on trignometrical surveys and mariners' observations. For the middle ages Arab geographers and cartographers remain our only sources of information. Unfortunately Arabs were not good map-makers, and although, their knowledge of Indian geography was extensive, they did not leave behind good maps of the tracts known to them. Nevertheless, Ibn-e Haukal's diagrammatic sketch of Sind is notable for its geographical details.

Dutch and Italian maps, such as those made by Mercator and Vignola, contain valuable evidence on the geographical setting of India during the sixteenth and seventeenth centuries. With increasing involvement of the Europeans in India significant advance was registered in the preparation of maps of India. The maps of Delisle (1723) and Bourgingnon d' Anville (1737) were definite improvements as they were based on mariners' surveys and the observations of Jesuit missionaries respectively. D'Anville's *Carte de l'Indie* (1752) was remarkable as he had, 'hardly overlooked any possible source of information'. Later advances in knowledge continued to be incorporated in maps such as those of Jefferys (1768), Robert Orme (1778), Rennell (1782-93) and Thomas Call (1793-1807). They are valuable documents for the historical geographer as they not only show the progressive knowledge of the micro-geography of India, but also allow us a rare chance of looking into the

past distributions of some of the phenomena, such as forests and marshes, which have since then disappeared and have not been incorporated in the later maps.

On a regional basis Rennell's *Atlas of Bengal and Bihar* (1779-83), Wilford's earlier map of Upper Provinces (1800) and later of "the countries to the west of Delhi as far as Cabul and Multan" (1804), Kelley's *Atlas of South India* (1782), Colebrook's map of South Peninsula (1800) and Reynold's map of Western India are of immense historical value (132, 1945).

Studies of the Aspects of the Natural and Social Environment

It is quite natural that a significant number of studies made in India in the field of historical geography pertain to that borderline zone where it has inter-faces with other disciplines. Such studies have generally focussed attention on geomorphological, climatic and hydrographic change on the one hand and on the reconstruction of the population and economic and urban geographies of the past, on the other.

Geomorphological Change

The geomorphological change since the Pleistocene times has received attention in a number of studies. De Terra and Peterson (62, 1939) carried on extensive studies on the formation of *Karewas* in Kashmir and of terraces in the Soan Valley. In a later contribution, De Terra extended his study to analyse the processes of terrace formation in the Narmada valley. Other major contributions in this field have come from Blanford (37, 1876), Heron (84, 1938), Krishnan (102, 1952), Hora and Mathur (92, 1952), Pithawala (134, 1952) and Raychaudhuri and Sen (146, 1952) on the recent and sub-recent depositional and erosional features in the Indian Desert and the sub-Aravalli region; from Ali (22, 1941) and Siddiqi (162, 1944) on the Ghaggar Plain in Haryana and North Rajasthan; from Zeuner (185, 1950) on the Pleistocene depositional sequence in Gujarat; and from Foote (74, 1912) on the laterite gravels of Madras. In a recent contribution, Sen (158, 1968) has studied geographical and seismic evidence to reconstruct the Palaeogeography of the Calcutta Metropolitan district and its neighbourhood.

Climatic Change

Significant studies have been made on the peri- and post-glacial climatic change. Richards, Cammiade and Burkett (153, 1932) drafted

evidence on the climatic change in the entire south-east Asian region during the early Palaeolithic times. De Terra (61, 1936) attempted a similar study of the post-glacial climatic change in North-Western India. Among other contributions in this field may be mentioned those of Bose, Sen and Ray (41, 1951) on the Stone Age Climatic Change in Mayurbhanj; Banerji (27, 1952) on the climatic change in the Indian Desert; and of Deb (63, 1956) on the Palaeoclimatology of the Ganga delta.

Changes in River Courses

Keeping in view the crucial role that rivers have played in the socio-economic life of the Indian people, it is not surprising that studies in the changes of river courses have been at the centre of attention of historical geographers. A large number of such studies deal mainly with the changes in the courses of the North Indian rivers, especially those of the Indus system and of the region of the Indo-Gangetic divide. With this latter theme may be classed the long-drawn controversy of the 'lost' river of the Indian Desert, generally identified with the Saraswati of the Rigvedic hymns.

Before Oldham (128, 1874) made his major contribution to the Hakra controversy, notices of it had appeared in Tod's *Annals* (1829, 1832), Hodgson's *Report on the proposed Tehara Canal* (1847), Topographical Revenue Survey (1867), Bahawalpur Irrigation Survey (1869), Davidson's *Settlement Report of the Ludhiana District* and Cunningham's *Ancient Geography of India* (1871). Oldham cited historic and topographic evidence as well as local tradition on an extensive scale to show that the existing dry channel of the Hakra was the deserted bed of the Sutlej and that it was not a tributary to the Indus. Nearchus (127, 1875) controverted Oldham's arguments 'seriatim' discarding all the major contentions of the latter. Oldham (129, 1893), however, did not deviate from his earlier position and presented further evidence in support of his views. Raverty (141, 1892) expanded the scope of this debate to include changes in all the rivers of the Indus system which had altered their courses 'a hundred times over'. In his long paper Raverty quoted medieval historical works and chronicles to assert that Sutlej flowed into the Hakra as late as the thirteenth century, a point which was disputed in the light of the same historic evidence by Habeeb (80, 1954). Notably geographic treatment of the whole problem came from Khan (101, 1934), Ali (21, 1942) and Pithawalla (136, 1952). Of these, Ali's study was of immense significance as it rested primarily on physiographic evidence. Among other studies of the Hakra controversy may be mentioned Oldham (130, 1886), Raychaudhuri

(144, 1943), Siddiqi (163, 1944), Chhibber (51, 1949) and Ahmad (4, 1968).

No comparable work on the Ganga and its tributaries has, however, been so far attempted. The studies of Dey (65, 1921) and Dwivedi (72, 1958) are notable exceptions. In these studies the old course of the Ganga has been traced and the problem of the shifting of the confluence of the Ganga and Yamuna has been analysed. Sen (159, 1968) referred to some of the changes in recent history in the Brahmaputra, Tista, Kosi, Bhagirathi, Damodar, and the Adhwara rivers. Stein's (169, 1900) study of the change in the confluence of the Jhelum and its tributary—the Sindh—provides a good example of how historical and geographical evidence can be competently utilized to study hydrographic changes.

Ethnography

Systematic studies in the field of ethnography have been few, although ethnographic references are found in a number of studies not directly historico-geographical. Among the works exclusively devoted to ethnographic problems, a few studies may be mentioned. Chatterjee (48, 1952) described the six main races and the nine subtypes of Vedic India along with their movements which resulted in the synthesis of the Aryan and the non-Aryan cultures. Chaudhuri (50, 1955) attempted a general survey of the peoples and races of ancient India as deduced from the Puranic sources. Pszyluski (137, 1960) described in detail the two ancient peoples of the Punjab—the Udumbaras and the Salvas—with the help of the references in the ancient Indian texts and the Greek sources. Some other works of this category are those of Vidyabhusana (181, 1902) and Law (108, 1944) on the Lichavis, of Carnegy (43, 1876), on the Bhars of Oudh and Benares and of Smith (168, 1877) on the Bhars of Bundelkhand.

Migrations

Mukherji's study (121, 1961) of the migration of the Jats is by far the most useful one. Other studies include Chakladar's work on the Aryan colonization of Eastern India (44, 1962); Ahmad's Survey (5, 1965) of the migration of the Rathors from the Ganga Valley to Rajasthan; Mukherji's analysis of Santal migration (123, 1940) and Sher's work on the Sansis of the Punjab (161, 1965).

Population and Settlement Geography

Work done in the field of population and settlement geography

for any past period of Indian history is largely indirect and highly fragmentary. Population estimates for the Mughal period were made by Moreland (120, 1962). Tod estimated the populations of the various Rajput principalities in the early nineteenth century (180, 1829; 1832). Other notable contributions came from Acharya (2, 1946), Singh (165, 1955), Singh (164, 1965) and Tamaskar (176, 1968).

Economic Geography

A number of studies have been made depicting the many facets of Indian economic geography in various periods of history. Dutt (71, 1927), Nath (126, 1929), Apte (25, 1952), Shah (160, 1964), and Renou (152, 1959) made valuable studies of the economic set-up—particularly cropping patterns, agricultural practices and rural industries. Useful, though largely indirect, material is found in the works of Moreland and Irfan Habeeb on agriculture during the medieval period.

On industrial geography notable work has been done by Dikshitar (69, 1943) and Kadri (98, 1946).

Using the evidence of the Mughal chronicles and court histories, Kadri (97, 1947) reconstructed the main routes of Mughal India. Appadorai (24, 1931-32) described the trade and distribution of pepper on the Malabar Coast during the medieval times. Similar studies on the late medieval trade centres of South India were made by Natesan (125, 1932), Thomas (178, 1932), and Saletore (157, 1945). Stein's classic work on the Pir Pantsal route (170, 1895) continues to be a model for such studies.

Urban Geography

Besides Stuart Piggott's study (133, 1945) of a dozen ancient cities of India, and numerous references to the urban morphology and setting of the two pre-historic metropolises of the Indus Valley in archaeological literature, Raza presented a study (151, 1951) of urbanization in pre-historic India. For the historic period, important contributions were made by Campbell (42, 1866), Layard (111, 1953), Law (110, 1947 and 1948), Irvine (95, 1907; 94, 1909; 93, 1910), Hodivala (85, 1920; 91, 1920; 87, 1923; 88, 1923; 89, 1923; 90, 1923; and 86, 1929), Bhattasali (35, 1939 and 1941), Forrest (75, 1903), Rao (139, 1933), Alam (13, 1950), Naqvi (124, 1968) and Karimi (100, 1970).

Spatial Differentiation and the Regional Framework

An attempt has been made by a number of scholars to understand the nature of Indian regionalism through a study of the regional divisions of the country at different points of time. Pusalkar (1952) recognized early Aryan homelands in the *Saptasindhava* on the basis of the evidence contained in the Rigveda. Law (1932) made an attempt to identify, though with limited success, the spatial pattern of the *solasa mahajanapadas* of the sixth century B.C. The seventh century Buddhist principalities, as Hiuen Tsiang found them, depicted the prevailing political situation of the age. Cunningham (1871) attempted to place these principalities on the map by demarcating their extent and boundaries. Dey (1949) came out with a remarkable synthesis when he recognized the major structure lines of Indian historical geography visualized in the perspective of the relative permanence of boundaries throughout the course of history. Subbarao (1958) studied this problem in some depth, tracing the evolution of nuclear regions, and of areas of isolation and relative isolation from the Palaeolithic times to the emergence of the early political territorial units in the sixth century B. C. and onwards.

Besides such studies at regionalisation, historical geographies of different regions of the country have been studied by a number of scholars. The area most intensively covered by such studies is that of Bengal in particular and of the eastern territories in general. Blochmann's comprehensive work (38, 1873; 1874; 1875; 1877) may be considered to be the outstanding work on the historical geography of Bengal. Other significant contributions are those of Cortesao (53, 1945; 1946), Raverty (142, 1876), Ray Chaudhuri (147, 1951), Law (105, 1947), Chakravarti (45, 1908; 1909), Dey (60, 1910), Beames (29, 1884; 1885) and Beveridge (32, 1876). Of the adjacent territories, Anga and Champa were dealt with by Dey (59, 1914) and Law (106, 1925); Koch Bihar, Koch Haji and Assam by Blochmann (39, 1872); Chutia Nagpur, Pachet and Palaman by Blochmann (40, 1871) and Orissa by Chakravarti (47, 1916). Other regions of India have not been adequately covered by studies in Historical Geography. It may, however, be stated that Stein's work on Kashmir and the adjacent territories (169, 1900) have yet to be surpassed for its concern for exactitude. Some of the other regional studies for northern India are Pithawala's study of Sind (135, 1937) and Law's studies of Sarasvati (108, 1935), Rajagriha (108, 1938), Kausambi (108, 1939), Panchalas (108, 1942), Ujjayani (108, 1944) and Magadh (108, 1946).

For south India, studies have been made which show the extent and boundaries of the ancient and medieval kingdoms and attempt

to understand their expansion or contraction within the geographical framework. Notable among them are the contributions of Chettiar (49, 1930; 1932) on Kongonadu and Pandyan, Rangacharya (138, 1928) on Tamilham, S. S. Desikar (64, 1929) on Tondiamandalam, and Baidyanathan (26, 1950) on Puli-Nadu. On historical geography with a definite regional bias two studies worthy of mention are those of Dave (58, 1937) on the Cauvery delta and Joshi (96, 1956) on the Heptanasia or the Seven Bombay islands.

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IV

Human Geography

12

Population Geography

A Trend Report

By

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SYSTEMATIC POPULATION geography is one of the youngest branches of geography. Though a number of population studies had been published before 1953, they mostly related to distribution, density and growth, to the complete neglect of other characteristics. In that year, Trewartha (84, 1953) pleaded for the development of population geography and its consideration as an equal of other branches of systematic geography. He was also the first, at least in the English speaking world, to offer a graduate course on population geography in 1954 and to initiate research students into this field. By now a significant growth of literature in this branch of geography has taken place, as is evident from the *Bibliographic Guide to Population Geography* compiled by Zelinsky (90, 1962), and subsequent articles and books.

Population geography studies man in all his aspects as an area-characterising and area-differentiating element. In demography, which also studies population, the focus of attention is on measuring/determining the rates and trends of various population characteristics. Population geography thus avoids duplication of what is done in demography, despite overlapping in objects of study.

Population Geography in India

Probably, the first systematic research conducted in population geography of an important region of India was for the doctoral dissertation of this author on *A Geographical Analysis of India's Population* at the University of Wisconsin under the guidance of Trewartha (28, 1956). It studies all the significant aspects of population such as distribution, growth, migration, sex-ratio, literacy, occupational structure, urbanization, etc. for the country as a whole.

Following his approach, Krishan wrote his doctoral thesis (46, 1968) on 'Changes in the Demographic Character of the Punjab's Border Districts of Amritsar and Gurdaspur: 1951-61'. This work is based on maps prepared from data by individual villages, and is a very detailed study. In terms of thematic mapping and analysis at local levels, this study is the first of its kind in India. A similar doctoral research work has been successfully completed by Chandna (13, 1969) on Haryana's districts bordering on the Union Territory of Delhi, and by Mehta (58, 1970) on Bist Doab in Punjab.

Nonetheless, the contribution of Indian geographers to population geography remains small. Post-graduate courses on population geography, though with varying contents, are now taught in many geography departments in the country and the Department of Geography at the Punjab University has become a centre of research in population geography.

It is true that a number of articles on population, dealing mainly with distribution, density and growth have appeared in Indian journals. But there has been a conspicuous lack of geographic studies on other aspects of population such as vital rates, migration, sex-ratio, literacy, religious composition, occupational structure, urbanization, etc. However, a comprehensive review of population geography will need an examination of the following aspects of population:

(1) Distribution and density;
(2) Growth and migration;
(3) Sex composition;
(4) Literacy;
(5) Occupational structure;
(6) Religious composition;
(7) Urbanization; and
(8) Comprehensive area studies.

Distribution and Density

The most exhaustive account of distribution of population in India is available from the population sheets (41, 1959) published by the National Atlas Organization under the direction of Professor S. P. Chatterji. These sheets are on 1:1,000,000 scale and depict (i) physical background and administrative boundaries in light shades, (ii) distribution of rural population (1951 census data) by villages in terms of their size and dominance of agricultural/non-agricultural population and (iii) distribution of individual urban places by their size and functions. The backside of these sheets provide very useful description on the distribution of population in the area covered by each. There is hardly any area of comparable popu-

lation and size in the world where population distribution has been mapped in so great a detail as in these sheets. It was on this basis that Chatterji (16, 1962) described in detail the distribution of rural and urban populations in the country's seven macro-regions. He examined the role of physical factors, the great age of India as a human habitat, and political events in introducing regional variations in population distribution. Ahmed (3, 1941) had earlier studied the influence of physical and cultural environments on the distribution of population in India as a whole. There are several published articles concerning the distribution and density of population in individual states, geographic regions, and districts. Among these, mention may be made of Kuriyan on Kerala (51, 1938), Verma on Punjab (86, 1956), Prasad on Bihar (65, 1956), Anantapadmanabhan on Madras (4, 1957), Chatterjee on West Bengal (15, 1961)) and Krishan on Orissa (47, 1968). Nitya Nanda published a study on 'Distribution and Spatial Arrangement of Rural Population in East Rajasthan' in which, in addition to distribution, he also discusses arithmetic, physiological, agricultural and nutritional densities (62, 1966).

Among the regional studies relating to distribution and density of population, mention may be made of the valuable study of Bose on Damodar Basin (10, 1952; 11, 1946), Bhat on Upper Panchaganga Basin (9, 1953), Singh on the Umland of Banaras (76, 1956), Kayastha on Himalayan Beas Basin (45, 1956), Padhye on Melghat (63, 1961), and Arunachalam and Mathure on Ulhas Basin (5, 1961).

Population studies on individual districts were somewhat popular with Madras University during the thirties. A work of this nature for Coimbatore district by Krishnaswami (49, 1930) deserves mention. More recently, several detailed population studies of individual districts, based on village data, have been conducted in the Punjab University. Almost all the districts of Punjab and Haryana have been covered in terms of their population characteristics (and changes therein during 1951-61) in dissertations for the Master's degree in Geography.

It will thus be seen that, despite the availability of very detailed data (even by villages), several regions and local areas still remain unstudied in respect of patterns of distribution and density of population. Even in the studies that have been carried out at different levels, the emphasis on physical factors in explaining the distributional pattern of population is beyond proportion. Moreover, population distribution has rarely been studied with reference to size and spacing of settlements, and densities, other than arithmetic, have seldom been mentioned.

Growth

The process of population growth in India, particularly during its census history, has attracted the attention of several scholars. Davis (19, 1951) rendered a thorough analysis of the history of accelerating rate of population growth in the Indian subcontinent. His work, however, lacked strict geographical orientation. Before him, Geddes (25, 1942; 26, 1953) had dealt with the theme of variability in the rate of population growth in India from decade to decade. Later on he, in collaboration with Learmonth (26, 1953), discussed the regional variations in variability in population change in India. The spatial patterns of population change in India during 1891-1951 were given geographic treatment by Trewartha and the author (85, 1957). For regional aspects of population growth during 1951-61, this author conducted another study (33, 1962). Through a comparative study of maps, it brings out the inverse correlation between density and growth of population. A similar study for the same period has been conducted by Bhat (7, 1961).

Apart from the above studies covering the whole of India, certain geographers have analysed the trends in population growth in some of the states. Singh (77, 1947) published a paper on this subject relating to Uttar Pradesh and noted the influence of physical phenomena on the distribution and growth of population in the state. Population growth in Orissa was analysed by Sinha (80, 1958) who later assessed the impact of increase in population on the economy of that state (79, 1963). An elaborate study of the pattern of population growth in Punjab during 1951-61 was made by this author and Ojha (39, 1964). In a subsequent study on 'Redistribution of Population in Punjab', this author (32, 1967) has pointed out that the demographic dynamism of Punjab during 1951-61 is not only reflected in the phenomenally high rate of its population growth, but also in the sizable movement of its people to other states of India and foreign lands and considerable amount of redistribution of population within the state. Such studies for other parts of India are obviously needed.

Some research publications on population growth for areas smaller than a state are also available. In this category, Chatterjee and Ganguli's study of Nadia and Tirunelveli districts (17, 1943), Ramachandran's study of Malnad, (66, 1965) and Krishan's study of the border districts of Amritsar and Gurdaspur (48, 1968) are noteworthy.

The accelerating rate of population increase in India during recent decades has alarmed many geographers with regard to population *vis-a-vis* food supply in our country. Raza (67, 1950) posed a question: "Is India overpopulated?" The same question was

repeated by Kuriyan (50, 1968) who stresses that there is a terrible imbalance between excessive numbers of people on the one hand and shortage of resources on the other. Spate (82, 1956) had earlier concluded that India is overpopulated considering its food situation. Mitra (61, 1965) also reviewed the position of India with respect to its population and food supply. Yunus (88, 1941) examined the problem of growing population in relation to production of food in Uttar Pradesh.

There is an almost complete absence of studies on the regional pattern of birth and death rates. Learmonth (55 1952) and Gosal (27, 1959) have inquired into the regional differences in fertility and mortality in India and given a broad analysis of trends. Similarly, very little work has been done on migration by geographers. Zachariah (89, 1964) investigated the problem of internal migration in the Indian subcontinent during 1901-31, but his analysis lacks regional approach. A detailed geographic analysis of internal migration in India (using 1951 census data by districts) by this author (29, 1961) is probably the only attempt in this potential area of research. Based on a detailed map and allied data, he identifies areas of in-migration, out-migration, little in-or-out-migration and discusses the causal factors associated with the varying trends of mobility in different parts of the country. Earlier, Dayal (20, 1959) had examined some aspects of population growth and rural-urban migration. The phenomenon of in-migration to Indian cities was also examined by Lall (53, 1961). Sengupta (72, 1951) traced the pattern of in-migration to the Assam Valley, and Ahmad (1, 1961) differentiated between the migrational patterns operating in Ganga Plain and Chota Nagpur Plateau in Bihar.

The preceding review reveals that problems relating to (i) impact of population growth on economic and social resources in different parts of India, (ii) regional variations in birth and death rates, (iii) migrational trends at regional and local levels deserve serious attention from scholars in geography who, with their tools of mapping and spatial analysis, can make a contribution of their own.

Sex Composition

There are only a few articles on this aspect of population. The present author's attempt (35, 1961) to analyse the regionalisation of sex composition of India's population as in 1951 was the first in this direction. With the help of a detailed map, he brought to light wide regional contrasts in sex ratio, and examined the factors associated with these variations. A similar pattern of sex-ratio in India's population, as in 1961, was observed by Sen (70, 1963). An

elaborate discussion on regional variations in changes in sex-ratio during 1901-61 in the population of India and Pakistan was made by Visaria (87, 1967). A similar study, but of a highly generalised nature, was conducted by Desai (21, 1967).

A few articles on sex composition of urban places have also appeared in geographical journals in India. Lall (52, 1962) made a study of age and sex structure of Indian cities. Sen (69, 1963) investigated the sex-ratio patterns of class III urban places (population 20,000 to 50,000) in India, and Sharma (73, 1966) examined the various factors responsible for differences in sex-ratio of urban places in Rajasthan.

Studies on age-structure, particularly by geographers, are conspicuous by their absence. This is a serious gap.

Literacy and Education

This author (30, 1964) made an interpretative study of literacy in India in which he discussed the regional variations in literacy, mentioning a variety of factors with which these variations are associated. Later, in his presidential address to the Indian Council of Geographers, he (34, 1967) analysed the regional aspects of rural literacy in India. The only other study of areal patterns of literacy in India is by Tirath (83, 1966). There is thus a strong case for geographic research on (i) progress of literacy, (ii) differentials in literacy by residence (rural-urban), sex, religion, caste, occupation and age, (iii) attitude of various population groups towards education, and (iv) impact of recent growth of literacy on the political and socio-economic aspects of the life of the people. Needless to say, the spatial perspective should be emphasised in all such studies.

Working Force and Occupational Structure

The present author wrote an article on the occupational structure of India's rural population (31, 1958). Based on what emerges on a map showing the proportion of non-agricultural population to total population, he focussed attention on areal variations in the occupational structure of rural population. Mitra (60, 1967) investigated the changes in occupational structure of our population during 1951-61 and noted some shift from agricultural to non-agricultural activities. The only article on the regional pattern of female working force in rural India comes from Mehta (57, 1967). Similarly, Chandna (14, 1967) conducted a study of Punjab's rural female working force. The occupational structure of rural population in Punjab

had earlier been studied by this author and Krishan (40, 1965).

The number of articles listed in the present section shows that little work has been done on the working force and its occupational structure in India. Intensive studies are therefore, needed on: (i) changing pattern of occupational structure of India, (ii) extent of unemployment among both educated and uneducated persons in different parts of the country, and (iii) future supply of labour and availability of employment opportunities at national, regional and local levels.

Religious Composition

Geographic work on religious composition of India's population is negligible. Ahmad (2, 1944) described the communal pattern in general and pleaded for separate rights for different communities. However, it was Brush (12, 1949) who made a detailed geographic study of religious communities in India on the basis of 1941 data. Davis (19, 1951) emphasised the importance of caste and religion in the life of the Indian people, and devoted two chapters of his book to the demography of caste and religion in our country. His analysis is also based on 1941 census data. More recently, the present author and Mukerji (38, 1970) looked into the spatial pattern of religious composition of our population as existing in 1961. The present author (36, 1965) had earlier observed significant changes in the religious composition of Punjab during 1951-61.

Schwartzberg (68, 1965) noted the role of caste in Indian rural society, and analysed the distribution of some selected castes such as Brahmans, Rajputs, Jats, Kurmis, Lodhs, Ahirs, Sheikhs, Chamars, Pasis and Nais in the North Indian Plain. He concluded that their distribution is not random but is related to specific facts of history and to the distinctive role played by caste in the total socio-economic system.

The few research publications on religious composition of our population are thus largely confined to a description of the distribution of various religious groups. The available data on a number of attributes of scheduled castes have not been made use of by Indian geographers. There is, at present, no geographic study of the scheduled castes, notwithstanding its great practical importance for planning.

Urbanization

There is little research material on urbanization in India as a

whole. No doubt, Davis (19, 1951) devoted two chapters to urbanization in his book, and Lall (54, 1968) made some comments on the same theme. But their studies were of a general nature. There are some research articles on urbanization in certain states/regions of India. Dutt (22, 1956) described the process of urbanization in Bengal, while Kar (44, 1962) concentrated on the pattern of urban growth in lower West Bengal. Urbanization in the Punjab plain was studied by Jauhri (43, 1957) and later by Chawla (18, 1958). More recently, the present author (37, 1966) made an elaborate analysis of urbanization in Punjab from 1881 to 1961. Spatial variations in degree of urbanization in Madhya Pradesh were examined by Mehrotra (56, 1961). Singh (78, 1967) described the distribution and character of cities of the Ganga plain, while Sinha (81, 1968) traced the growth of towns along the Ganga in Bihar during 1901-61. Some aspects of urbanization in Uttar Pradesh were discussed by Ganguli (23, 1963) while Singh (75, 1967) made a detailed analysis of the trends in urbanization during 1960-61 in the same state. A comparative study of population characteristics of towns belonging to different functional groups in Gujarat was attempted by Janaki (42, 1966). The towns in Mysore were studied in detail by Prakasa Rao (64, 1964).

A detailed study of urbanization in India, from the earliest census year to the latest is a potential field for future research. Equally important are the other attributes of urban population such as sex-ratio, literacy, and occupational structure.

Comprehensive Area Studies

A recent contribution of the Indian Census (1961) has been the publication of census atlases of states and one of India as a whole. However, geographic studies covering all the significant population attributes of any area are very few. The present author's *A Geographical Analysis of India's Population* (28, 1956) is an attempt in this direction. The doctoral theses, one by Krishan (46, 1968) and the other by Chandna (13, 1969), on small areas in the Punjab Plain, based on data by villages, represent similar comprehensive area-studies. The population characteristics of Andamans have been described by Sen (71, 1959), of Nagaland by Singh (74, 1965), and of Rarh Plain of Murshidabad by Banerjee and Ray (6, 1967). Mehta (59, 1969) contributed an article on the demographic character of Himalaya, west of Nepal.

Bhat (8, 1961) has advocated the case for population studies in India on macro, meso and micro levels. Such studies, if carried out with regional approach, will be of great help in the task of planning.

Conclusions and Suggestions

The following are the potential areas of research in India's population geography:

(1) Distribution of population with special reference to size and spacing of settlements;
(2) Regional aspects of population pressure on physical and social resources;
(3) Spatial analysis of birth and death rates; and attitude of different population groups to family planning and areal variations therein;
(4) Migrational patterns at national, regional and local levels, identifying areas suffering from population pressure and others which are endowed with economic potentialities;
(5) Areal study of age structure in relation to future growth of population, and patterns of employment;
(6) Impact of the growth of literacy and education on the political and socio-economic conditions of different areas of India;
(7) Regional analysis of changes in the occupational structure of the working population with special emphasis upon diversification of rural economy;
(8) Comprehensive study of urbanization since the earliest census year;
(9) Population characteristics of scheduled castes and scheduled tribes;
(10) Detailed studies on the population geography of small areas in different states (using village data); and
(11) Studies of border areas of various linguistic states with regard to their population characteristics and changes therein (using village data).

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13

Geography Of Rural Settlements

A Trend Report

By

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SETTLEMENT GEOGRAPHY is concerned with the spatial variations in the processes of settling and their manifestations on the earth's surface. It is the spatial variations in settlements, their various attributes and the co-variations of spatial correlates that comprise the basic theme of settlement geography. Since 'settlement' in any area is intimately related to the 'habitat, habit, and inhabitant', the understanding of all these phenomena is fundamental to the study of settlement geography.

The geography of rural settlements is a sub-field of settlement geography which deals with urban as well as rural settlements.

Although the study of rural settlements has immense significance for a country like India, this branch of geography has received only limited academic attention. Out of 1,854 research papers listed in *Progress of Geography in India* (Indian Science Congress Association, 1964 and 1968) only 49 deal with rural settlements.

This review purports to take stock of the entire work done in the geography of rural settlements in India. Its purpose is to (a) assess what has been accomplished by Indian geographers in their study of rural settlements, and (b) to point out potential areas for future research in this branch of the subject. It covers the following aspects of the problem:

(1) Programmatic statements and methodology;
(2) Evolutionary studies;
(3) Morphological studies;
(4) Tribal and caste settlements;
(5) Functional studies;
(6) Studies on house types;

(7) Studies on field systems and field patterns;
(8) Studies on cultural landscape; and
(9) Studies on place-names.

Programmatic Statements and Methodology

A perusal of Indian geographic literature on rural settlements reveals that there are only three research papers which deal with the methodology of this branch of geography. Subramanyam (95, 1926) used the title 'rural geography' and, among other topics to be included in its fold, he specified those on nomenclature, origin, situation and plan of the village. Ahmad (3, 1953) put forward a detailed outline for a comprehensive study of a village and pleaded for the study of settlement types and their areal differentiation. Singh (83, 1961), in one of the few programmatic statements, reiterated the concepts of settlement geography, enunciated earlier in Europe and North America.

For a proper development of settlement geography in future, it is necessary to evolve a body of logically sound and reasonably workable concepts for the study of rural settlements.

Evolutionary Studies

One of the primary interests of geographers is to trace the processes by which rural settlements originate and undergo change under the impact of different factors. In one of his early papers, Singh (84, 1957) traced the evolution of rural settlements in the Middle Ganga Valley through various periods of Indian history; and Singh (79, 1968) examined the territorial basis of medieval town and village settlement in Eastern Uttar Pradesh. Both these detailed articles emphasize the role of clan territories in influencing the settlement geography of the areas under study. Besides, Dixit (24, 1969) examined the evolution of rural settlements in the Dun Valley of Uttar Pradesh.

Through a probe into the history of land settlement in parts of Faizabad district, Singh (87, 1965) reconstructed the evolution of settlements in the area from the thirteenth century to the present day. Similarly, Singh (80, 1965) described the landscape created by different culture groups in the Varanasi district during the pre-Rajput period. The same author (81, 1965) reviewed the studies on settlements and place names as a part of historical geography.

Mukherji (56, 1964) speculated on the succession of cultural landscapes in Telengana villages on the basis of epigraphic, folk-lore, historical, and archaeological evidences. In his paper on rural set-

tlements in the Jatakas, he (53, 1969) described and interpreted the data provided by these genera of Buddhist literature. The settlements of the Jataka period had earlier been described by Tamaskar (97, 1967/68).

The theme of ruined settlements is present in Singh's (85, 1962) study of Ganga-Ghaghara Doab West. Padhye (66, 1965) discussed the phenomenon of desertion of villages in the Deccan Trap Region of Vidarbha. Taking four typical examples of settlements in the Ajay-Barakar Basin, Lahiri (36, 1950) envisaged the cycle of growth of settlements through successive stages of youth, maturity and old age.

There is a strong case for carrying out more geographical studies relating to the evolution of rural settlements covering the different areas of India. A comparative examination of these studies would further an understanding of the geography of the country.

Morphological Studies

Rural settlements develop distinct morphological features in the context of their life history. These features have interested many geographers who study the type, form, internal pattern, architectural style, etc. of rural settlements. Ahmed (2, 1952) deserves special mention for his classic work on rural settlements in Uttar Pradesh. It is a pioneer geographical study and the first of its kind. For India as a whole, the studies of Buschmann (14, 1954) and Bose (13, 1961) are noteworthy. Both provide a regional interpretation with the help of maps and photographs. Earlier Spate and Deshpande (92, 1952) had given a panoramic view of the whole country in their paper on the 'Indian village' in which the authors highlighted the castewise segregation in the internal morphology of Indian villages. Ahmad (1, 1962) also put forward some generalizations on Indian village patterns. On the basis of sample studies, Learmonth and Learmonth (37, 1965) described the characteristics of villages in different parts of India.

Among the morphological interpretations of rural settlements in different states of the country, special mention may be made, apart from E. Ahmad's work on Uttar Pradesh, of the analysis of dispersed types of rural settlements in Kerala made by Janaki (29, 1953). Misra (38, 1965) identified two types of rural settlements, clustered and scattered, in Himachal Pradesh, and Sen (75, 1966) noted the spatial variations in settlement types in Rajasthan. Using his own formula, Mukerji (54, 1969; 55, 1970) examined the areal differences in the spacing of rural settlements in Andhra Pradesh and Rajasthan.

Some papers deal with rural settlements of regions smaller than

states. These include: Deshpande (22, 1942) on Bombay Karnatak; Anas (4, 1954) on the Sub-Himalayan Range; Bhattacharya and Verma (9, 1957) on Son Valley in Madhya Pradesh; Kanaujia (31, 1958) on the Terai Region of Uttar Pradesh; Kaushic (33, 1959; 32, 1962) on Jaunsar Himalaya and Garhwal Himalaya; Nityanand (62, 1960; 61, 1961) on East Rajasthan; Kayastha (34, 1961) on Western Rajasthan; Chatterji and Das (15, 1964) on Puri Chilka Coastal Tract; and Prasad (70, 1966) on Chotanagpur Plateau. All these papers discuss the rural settlement types and forms as revealed on Survey of India 1" : 1 Mile topographical sheets and maintain a regional perspective. Among the explanatory factors, however, physical features have been over-emphasized at the cost of cultural and historical factors.

A few scholars examined the rural settlements of individual districts: Vishwanath (102, 1956) discussed the rural settlements of Tanjore district; Sen and Guha (76, 1960) of Bankura; Duggal (26, 1961) of Moradabad; Bhattacharya (10, 1966; 11, 1967) of Murshidabad; and Ayyar (5, 1969) of Jabalpore. These papers described the regional pattern of settlements as emerging on maps, and provide useful material for understanding the geography of respective districts.

Some papers, concerned with holistic socio-economic surveys of individual villages, provide details regarding the type, form and plans of rural settlements. Nirmala (59, 1960) described the settlement pattern of village Vittalam in Chittoor district; Ramachandran (71, 1960) of village Mahammadapuram in North Arcot district; Thiru (99, 1960) of village Nolambur; and Devi (23, 1962) of village Edakkad. There is a distinct anthropological and sociological bias in these papers.

The preceding review brings out that, in spite of a wide regional variety of rural settlement types, forms and patterns in the country, only a few areas have been studied. What is required is a comprehensive description and interpretation of form and structure of rural settlements in different parts of the country.

Tribal and Caste Settlements

In recent years, a number of geographers have evinced keen interest in the morphology of tribal and caste settlements. Mention may be made of papers on the Badagas by Pillai (69, 1937); the Todas by Sundaram (96, 1943); the Bhils by Srivastava (93, 1946); the Hos by Sinha (90, 1950); the Hindu Jats by Mukerji (48, 1957; 47, 1959); the Nats by Tikka (100, 1959); the Korkus by Padhya (68, 1962); and the Birhors by Guha (28, 1966). These studies are

based on documentary literature and field observations and deal with the type, site, form and distributional pattern of settlements of specific tribes and castes. Besides, Bhattacharya (8, 1956) examined the role of caste and tribal factors in influencing the morphology of rural settlements in Uttar Pradesh.

Detailed studies dealing with settlements of different tribes, cultures and economies have great scope in our country. Such studies, illustrated with suitable sketches and photographs, will make a useful contribution to regional studies in geography.

Functional Studies

Some rural settlements also function as central places for their surrounding areas. This aspect of geography of rural settlement has, however, remained neglected as morphological studies have been dominating the efforts of settlement geographers so far. It is only recently that some attention has been given to functional aspects of rural settlements. Singh (86, 1955) suggested that rural central places have a definite life history and these pass through various stages of evolution. Singh (78, 1966) described and analysed the spatial pattern of central places in the Middle Ganga Valley using a centrality index. Lahiri (35, 1967) recommended the dispersal of services from large cities and towns and their re-location in the surrounding villages. Much more directly geographical is the paper on "Rural Service Centres in Hooghly District" by Guha (27, 1967). Jayaswal (30, 1962) examined the morphological and functional attributes of Sachendi, a rural service centre in Kanpur district.

It will thus be seen that only a few rural service centres have been studied. The number of papers on spatial pattern of these places is also small. Proper criteria for identification of service villages and for determining their rank in hierarchy should also be evolved.

Studies on House Types

The first paper on house types was published by Subramanyam (94, 1938). He dealt with four main house types in South India. A long time after, Singh (84, 1957) brought out a geographical study of house types in the Middle Ganga Valley in eastern Uttar Pradesh. Sharma (77, 1960) made a study of house types in western Rajasthan, and Singh (88, 1965) of those in village Kurali of Meerut district. In his paper on rural housing in north Mysore plateau, Sinha (89, 1965) identified a house type with roofs of ridge type. Dikshit (25, 1965) provided a description of rural house types in Dehra Dun Valley, and Tewari (98, 1966) of those in Jaunsar Himalaya. In

his study of human dwellings in Sonpar region, Mishra (39, 1969) demonstrated the application of geographical methods in the analysis of house types. Besides, most of the articles on morphology of rural settlements, reviewed before, devote a part of their discussion to house types.

There are some papers on house types of particular rural communities or small rural areas. In all of these, the main concern is with a single house-type, as in the papers by Mukerji (52, 1962; 40, 1962; 46, 1962; 50, 1967) on Bhawanti House type in Andhra Pradesh, Jat House Types in the Upper Ganga Jamuna Doab, and Muslim house-types in the Meerut rural areas. Likewise, Vidyanath (101, 1962) described the circular house-type found in the Kolleru Lake Islands (between Godavari and Krishna deltas); and Noble (65, 1966) discussed the dwellings and temples of Todas. Another theme of comparative studies is illustrated in a paper on "Comparative Morphogenetic study of Jat and Saini House Types" by Mukerji (41, 1965).

Spate's book on India and Pakistan (91, 1967) furnishes considerable material on house-types scattered through different regional chapters. He has pointedly argued that the 'geography of the house' often reflects age-old religious and other traditions, and that the social factors are no less important than environmental. Of far-reaching significance is the attempt of Noble (64, 1969) to synthesize the material on the empirical attributes and genesis of traditional house-types of India.

Thus, two types of studies can be identified in the scholarly efforts focusing on the house-types: comparative-regional, and individual-regional. The former type uses a distributional method and reveals a heavy bias towards the environmental factors and the immediate economic conditions, while the latter uses culture-historical morphogenetic method and purports to establish the house-type as a part of the character of the area. It is, therefore, recommended that future efforts should be directed towards identification of morpho-functional types of houses and their regional distribution. It is equally essential to fit house types in the total character of areas. Recent changes in house types should also be given due attention.

Studies on Field Systems and Field Patterns

In addition to house types, field systems and field patterns have been recognised as another important element of rural settlement. Unfortunately, the number of research papers on this vital subject is very small. Mukerji (45, 1961) rendered a geographical analysis of the field patterns of Jat villages in the Upper Ganga-Yamuna

Doab. He (44, 1962; 49, 1963) conducted similar studies for a Reddi Village in Telangana and a Bhil Village in Mewar. A paper by Nitz (63, 1966) made a comparative study of the field patterns of Northern India and Germany.

The four papers mentioned above are representative of small regions of India. An enormous variety of field patterns remain to be studied, not only in terms of their regional characteristics, empirical attributes, origins and evolution, but also with regard to their role in cropping patterns, irrigation and farming practices, rural roads, and complex fabrics of rural social structure. Particularly useful would be the analysis of field patterns in relation to economic and social components.

Studies on Cultural Landscape

Geographers have given scant attention to cultural landscapes. Mukerji (42, 1963) described the cultural geography of wells in Telengana Reddi villages. This is one of the few papers dealing with irrigation landscape, employing cultural-geographical approach. Later, he (43, 1964) conducted a morphogenetic study of the cultural landscape of a Telengana Reddi village. Studies of cultural landscapes of sample villages in different regions of India are recommended for furthering an understanding of the regional geography of the country. Changes, rather than static existing pictures, need to be emphasized.

Studies on Place Names

Many research papers on this theme were published in the *Journal of the Madras Geographical Association* during 1930-40. Mention may be made of studies of place names in Coimbatore and Tanjore districts by Natesan (57, 1930; 58, 1937); in Pandinad by Bharati (7, 1932); in Anantpur by Rao (72, 1935); in Salem, Tanjore, South Kanara, and North Arcot by Chettiar (19, 1938; 17, 1936; 20, 1937; 18, 1938; 16, 1943); in Tanjore by Sastri (74, 1937); and in Tinnevelly by Ayyar (6, 1940). All these papers follow the same pattern and are contributions more to linguistics than to geography. They are essentially concerned with etymological analysis of suffixes.

In his paper on the nomenclature of Jat villages in the Upper Ganga-Yamuna Doab, Mukerji (51, 1956) discovered six principal factors—physical, economic, historical, religious, ethnical, and mythological, on which the naming of these villages is based. The studies by Datta (21, 1957) and Padhya (67, 1967) also deal with the distributional patterns of place names.

A work by a reputed scholar which deserves wide notice and study is that of Sankalia (73, 1949). In this work, the etymological derivations of the suffixes have been plotted on a large number of maps. A major contribution is on the territorial limits of historical administrative areas and of cultural regions.

Almost all the papers mentioned above are studies on place-names and not so much on the geography of place-names. Their main use lies in the wealth of information they provide about the regions. From such information, the geography of place-names can be worked out. It must be emphasised that etymological derivation of the suffixes is only the first step and the final goal must be its regionalisation. It is therefore, recommended that the generic suffixes be systematically plotted on separate maps and that these maps be correlated with others showing cultural, physical, and historical elements. Regions based on the dominance of particular suffixes be delineated and finally integrated with cultural and composite geographical regions. Moreover, data regarding the regional character, existing as well as the past, should be extracted from the suffixes, described and interpreted, either singly or in combination.

Recommendations

The geography of rural settlements is still considerably underdeveloped in India. This is true both with regard to content and quality of analysis.

There appears to be free adoption of ideas, in several cases even without acknowledgement, to the original sources, from general works such as those by Blache, Brunhes, and Houston which relate mainly to Europe. One should be cautious in doing so because the European background is very different from that of India. The rural settlements in India should not be studied to fit hypotheses developed in the West.

Among the various types of studies on rural settlements in India, those relating to morphology have easily been the most numerous. It is only in recent years that functional studies have started appearing.

In explaining the various attributes of rural settlements and in describing and classifying them, physical factors have received far greater, and in many cases, exclusive attention. Only a few papers reflect due awareness of the role of the historical factors underlying the existing attributes and distributional pattern of rural settlements.

Not many papers are based on well executed maps and diagrams. In many cases, the scale of the maps is too small to help a proper reading and interpretation.

The terminology used in the description and explanation of the rural settlements and its constituent features is generally that evolved in Europe. There is a need to coin terms which are relevant to the Indian context.

It is recommended that:

(1) Rural settlements, their features and attributes, should be studied systematically and their classification should be based on empirical and mappable attributes.

(2) As rural settlements are cultural artifacts, it is necessary to evaluate the respective roles of physical and cultural factors objectively. In India, rural settlements have a history behind them. Due consideration should, therefore, be given to the relevant historical lineaments also.

(3) Several of the important attributes of rural settlements are qualitative. These can, therefore, be identified, listed, and explained only through properly organised field observations. For quantitative parameters, the census volumes provide a wealth of data all of which should be utilised.

(4) Large-scale topographical sheets of various years may be compared to identify, map, and explain the changes in the rural settlements.

(5) A series of faithful, descriptive, regional studies of the various attributes of rural settlements and their complexes based on maps, photographs, and sketches, and data gathered from field observation and published and unpublished literature from a wide range of sources are the obvious need of the day. Regional variations in rural settlements and their integration with other phenomena should receive immediate attention. As rural settlements are a part of the character of an area, a critical study should be made of the extent to which and the manner in which they contribute to the characterisation of different areas.

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14
Urban Geography

A Trend Report

By

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Introduction

URBAN GEOGRAPHY is the geographic study of urban places which evolve, grow and exist as service centres, largely for their surrounding areas.

There are four main schools in the study of urban geography (107, 1954). The first is concerned with urban places as individual settlements, focussing attention on their setting, ecological growth, internal structure, external relations and comparative aspects. The second approaches urban places as distinct phenomena in themselves which has such attributes as distribution, size or growth and studies such problems as the process of urbanisation, size and spacing of urban places, or rural-urban fringe. The third views urban places as economic phenomena and is primarily interested in the economic base and functional classification of these places. The fourth devotes its attention to the problems of planning with special reference to urban land-use, transportation, and public utilities. Many geographers rightly attempt to combine all these approaches.

Growth and Status of Urban Geography

It was only after the publication of Singh's (154, 1955) book on Banaras that this field received due attention from Indian geographers. Following his pattern and approach, a number of scholars wrote doctoral dissertations on the urban geography of individual cities and towns. Such studies were facilitated partly because of the ease with which local field work could be carried out and partly

because of the availability of rich material on urban places in the municipal records or district, state and Imperial Gazetteers.

Another factor which stimulated the interest of Indian geographers in urban geography was the rapid growth of urban areas in our country in recent years which has given rise to a number of problems, particularly those related to housing, water supply and sanitary conditions. Such a bias is evident among urban geographers at Calcutta who had the benefit of collaborating with Calcutta Metropolitan Planning Organisation and were seized of the problems posed by the Calcutta Conurbation. In this context, special mention may be made of the work done by Kar (87, 1959).

Varanasi and Calcutta have thus been the two main centres of research in urban geography in India. The former specialised in historical, morphological and functional geography of individual cities, while the latter concentrated on urbanisation and the problems arising from urban growth. For an objective assessment, however, it is necessary to review the entire research work in urban geography in India in terms of the different schools of thought referred to earlier.

I. Urban Places and Individual Settlements

1. *Setting of Urban Places*: The setting of urban places covers their location, site and situation. Indian geographers invariably start with a discussion on their site, situation and historical growth and have shown greater interest in site. This is evident from Thakore's study (205, 1963) of sixteen sites of Delhi; Dann's study of towns in Coimbatore district and major cities of South India (30, 1930; 32, 1931); Ahmad's study of different types of urban places in India (3, 1954); and Varma's study of some types of town sites in the Aravallis (211, 1966). Many of the scholars have identified and described urban sites well. But they have not given adequate attention to placing these sites in the context of the total character of the areas. They have also been less concerned with discovering regional variations in urban sites. Nor have they examined these sites from the point of view of urban land-use planning.

2. *Historical Growth of Urban Places*: The earlier geographic studies on growth of urban places were confined to South India and were published largely in the *Journal of the Madras Geographical Association*. Mention may be made of the works of Subrahmanyam (201, 1938), Srinivasachari (197, 1939) and Kuriyan (97, 1941) on the growth of Madras City, and of Chettiar (27, 1939) on Coimbatore. Since the late fifties, however, a number of articles have appeared in the *National Geographical Journal of India*, Varanasi, on site, situa-

tion and evolution of various urban places, mostly in Uttar Pradesh.

Singh (143, 1958) worked on Jaunpur; Misra (109, 1958) and Tiwari (204, 1963) on Mathura; Singh (189, 1959; 180, 1960) on Kanpur and Allahabad; Nigam (119, 1960) on Lucknow; and Singh (151, 1965) on Meerut. Other studies published in the same journal include Kangra by Kayastha (94, 1958); Murshidabad by Bhattacharya (16, 1959); Barkaj by Singh (145, 1961); Bokaro by Singh (169, 1961); Dhanbad by Sinha (193, 1962); Azamgarh by Singh (171, 1963); Bindki by Jayaswal (82, 1963); Ootacummund by Romesh (136, 1964); and Udaipur by Dhabariya (38, 1964). In all of these articles, the authors have followed the approaches of Singh (154, 1955). He (157, 1958; 156, 1961) conducted similar studies on Faizabad-cum-Ayodhya and Bangalore City also.

Using somewhat different techniques and organization of material, some studies on historical growth of individual urban places were published in the *Geographical Review of India,* Calcutta. These include Joshi's study of Poona (86, 1952); Guptoo's study of Nainital (71, 1954); Mookherjee's study of Siliguri (112, 1957); Gupta's study of the ancient temple town of Tribeni-Bansberia (69, 1960); and Bagchi and Sen's study of Giridih (11, 1963).

The *Indian Geographical Journal,* Madras, also brought out some papers on this theme. Singh (175, 1952) studied Banaras; Dwivedi (56, 1963) Allahabad; and Dutt (47, 1966) Jamshedpur City. Among other works of this nature, mention may be made of the study of Bhatia (12, 1956) on Delhi; Mookerjee (110, 1958) on Nagpur City; Bhattacharya and Lodha (14, 1964) on Chittorgarh; Guha (62, 1964) on Serampur; Kumbhat (96, 1966) on Jodhpur; and Nigam (121, 1967) on Gorakhpur.

Growth of port towns also evoked some interest among geographers in India. Subrahmanyam (198, 1931) discussed the geographic aspects of Calicut; Pereira (124, 1938) of Mangalore; Tyagarajan (206, 1941) of Tuticorin; and Alam (6, 1959) of Masulipatam. In recent years, however, most of the research papers on the evolution of port-towns in India were published in the *National Geographical Journal of India,* Varanasi. These include Karwar by Honrao and Prabhu (73, 1957); Bombay by Singh (176, 1960); Paradip by Dalua (28, 1960); Vishakhapatnam by Rao (130, 1960; 131, 1966); Port Blair by Lal (103, 1962) and Kayastha (93, 1963). These studies include discussion on urban landscape, hinterland, and demographic features, apart from growth of these places.

A few urban settlements such as Mungra-Badshahpur, Sachendi and Robertsganj interested Singh and Singh (167, 1960), Jayaswal (83, 1962), and Lal (102, 1963) respectively. The technique followed in the study of these places is, however, similar to that used for various urban

places. The emphasis continues to be on the description of their evolution, morphology and functional zones.

Thus, the quantum of work done on the evolution of urban places in India is considerable. There is, however, a kind of repeat performance in these studies. Attention needs therefore, to be given to comparative studies of towns to produce new germinal ideas for formulation of a theory of urban growth in India.

3. *Internal Structure of Urban Places*: The most comprehensive review of research on morphology of Indian cities was made by Brush (18, 1962). He observed that Indian cities have their own peculiar structure and the theories evolved for the Western cities are not relevant to them.

In the Indian literature on Urban Geography, the word 'morphology' has often been used as synonymous with 'functional zones'. Logically, however, morphology and functional zones are two different aspects (though intimately inter-related) of the internal structure of urban places (Dickinson: 40, 1948). Dixit (42, 1961) has rightly called for clarification on terminology relating to functional zones and posed the question, "Do functional zones exist?" Before him, Sen (139, 1959) had discussed the technique of classifying the functional zones of a city on the basis of occupational structure of its population.

Among the case studies on morphology of individual urban places in India, that of Guha (66, 1953) on Calcutta; of Mukerji (115, 1963) on Modinagar; of Singh (158, 1955; 153, 1956; 159, 1956), on Gorakhpur, Ballia and Mirzapur may be noted. Singh in collaboration with Singh (166, 1957) examined the morphology of the twin township of Dehri Dalmianagar also. The functional zones of Ranchi were described by Singh and Mukherji (163, 1957), and those of Dharwar by Prabhu (125, 1953). Punjabi (123, 1958) gave a detailed description of the planned city of Chandigarh. Singh (181, 1959; 188, 1964) identified the functional regions of Allahabad and Mughalsarai. Functional zones of Agra were discussed by Tiwari (207, 1958); of Jaunpur by Singh (144, 1960); of Murshidabad by Bhattacharya (15, 1961); and of Lucknow by Nigam (120, 1964). The morphology of Howrah city, Ajmer and Itarsi was described by Chatterjee (25, 1964), Upadhya (209, 1965), and Singh (141, 1967) respectively.

Guha (63, 1964), however, suggested a different method of designating morpholgical regions of Burdwan city. She divided this city into seven types of zones, namely, dynamic, static, rejuvenated, expanding, waiting for development, derelict, and agricultural enclaves. Hirt (72, 1961) threw light on the morphology of South Indian towns, with particular reference to their Dravidian type of architecture. The urban landscape of Thana was described by Mathur (106, 1966). Sundaram and Chandrasekhara (202, 1968) examined the

function-form relationships in some selected cities, including Madurai, Moradabad, Tiruchirapalli and Coimbatore.

In all the studies listed in this section, description and analysis are based on a few maps showing broad functional zones and location of salient features such as hospital, railway station, offices, parks, etc. For future research on this aspect, it is suggested that (i) internal structure of cities varying in size, functions, stage of growth, etc. should be studied in comparison with each other; (ii) areal differences in internal structure of urban places should be examined; and (iii) theories regarding internal structure of Indian cities should be formulated. Analytical studies of planned cities such as Chandigarh, Faridabad Township, Bhuvaneshvar, etc. would be of great value for planning of new towns.

4. *Demographic Features of Urban Places*: As early as 1941, Kuriyan (97, 1941) described the distribution of population in Madras city. The demographic structure of Allahabad was discussed by Singh (179, 1958) and later by Dwivedi (55, 1965). Siddiqui (140, 1958) studied the population of Moradabad City; Chatterjee (21, 1958) of Howrah City; and Singh (170, 1959) of Lucknow. In most of these papers, there is lack of emphasis upon intra-town variations in population characteristics, excepting density. More recently, Brush (19, 1968) examined the patterns of population density in certain Indian cities. The number of geographic studies of population attributes of urban places is however, small, notwithstanding their significance for urban planning.

5. *Non-Demographic Features of Urban Places*: Singh (185, 1960) and Dwivedi (52, 1961) described industrial growth and landscape of Allahabad; Kulkarni (95, 1961) of Poona; Chatterjee (24, 1963) of Howrah; and Gupta (70, 1967) of Faridabad. The study of cultural zones, in terms of educational, religious and recreational institutions, was carried out by Sen (138, 1956) for Bankura; Singh (178, 1960) for Allahabad; and Chatterjee (20, 1964) for Howrah. Dutt (46, 1966; 49, 1967; 48, 1969) surveyed the various markets in Howrah and Calcutta and identified their hierarchy. Guha (67, 1955) studied the patterns of rail lines and traffic conditions within and around Calcutta. Singh (186, 1960) investigated the impact of railways on the Kaval towns of U.P. The same author (184, 1959) had earlier described the transport and communication system of Allahabad. He, along with Singh, (168, 1963) conducted a road traffic survey of Varanasi. He (183, 1960) had also contributed an article on provision of various public utilities in Allahabad City. A study of hotel industry in Mysore city was conducted by Mahadev and Ramesh (105, 1967). The number of studies relating to non-demographic features of Indian towns is thus not large enough to permit any significant generalization.

6. *Umland of Urban Places*: It was Jefferson (84, 1931) who emphasised the role of umland in the growth of a town. In India, the pioneer work in this field was done by Singh (154, 1955). Following his lead, a number of geographers have delimited the umlands of various urban places in India. Singh (149, 1956) delineated the umland of Agra; both Singh (190, 1961) and Dwivedi (54, 1964) of Allahabad; Mukerji (116, 1962) of Modinagar; Janaki and Ghia (77, 1962) of Baroda; Dutt (50, 1963) of Jamshedpur; Singh (152, 1964) of Meerut; and Chatterjee (22, 1965) of Howrah.

There have been some studies on individual attributes of umlands of certain urban places. Singh (160, 1956) traced the trend of urbanization in the umland of Banaras. Kar (88, 1962) described the economic characteristics of the metropolitan sphere of influence of Calcutta. Commuting to this city was studied by Dutt (44, 1964). Saxena and Singh (137, 1965) surveyed the daily movement of labour to Meerut City. Reddy (134, 1961) studied vegetable markets in Hyderabad City, and Krishan (61, 1963) described the spatial pattern of vegetable supply to the planned city of Chandigarh. A few geographers have also discussed the different methods suitable for delimiting umland. Nath (118, 1962) reviewed the existing techniques employed for this purpose. Ellefesen (58, 1962) suggested that hinterlands of Indian cities can be determined by examining the population characteristics of villages surrounding them. By taking Poona as a case study, Dikshit and Sawant (41, 1968) examined the concept of hinterland as a region, observed its characteristics and suggested methods of delimiting it.

A detailed note on this important topic has been included separately in this volume.

8. *Holistic Studies of Individual Urban Places*: The largest number of doctorates in geography in India has been in Urban Geography. The pioneer work of Singh (154, 1955) on Banaras set a pattern for later research in this field. Mention in this context may be made of the doctoral theses of Alam's (5, 1965) on Hyderabad-Secunderabad; Singh (173, 1966) on Allahabad; and Chatterjee (23, 1968) on Howrah. In terms of content and methodology, however, Shah Manzoor Alam's work represents a departure from that of R. L. Singh. Other studies include Rao (132, 1937) on Conjeevaram—a temple town; Deshpande (36, 1956) on Visnagar (North Gujarat); and Kar (90, 1960) on Calcutta. Janaki and Sayed (78, 1962) produced a monograph on Padra town, situated near Baroda. Following his approach in the Banaras study, Singh brought out a book on the urban geography of Bangalore (155, 1964).

9. *Comparative Study of Urban Places*: Some authors have attempted comparative urban geography studies of different places.

Among these, reference may be made to the work of Dann (31, 1933) on Trichinopoly and Srirangam; Spate and Ahmad (196, 1950) on Kanpur, Agra, Varanasi, Aligarh and Lucknow; Spate (195, 1956) on the two federal capitals—New Delhi and Canberra; Karan (92, 1952) on the historical city of Patna and the industrial city of Jamshedpur; Singh (161, 1957) on two small towns—Sultanpur and Chunas in Eastern Uttar Pradesh; and Prasad (127, 1958) on "double" towns in India. From the geographic point of view, comparative studies of this kind have great significance.

II. Urban Places as a Phenomenon

1. *Process of Urbanization*: Mention may be made of Natesan's work (117, 1931) on European trade centres of Malabar; Dann's (29, 1931) on the urban geography of the same area; and Subrahmanyam's (200, 1941) on distribution and relative growth of urban places in Tamil Nadu. Deshpande (35, 1941) described the regional pattern of urbanization in Bombay Province; Ahmed (4, 1956) in Uttar Pradesh; and Ali (7, 1956) in the Indian desert. Taking some cities of Eastern Uttar Pradesh as illustration, Rizvi (135, 1956) demonstrated the role of rivers in the evolution of urban centres. Ramanadham and Venkateswarlu (129, 1957) emphasised the role of economic factors in the origin and growth of towns in Andhra Pradesh. The importance of historical factors was underlined by Singh (142, 1957) in his study of urban places in Orissa. Urbanisation in Bengal or in parts of it was analysed by Dutt (34, 1956), Guha (68, 1957), Mookerji (114, 1957) and Kar (89, 1962). Mehrotra (108, 1961) differentiated the various parts of Madhya Pradesh in terms of their degree of urbanization. Jauhari (79, 1962; 81, 1962; 80, 1964) studied the evolution and growth of urban places in Sutlej-Yamuna divide. Singh and Singh (165, 1963) conducted a study of the evolution of the medieval towns in Saryu-Par Plain of the Middle Ganga Valley. A detailed geographic study of towns in Mysore was conducted by Prakasa Rao (126, 1964). In his investigation of urbanisation in Bihar and Assam, Mookerjee (113, 1963) suggested a somewhat different measure of urbanisation, and Ahmed (2, 1956) described the distributional pattern of cities in India and Pakistan.

The Calcutta Conurbation attracted the attention of some geographers, including Singh (177, 1958); Dutt and Chakrabarty (51, 1963); Lahiri (98, 1963) and Bagchi (10, 1966). Earlier, Ghosh (60, 1950) had described the urban pattern of Calcutta.

On the methods of delimiting areas of urban concentration or urban zones, Vasanta (212, 1957) and Datta (33, 1967) contributed two articles, and Dwivedi (53, 1964) reviewed the concept of conur-

bation in the Indian context. Lahiri (100, 1966) suggested that for stimulating urbanization and for its equitable distribution in an area, some suitable villages should be developed into urban places.

It is necessary that urbanization should be viewed in the context of the total character of an area and its planning must form an integral part of any scheme of regional development.

2. *Size and Spacing of Urban Places*: Among the few studies on this aspect, that of Singh (162, 1955-56) was a pioneering effort. He identified urban hierarchy in the umland of Banaras. Similarly, Kar (91, 1960) studied urban hierarchy around Calcutta. Spatial pattern of central places in the Middle Ganga Valley was discussed by Singh (148, 1966). Tamaskar (203, 1966) described the distribution of weekly markets in Sagar-Damoh Plateau; and Guha (64, 1967) identified rural service centres in Hooghly district.

Some authors have also contributed to the conceptual framework of size and spacing of urban places. Bhatia (13, 1962) confirmed the validity of Jefferson's (85, 1939) law of primate city; Singh (172, 1965) developed the stability theory of central places; and Achuta Rao (1, 1967) reviewed the concept of twin towns. Such studies, which are likely to help in devising theories about hierarchy and distributional pattern of urban places in India should receive greater attention in future.

3. *Optimum Size of Urban Places*: What is the optimum size of a City? This question has always interested town-planners and geographers alike. Among Indian geographers, Sinha (192, 1964) suggested the basis of working out the optimum size of an urban place; and Lahiri (99, 1940) studied the relationship between the size of an urban settlement and the cost of providing services to it. In view of the practical utility of this concept, it would be useful to develop it further.

4. *Rural-Urban Fringe*: The land on the periphery of urban places is partly rural and partly urban and has a potential for urban development. But only a few articles on this problem have appeared in geographic journals in India. However, it was as early as 1940 that Subrahmanyam (199, 1940) was seized of the problems of the suburban tract of Madras. Singh (187, 1962) made a comparative study of the fringe areas of the five Kaval towns, and Ganguly (59, 1967) of those of Calcutta. The concept of urban fringe and the method of its delineation were discussed by Mookerjee (111, 1963). Undoubtedly, rural-urban fringe is emerging as a characteristic feature of at least big cities in India. Geographers need to devote their efforts to the investigation of these areas as such studies could help in tackling the problem of the unplanned urban sprawl.

III. Urban Places as Economic Phenomenon

1. *Urban Economic Base*: Urban economic base refers to the pattern of production and distribution of goods and services by an urban centre. In studies pertaining to this aspect of urban geography, a distinction is made between the basic and non-basic functioning of an urban place. Practically no work has been done on the economic base of urban places in India. Alam (5, 1965) made the solitary attempt by distinguishing basic and non-basic industries and employment in Hyderabad-Secunderabad. Besides, a review article on the Basic-non-basic Concept was contributed by Singh and Singh (164, 1966).

2. *Classification of Urban Places*: Authors attempting to classify urban places in India have considered function as the most suitable criterion. Lall (101, 1959) devised a statistical technique for classifying Indian Cities on the basis of their functions. Following Nelson's method, Singh (147, 1959; 146, 1961) gave a functional classification of towns in Uttar Pradesh, and later examined the changes in functions of some small towns in the same state. Anantapadmanabhan (8, 1962) attempted a functional classification of urban centres in Madras state. Rafiullah (128, 1965) suggested that the urban centres should be classified functionally into the categories mononomial, binomial, trinomial, quadrinomial and polynomial on the basis of employment data. Employing sophisticated statistical technique of multi-variate analysis, Tiwari (208, 1968) examined the functional pattern of towns in Madhya Pradesh. His method is partly identical to that used by Smith (194, 1965) in his study of functions of Australian towns.

The preceding discussion reveals that Indian geographers have classified urban places on the basis of their functions and have largely followed the techniques developed for this purpose by geographers in the West. It would be of equal geographic interest to classify urban places on the basis of other characteristics such as site conditions, ecological growth, morphology, etc.

IV. Applied Urban Geography

Singh (150, 1958) stressed the role of geography in town planning in India. Prakasa Rao (133, 1943), and Guha (65, 1966) discussed concepts of town planning, with particular reference to their relevance to Indian conditions. Hoselitz (74, 1959) in his review of "Cities of India and their Problems" came to the conclusion that, in the light of present trends of urban growth in India, town and city planning is imperative in spite of scarcity of resources.

Indian geographers who are interested in the applied aspects of Urban Geography have devoted their attention mainly to (i) examination of official master plans, (ii) urban land use surveys and planning, (iii) slum areas and their development, and (iv) improvement in distribution of public utility services in urban places. Dutt (45, 1959) assessed the official Master Plan of Jamshedpur; and Singh (174, 1961) and Dwivedi (57, 1962) of Allahabad; Verma (210, 1962) and Dhabariya (39, 1965) put forward schemes for planning of Jabalpur and Udaipur, respectively. A scheme for urban development of Siliguri was suggested by Pal, Dutta and Chakravarty (122, 1965). Chaudhri (26, 1967) highlighted the problems of Kulti-Burnpur industrial complex.

A few geographers conducted urban land-use surveys and suggested improvement therein. Dubey (43) got his doctorate degree on "Use and Misuse of Land in Kaval Towns". Sinha (191, 1965) made a plea for adoption of a rational urban land policy in India. Jadhav and Kulkarni (76, 1967) suggested a systematic land-use plan for rural-urban fringe of Poona. Earlier, Hunt (75, 1951) had elaborated upon techniques and importance of urban land-use surveys in India.

Associated with the studies on land use were the investigations of slum areas. Dhabariya (37, 1965) described the characteristics of blighted areas; and Singh (182, 1966) attempted a geographic analysis of slum areas in Indian Cities, with special reference to Kanpur.

It was as early as 1928 that Anstead (9, 1928) was aware of the problem of sweage in Indian cities, particularly Madras. In 1966, Lee and Burton (104, 1966) expressed their concern over future water supply for Indian cities. A detailed diagnosis of the problems of urban development in India was, however, made by Breeze (17, 1963).

There is a good deal to be done in the field of Applied Urban Geography, especially in the sphere of distribution of public utility services in the city and future use of its vacant land. It requires an active collaboration between the city planning agencies and geographers.

Conclusions and Suggestions

1. It was mainly after the publication of Singh's book on Banaras in 1955 that Urban Geography received a stimulus in India. Considerable amount of research work on this subject has since appeared, laying emphasis on setting, historical growth, morphology, functions and delimitation of umland of individual towns. The urban geographers at Calcutta, by comparison, have devoted their

attention largely to the process of urban growth and problems arising from it, particularly in the Calcutta conurbation.

2. There has been a general tendency to study individual urban places. Comparative studies aiming at deriving generalizations with regard to various aspects of towns are still rare. Equally conspicuous is the lack of efforts at regionalizing the characteristics of urban places for India as a whole, or for its various parts. These tasks should be taken up soon.

3. Among the various aspects of Urban Geography, the size and spacing of urban places deserves special consideration, especially for facilitating the task of regional planning.

4. Rural-urban fringe is another field to which geographers should devote serious attention. The haphazard sprawl of almost all the cities has resulted in a loss of considerable amount of rich agricultural land, apart from creating other problems. The study of rural-urban fringe areas would help in evolving a rational plan for future growth of urban places.

5. Urban land-use planning, is still another aspect of urban geography to which geographers can make significant contribution. The intensity of land use, misuse of land, potentialities of vacant lands and identification of slum areas are the special questions which geographers should investigate for the planners.

6. It is also necessary that geographers should devise better cartographic methods for representing urban phenomena more effectively.

7. Above all, studies in Urban Geography deserve greater degree of precision and quantification in order to make them really useful for planning as well as for developing valid generalizations.

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The Concept Of Umland With Reference To Indian Cities

A Trend Report

By

R. L. Singh

The Concept

THE WORD 'umland', with a geographical meaning, was first used by Andre Allix, a French Professor, in 1914. He claimed to have coined it himself to express his concept of economic domain, meaning thereby the areas immediately around an interior city, more particularly a fair centre (2, 1922). To him, 'umland' was comparable to 'hinterland' but he restricted the latter expression to ports only. The term was again used by the same author in 1922 in his article in the *Geographical Review*. Dodge (6, 1932), an American Geographer, was perhaps the next to use the word 'umland' in 1932. Later in 1937, Whittlesey defined the umland of Kano as the "immediately tributary area extending 30 or 40 miles on all sides of the city". Van Cleef also used the word independently in the same year as he divided the "economic domain into two parts, placing in the umland those communities that behave economically as though they were located within the political limits of the primary centre, and including in the hinterland (continuous) those communities most, but not all, of whose economic activities are focussed on the primary centre". He also showed interest in establishing the German origin of the word 'umland' and traced its appearance in a German dictionary as early as 1883 antedating Allix's claim of its coinage in 1914.* Subsequently a number of English-speaking geographers have shown familiarity either with the word as such or with its substitutes like 'urban hinterland', 'sphere of influence', 'catchment

* The Swedish word 'Omland' has the same connotation as the German term 'Umland'.

area', 'urban-field', 'city-region', etc. However, this author's work on Banaras (20, 1955) happens to be the first to show a special preference for the expression 'umland'; and its definition contained therein, *viz.*, 'umland' of a particular town or city is "the area in which the region and the city are culturally, economically and politically interrelated" has got due recognition in Stamp's glossary of Geographical terms (24, 1961).

After the introduction of the concept of umland by the author in Indian Geography in 1955, the problem has been studied by several other scholars; and although most of the researchers in the field have worked, more or less, on similar lines with similar understandings, a few have opted for expressions other than 'umland'. Among those who have preferred to use 'umland' are Singh (18, 1956), Singh (23, 1961), Nath (15, 1962), Mukerji (14, 1962), Dutt (7, 1963), Dwivedi (8, 1964), Mathur (13, 1968), and Krishan and Agarwal (11, 1970). Mukerji has not been able to avoid the occurence of words 'hinterland' and 'tributary area' as synonyms of 'umland'. But Janaki (9, 1962) uses 'tributary area' and Singh (19, 1964), and Mahadev and Jayasankar (12, 1969) go in for 'urban-field' and 'city region' respectively. Alam (1, 1965) finds that the service areas of Hyderabad-Secunderabad are not alike in their extent, and calls them areas of 'metropolitan dominance' and 'metropolitan association' (perhaps after Dickinson). Chatterji (3, 1967) reserves the term 'hinterland' for Howrah, perhaps to denote its character of a shipping centre. Dikshit and Sawant (5, 1968) use 'urban field' as parallel to 'hinterland' and have unhesitatingly associated it with an inland centre like Poona.

It may be stated that Singh (18, 1956, p. 149), Singh (23, 1961, p. 37), Nath (15, 1962, p. 34), Mukerji (14, 1962, p. 269), Singh (21, 1964, p. 85), and Dwivedi (8, 1964, p. 133) have shown the least deviation from the author's view regarding the concept of umland. Dutt has a clear leaning towards Van Cleef when he states "a 'hinterland' is a wider economic sphere of a city, whereas an 'umland' is the play-ground of inter-play of cultural, economic and political phenomena, whereby the city and its surrounding region are functionally integrated to each other" (7, 1963, p. 84). To Krishan and Agarwal, umland is "the contiguous tract which surrounds a service centre and is functionally integrated to it through certain specified criteria" (11, 1970, p. 31). But on the contrary, contiguity is not essential for Chatterji who observes: "The Hinterland of a city is composed of areas intimately linked with it. Most of these areas surround the city, others are located at some distance away from its immediate surroundings" (3, 1967, p. 161). Explaining their concept of hinterland as a region, Dikshit and Sawant write: "Such a region

is defined on the basis of nexus of relationships where the binding force of the region expresses itself in the circulation of goods, movement of people, flow of ideas and a considerable degree of interdependence between the core and the area around" (5, 1968, p. 1).

Delineation

The umland boundaries of over a dozen Indian towns and cities, namely, Banaras (20, 1955), Agra (18, 1956), Allahabad (23, 1961; 8, 1964), Modinagar, (14, 1962), Baroda (9, 1962), Jamshedpur (7, 1963), Hyderabad-Secunderabad (16, 1961; 1, 1965), Bangalore (21, 1964), Meerut (19, 1964), Howrah (3, 1967), Dehra Dun (13, 1968), Poona (5, 1968), Chandigarh (10, 1963; 11, 1970) etc., have been determined so far. All these researchers agree that these limits are vague. The umland peripheries generally overlap with neutral or transitional zones falling under the influence of two or more centres; and as such, a precise delineation of umland is not easy. However, the boundaries of umland are generally defined by superimposing the zones of some important functional linkages, though always with a degree of approximation and minor adjustments with administrative boundaries. It must also be noted that the service areas of different functions are not co-terminous and that the urban influences exhibit a gradient character. Keeping this in view, provision has been made, not only for primary and secondary umlands (23, 1961, p. 42), but also for a tertiary umland (21, 1964, p. 89). Casual references to 'Unifunctional' (based on a single function) and 'composite' (based on more than one function) umlands also occur (5, 1968, p. 2).

The umland boundaries are affected by physical as well as cultural factors. The negative role of physical factors like hill ranges and unbridged rivers in partially restricting the umlands of most of the centres has been noted. On the other hand, the elongation of the bus service zone of Agra along the Yamuna (18, 1956, p. 152) speaks of a positive role that rivers sometimes play. The city being very much a cultural unit, the socio-economic and cultural factors also play an important role. For example, the milk supply zone often shows a bulging towards villages of some particular castes like 'Gwalas' and 'Ghosis' who take to milk supply as their traditional business. Similarly, the extent of the food grains supply zone of a city depends upon the agricultural condition of the surrounding villages and their road connections. The centrifugal force exerted by a town on the umland of its neighbouring centre is also responsible in limiting the umland of the latter. Further, owing to the technological and scientific advances which change the pattern of

resource utilization, the town-country relationship remains dynamic; and hence the umland limits also tend to be mobile. The umlands of riverine cities, which possessed elongated shape during the days of water transport, have gradually acquired compact shapes with the development of rail and automobile transport. Sometimes, the emergence of one or more new centres in the neighbourhood, with their fresh umlands, is also likely to introduce changes. The planned city of Chandigarh, for instance, has very successfully captured the erstwhile umlands of a number of other towns in the neighbourhood (11, 1970).

Criteria

As the city and its umland are 'culturally, economically and politically interrelated', the criteria used in delineation of umland are also generally chosen from these three fields. The six zones—vegetable, milk supply, supply of grain and other agricultural products, bus service, newspapers circulation and administrative—used by the author in 1955 have been popular in all the later works, although a few new ones like the commuters' zone, educational zone and hospital service zone are also adopted by a number of authors. Zones based on retail sales, bullock cart, bicycle, rikshaw, drug sale, cinema, police, banking, fish, egg and poultry, livestock, etc., are less important having been only in casual use.

The vegetable supply zone has been so attractive to the Indian geographers dealing with the umland that it is common to most of the works, and has also been applied as a single criterion for measuring the regional relationships of at least two centres—Chandigarh (10, 1963) and Hyderabad (16, 1961). Though compact in nature, the vegetable zone is so small in areal extent that it hardly covers even limits of the primary umland. Similar is the case with milk supply zone also. The food grains and other agricultural products supply zone covers a wider area and has shown its merits by coinciding with the composite umland boundary in a few cases. Its growth is sometimes handicapped by imposition of Government controls on movement of foodgrains from one political unit to another as is the case with Jamshedpur where the boundary between states of Bihar and Orissa acts as a limit of the town's grain supply zone in that direction. The bus service zone has generally not yielded satisfactory results for two reasons: (i) The automobile transport is not yet so well developed in India as in the Western countries, and (ii) the zone is very irregular as it includes areas up to only 6-8 km away from the bus routes. The newspaper circulation zone does not suit smaller centres as they hardly publish any local dailies.

Administrative and hospital service zones are medium in size and may give useful results for certain towns. The commuter, education (upto Intermediate level), retail sale, bicycle, rikshaw, cinema and banking zones are indicators of deep relationship between the region and the service centre and thus may be helpful in demarcation of the primary umland. The drug sale and police zones indicate nothing new as they coincide with the hospital and administrative zones respectively. Fish, egg and poultry, and livestock supply zones have been used only in the case of Howrah where they have not shown any promising results.

Existing Gaps and Need for Further Research

In spite of the fact that the research on umlands of Indian cities has already completed a fifteen years span, a number of gaps still exist which are partially true for studies abroad as well. The most striking of these is the lack of precision in umland boundaries. They are arbitrary, imaginary and vague. The responsibility for this lies, not upon the researchers, but on the non-availability of necessary data. It is not possible to collect minute information on an individual level for many reasons. The problem may be more easily tackled by the Government, either by enlarging the scope of its census operations, or by making some other alternate arrangements for the data collection. Further, different geographers have taken different sets of criteria in their respective studies and this makes a comparison of their findings difficult or even impossible. Hence a standardisation of criteria is called for; and this, in its turn, will need similar data for all the centres. Whatever criteria have been used so far, the information is gathered mostly from the city. The collection of data from the rural areas by administering a questionnaire to the villagers is also equally essential. It may also be pointed out that the intensity of functional integration with the city is not evenly distributed throughout the umland. Settlements on one side of the city may be more intensely related than those on the other located at the same distance and while some villages are dependent on the city for all of their buying needs, there may be others whose needs are partially served by a smaller service centre in their neighbourhood. The first steps to analyse such internal differences in individual umlands have already been taken (22, 1957; 17, 1966). But considerable further work is needed in this context.

The use of umlands as planning regions will be of great significance. The hierarchy of umlands is also easily changeable into a hierarchy of planning regions. Further, the study of umlands may be of immense help even in town-planning as no survey of a town

is complete without a reference to its regional relations. Towns serve as growth poles and growth centres for the surrounding regions. Hence the analyses of the growth-promoting and growth-retarding factors and their interactions are also to be taken into account for long-term planning.

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16

Man And Environment

A Trend Report

By

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THE STUDIES of man and his environment can be broadly divided into two major categories: (1) natural hazards and (2) environmental deterioration due to human activities. The former will cover floods, droughts, earthquakes, landslides, etc. and the latter will cover pollution of land, water and air.

Studies by geographers on pollution problems in India are extremely few. It is really a field which demands early attention. Similarly, contributions by geographers on cyclones and hazards associated with it are modest. This inadequacy has naturally been reflected in this review.

Natural Hazards

I. FLOODS

If the actual rainfall in a year for a particular area is in excess of the normal by more than twice the mean deviation, that year is defined as a year of flood. It is interesting to note that the largest number of rainfall abnormalities, i.e. floods and droughts occur where rainfall is low, viz., in northwest India.

From statistical records it appears that the chance of country-wide occurrence of flood is once in twenty years. However, there may be six or seven years out of 20, when parts of the country are affected by abnormally heavy rainfall. There is, of course, no regular periodicity of floods and reliable predictions are difficult. Again, in many years, while some parts of the country suffered from droughts, other parts had floods. Only in seven years out of a series of

77 years, was the entire country free from both drought and flood, i.e. in 1885, 1906, 1921, 1930, 1940, 1943 and 1947.

It is extremely unlikely that there will be successive years of country-wide drought and flood. But there are also exceptions as in 1965 and 1966 when there was serious failure of rain in eastern U.P. and Bihar. However, there were general droughts and general floods in adjacent years, i.e. in 1877 and 1878; 1917 and 1918.

The damage by recurrent floods has been extensive. According to *Bhagirath,* the total direct and indirect losses due to floods would amount to about Rs. 100 crores a year during the period 1953-65. The major components of this huge average annual loss were: crop damage, Rs. .43 crores; loss due to damage of public utilities and houses, Rs. 14 crores; and cost of relief operations, Rs. 10 crores. During the period, on an average, five million acres of crop land have been affected.

Jha (1, 1955) analysed the flood problems of North Bihar and indicated the recurrent nature of losses due to floods. Chakravarty (3, 1958) found that the rivers coming out of the Himalayan mountains have been susceptible to severe floods in the Ganga Plain and cause considerable damage as the Ganga Plain is densely populated. It has also been observed by the author that the frequency and intensity of floods are mounting with time due to accelerated rate of sedimentation. Chatterjee and Bagchi (5, 1961) analysed the recurrent flood problems of West Bengal. Chatterjee (4, 1957), in his paper contributed to the symposium on flood control, observed that flood hazards have been increased due to man's interference with natural drainage conditions. He stressed that flood-plain occupancy should be regulated on a scientific basis if conditions are not to deteriorate. Bajpai and Misra (2, 1939) studied the most flood-affected areas of eastern U.P. and proposed certain preventive measures. Sircar (8, 1953) analysed the flood problems of south-western West Bengal with reference to the three rivers of the region, viz. the Kansai, Rupnarayan and the Subarnarekha. He indicated how the extent of flooding has taken a turn for the worse. Sinha dealt in detail with the flood hazards of the Mahanadi Delta (6, 1953) and the coastal plain of Orissa (7, 1956).

Broadly, flood-prone areas may be grouped into four zones, viz.,

(1) *Eastern Zone,* from the Ghagra Valley to the Brahmaputra Valley. In this belt, the menace is very acute in the Brahmaputra Basin of which the worst affected area is the Nalbari Sub-Division of Kamrup District.

(2) *Northern Zone,* covering Jammu and Kashmir, Punjab and western U.P. The Jhelum and the Chos of Punjab pose some serious problems. Floods also occur in the Ravi, Beas and the Sutlej Basins.

At times, the districts of Hoshiarpur, Kapurthala and Gurdaspur have been seriously affected.

(3) *Southern Zone*, flood susceptibility is quite high in the coastal areas of South India. The problem of drainage in the Krishna-Godavari Delta, particularly in the Kolleru Basin is very serious. At times, the districts of Krishna, Guntur, Khammam, Nellore, Vishakhapatnam and parts of West and East Godavari Districts have been affected.

(4) *Orissa Zone*, the rivers Mahanadi and Brahmini, carry large volumes of water but, due to the flat terrain of the estuarine areas and the nature of the distributaries, adequate outlet for this enormous volume of water is not often found and drainage congestion occurs.

The Japanese geographers have prepared hydrological maps of rivers susceptible to floods. They have demarcated precisely the flood-affected areas in river basins indicating the nature and extent of the damage caused by successive floods within a certain period, and the changes in the micro-relief of flood-affected areas as a result of erosion and deposition by flood waters. Similar maps could be prepared in India. They would be highly useful in forecasting future floods, giving warning to farmers living in the flood plains and minimising flood damage when floods actually come.

II. Droughts

If the actual rainfall happens to be below the normal by more than twice the mean deviation, that year is defined as a year of drought. From the examination of relevant statistics it appears that droughts have occurred over the largest number of places in the years 1877, 1899 and 1918. Such a nation-wide calamity might be expected to occur once every twenty years.

Years when only some zones of the sub-continent are affected by droughts, as in 1920, may occur more frequently, i.e. 4 or 5 times in a spell of 20 years. For the rest of the years, there may be 1, 2 or 3 sub-divisions affected by droughts which may be regarded as more or less normal.

The adverse effect of drought is expressed in serious damage to crop production which, in extreme cases, particularly when droughts are repeated in succession, leads to famines. The areas where famines have occurred several times and are most exposed to this danger are Rajasthan; the districts of Bijapur, Dharwar, Ahmednagar, Satara and Sholapur in Maharashtra- Deccan; Anantapur, Cuddapah and Kurnool districts of Andhra Pradesh; Ramanathpuram of Tamil Nadu; Bellary district of Mysore; Rohtak, Gurgaon and Hissar

districts of Punjab and Haryana; and Saurashtra. Famine may be very severe in the areas where rainfall is normally regular and where protective irrigation works have not been constructed on an adequate scale. Dry spells in such areas could create acute famines. Chatterjee (9, 1944) has estimated that between 1875-1900, about 10 million deaths took place as a result of famines alone.

Famines have grave social, moral and economic consequences and are recurring calamities in India. It was estimated by the Famine Commission of 1880 that, on an average, there are two bad seasons to seven good. Chauhan, D. S. (10, 1958) has observed: "During the last 300 years, we have experienced 26 major famines; during the last 700 years, there have been 17 very severe food disasters; and during historical times, of the 34 great famines of the world, 18 have occurred in India. The frequency and cyclic order show the peculiar susceptibility of this country to crop failures and recurrent shortage of food supply". However, it might be noted that, due to the vastness of the Indian Union, famine conditions covered the whole of the country at no time. As Loveday said, "History gives no example of drought extending over the whole of India, and meteorologists declare such an event impossible."

The basic approach to combat the effects of drought and consequent flood disasters would be the provision of water for irrigation in the drought-prone areas. As the extent of the drought-prone areas is vast, it might not be possible, due to fiscal limitations, to pay attention everywhere. The other approach could be to find out alternative crops/fodder which are drought resistent or require less water and introduce them in cyclical order in the drought prone areas so as to coincide with the probable drought-cycle.

III. Earthquakes

Earth tremors of varying intensity have occurred in India. However, they are mostly confined to the Himalayan areas and north-eastern and north-western hill areas of the Peninsula. Although the Peninsula proper has remained more or less free from earthquakes, yet tremors have been recorded in the western coastal tract and in the Narmada Valley.

In the Cutch earthquake of June 16, 1819, one of the world's greatest earthquakes, a big vault developed for a distance of nearly 90 miles with an east-west alignment along the northern part of the Rann of Cutch.

A terrible earthquake shook North Bihar in January 1934. It also involved the southern part of Nepal. The worst affected areas in North Bihar and Nepal were Motihari, Kathmandu and Monghyr.

Assam experienced a catastrophic earthquake in August, 1950. A vast area was affected along the sub-Himalayan belt from Dibang to Subansiri. The latter river was dammed by a great landslip whose breaching, a few days later, caused a major flood.

Koynanagar and neighbouring areas in Satara District in Maharashtra suffered from a severe earthquake in December 1967. The shock was quite widespread, its impulses reaching as far as Hyderabad, Bangalore and Ujjain. The experience of Koynanagar is quite unique as geologists generally consider peninsular India, on which Koynanagar is located, as a stable land-mass and relatively free from tremors.

Ali (11, 1950) and Bose (12, 1952) examined the Assam earthquake of 1950 which caused serious erosion of slopes of the Abor, Mishmi and other hills and choked several rivers (i.e. Lohit, Dibang, Dihing and Subansiri) for few days. Ghosh (14, 1950) investigated the effects of the Assam earthquake on roads.

West (18, 1935; 19, 1937) has made several studies on earthquakes in India and has prepared a map showing (i) danger zone with epicentres of severe earthquakes since 1850; (ii) zone in which severe damage might be caused by the earthquakes originating in the danger zone; (iii) area of comparative safety; and (iv) zone of minor shocks in south India.

There have been several contributions on the genesis of earthquakes by Fermor (13, 1934), Vivekananda (17, 1936), Pendse (15, 1948), and Tandon (16, 1954).

As a case-study, the areas in Assam susceptible to earthquakes, might be taken up on a priority basis. Analysing the effects of earthquakes, it might be investigated how human adaptations could best be made to reduce the hazardous effects of earthquakes.

Environmental Deterioration Due to Human Activities

I. Land Degradation

Factors responsible for deterioration of land resources by human activities may be classified under three heads:

(a) Soil erosion due to deforestation, faulty methods of cultivation, and over-grazing;

(b) Rise of salinity and alkalinity due to injudicious use of irrigation water; and

(c) Soil exhaustion.

It has been estimated in the "Review of the First Five Year Plan, 1957" (p. 138) that out of the total area, about 200 million acres of

land are exposed to hazards of wind or water erosion, and of lands actually under cultivation, about 100 million acres are facing erosional problems. Extensive ravine lands covering about 3.5 million acres have been created in U.P.-Rajasthan border areas. It is further estimated that about 80,000 acres each in M.P., Rajasthan and Gujarat are badly eroded by gully (ravine) action.

Shifting or jhuming cultivation which is practised on a large-scale in Assam, M.P., Himalayan Foot-Hills and Western Ghats, also erodes land resources.

Based upon the findings of the 'Waste Lands Survey and Reclamation Committee' set up by the Planning Commission, Shafi (20, 1968) has analysed the problems of wastelands in India. Due to excessive irrigation and resultant water-logging, extensive areas have been transformed into saline wastelands. About 15,000 to 20,000 acres of fertile land are being thrown out of cultivation every year on account of salinity, alkalinity and water-logging in the Punjab and Haryana. Large areas in Ferozepur, Gurgaon, Rohtak, Hissar, Amritsar, Gurdaspur and Karnal districts have been affected by rising salinity/alkalinity. The total area affected by excessive irrigation and containing salts and lacking proper drainage facilities in this region is estimated at three million acres. Shafi also found that the land is very often levelled for extending cultivation and as a consequence, flow of surface run-off is not so quick and free. This contributes to raising of water-table which, in turn, leads to water-logging. The soil near the roots of crops then gets saturated with water, which reduces the vitality of the plant and lowers production.

In India, the use of fertilizers is very meagre. Continuous cultivation without adequate use of fertilizer has led to soil-exhaustion in many years.

In view of the foregoing review, studies on proper use of irrigation water should be given high priority. It is expected that, with the development of Indian economy, more and more land would be brought under irrigation. If corrective measures are not taken in the light of the experiences in Punjab and Haryana, our land-resource may be seriously depleted and new problem areas would be created. It is therefore, suggested that case studies be taken up on inter-relationships of the terrain, including drainage, the quantity and quality of irrigation water needed, and crop-production. Representative regional areas might be selected for such studies.

Another problem for study would be the reclamation possibilities of ravine areas. Cost implications of the proposals should form an essential part of the study, and it should be prepared and executed in such a manner as to enable implementation of the findings.

II. Pollution of Water

With the progress of industrialisation and urbanisation in the country, more and more industrial and urban wastes are discharged into the nearby water-courses. Many of the discharges are untreated and this leads to serious health hazards and fish mortality. The danger is particularly potent in steel-towns. Large-scale coke-oven plants are parts of steel factories and their wastes contain phenolic liquid which is a severe pollutant of streams. Saha (21), in analysing the water pollution problems of Durgapur-Asansol which has a large number of industries and many important urban centres, assessed that by 1986, more than 70 mgd. of untreated wastes of various types with different extents of pollution loads would be thrown into the streams of the Durgapur-Asansol Region. Against this, the dry weather flow of the Damodar is about 240 mgd. and in the Ajay, this would not come to more than 50 mgd. Thus even assuming that this waste is suitably distributed between these two streams the dilution factor would be about 4.1 which is alarming for untreated waste water and when pumped in will throw any water purification system out of gear. These observations point out to the urgent need of devising suitable methods for treatment of wastes in industrial and urban areas.

Water-pollution problems of metropolitan areas should be taken up first. Study projects could profitably be undertaken on (a) spatial nature of water pollution, (b) water-pollution and fish-life, and (c) prospects of using treated effluents in agriculture and its cost-benefit ratio.

III. Pollution of Air

Sources of air pollution are broadly classified into (1) natural, and (2) man-made. Dust storms, forest fire, mine fire, volcanic eruptions, etc. are natural ways of air pollution. But these are not regular features and occur only occasionally. Air pollution has assumed serious proportions mainly because of human activities. Chakraborty and Rao (23, 1959) have dealt with the problems of air pollution arising out of power generation. It has been said that if coal is completely burnt it would give out only carbon dioxide, water vapour, sulphur dioxide and free nitrogen leaving behind mineral matter such as ash. But if the combustion is not complete, products would include soot, tar, phenol, carbon monoxide, amonia and gaseous hydro-carbons. Similar is the case with the combustion oil. These materials, when injected into the atmosphere, pollute air. Besides coal and oil, other raw materials used in the industries could also be sources of air pollution.

Chakraborty and Rao (23, 1959) after a study of 'Atmospheric Pollution—A Study in Calcutta', observed: "From the clinical and hospital experience, one can surmise that temporary smoggy conditions encountered do have an etiological part to play in the greater incidence of respiratory and allergic conditions in the winter months". From the town-planning point of view, Bhattacharya (22, 1970) stressed the need of residential land-use planning in a manner which prevents/reduces the hazards associated with air pollution by industries. He advocated seclusion of tanneries from housing areas and provision of adequate green inter-spaces between major industries and residential areas.

In India, due to limited industrialisation-urbanisation air pollution problems are not so acute as in the advanced countries of Western Europe and USA. However, the problem is becoming serious in the large metropolitan areas.

A sample survey of air pollution problems of metropolitan areas in spatial terms, indicating the varying intensities of the respective sources of pollution could be a useful guide to formulate air pollution control policies.

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Floods

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17

Medical Geography

A Trend Report

By

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and
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Introduction

THE TERM 'medical geography' was first used by medical workers who prepared maps and atlases showing the distribution of diseases as important tools of analysis (5, 1892). But geographers soon began to search for factors behind the incidence of certain diseases and their spatial pattern of occurrence and spread. Considerable work on these lines was done in Germany, France, Russia, Latin America and U.S.A. Realising its importance, the International Geographical Union (IGU) constituted a Commission on Medical Geography and its first report was discussed at the IGU Congress in Washington in 1952. The Commission defined medical geography as "the study of geographical factors concerned with cause and effect of health and disease". Since then the analysis of health and disease through man-environment relationship has engaged the attention of geographers and medical geography has emerged as a specialised branch of geography.

Population growth and its variability, birth and death-rates, infant mortality, food habits, characteristic diets and nutritional deficiencies, socio-cultural and religious factors, seasonal and regional variations in climate, certain topographical features such as water-logging, availability of essential services and amenities such as water-supply, health facilities and education are some of the aspects which serve to explain the spatial distribution and incidence of certain diseases and conditions of health. A multi-factor disease may involve the study of several differing geographies and of several different ecologies underlying the areal distribution pattern (16, 1950).

Thus medical geography covers a wide field of research with overlapping interest, not only with other branches of geography, but with other disciplines like sociology and demography as well. In understanding the nature of the environment under which different pathogens survive and spread the disease, the geographer has to acquire some knowledge from the professional medical workers. Interdisciplinary effort is thus essential. The objective of the present study is to analyse the geographical aspects covered by selected studies in the field in medical geography in India.

General Studies

The data and the studies of professional medical workers contain a wealth of information amenable for a systematic geographic analysis. These have been critically reviewed by Learmonth (9, 1965). Likewise the review of the progress of geography in India by Chatterjee contains a brief report on the contribution of geographers to the medical geography of India (2, 1963-68).

In a study of regional differences in Natality and Mortality in the sub-continent of Indo-Pakistan, Learmonth has brought out significant regional differences and regional groupings in the distribution and incidence of certain diseases (15, 1952). The study covers the period between the two world wars which was also uninterrupted by a major famine.

Infant mortality, regarded as one of the major indices of general health conditions in a community, is closely related to general conditions of hygiene, diet and health; and the study of Chandrasekhara shows that there are marked variations between different socio-economic strata of the community within and between regions (1, 1958). Cultural and religious factors were also found to be deeply woven into the problems of infant mortality and health.

Endemic Diseases

Regional ecological conditions seem to provide clues in explaining the causes for the endemic nature of certain diseases. For instance, high incidence and low variability of malaria were found to be related to humid conditions such as those in the forested hilly tract of the Western Ghats and the humid rice-growing areas of the West-Coast plain and the Lower Ganges plain where the stagnant pools of water provide ideal conditions for the spread of the disease (12, 1958). In general, the map of Malaria in 1938 brought out significant areal differences in endemicity associated with topographical and climatic conditions. Unlike the relatively perennial

occurrence of malaria in the humid and forested hilly tracts, high incidence of malaria was also noted in paras of Punjab and Western Uttar Pradesh in the monsoon season. It has been reported recently that the monsoonal rain in semi-arid and arid parts of Western Rajasthan, while providing relief to famine-stricken people, has also brought with it the incidence of malaria and similar fevers which is attributed to the use of stored water in tanks and reservoirs.*

The study of cholera by medical workers and geographers also illustrates the relevance of regional ecological background for explaining the cause of the disease and in adopting preventive measures on a regional scale. De identified the confluence of the Hooghly, the Rupnarayan and the Damodar as the endemic focus of cholera (3, 1957). Likewise, the Lower Ganges Delta has been described as the endemic home of cholera as the cholera *vibrio* thrives well in alkaline water bodies. One possibility is that the pools of standing water in the delta turn alkaline during the dry season (19, 1957; 20, 1958). Studies of the locations of religious places and fairs also bring out significant relationship between seasonality and the incidence of cholera (11, 1961).

Like malaria, the incidence of *filariasis* and *Leishmaniasis* also shows local and regional variations and these are attributed to climatic conditions as in Kerala (17, 1968; 18, 1967). Guineaworm disease has been studied from a geographical point of view by Tewari (26). Apart from correlating the disease with natural environment and social hygiene of the rural population of Rajasthan, the author has identified three zones in Rajasthan with differing incidence of this disease. These zones show marked variations in topography, rainfall and availability of water for drinking purposes. Low incidence of this disease in the eastern part and towards the plains of the Punjab and Uttar Pradesh is attributed to the availability of underground water as a relatively safer source than hoarded rain water used in other parts.

Rajasthan with its extreme aridity and floating dust and sand has high incidence of trachoma as revealed by Indrapal's study (6, 1968). Areas of high density of livestock in Rajasthan are also shown as areas of high incidence of hookworm diseases (8, 1968).

The underground water in parts of the terai belt around Nainital-Bijnor area of U.P. having excessive ferruginous minerals seems to be the cause of some intestinal diseases (7, 1968).

Regional Differences

General conditions of health, prevalence of diseases like malaria

* *Hindustan Times*, 6th November 1970.

and plague and natural hazards like floods and famine and their impact on population growth and variation have been studied by Geddes, using the population data for 1881-1931 (4, 1942). Distinct demographic regions revealed by his study have a marked relationship with areas of high incidence of one or more diseases, particularly of malaria, small-pox, influenza and plague. Lacking reliable data on deaths by various diseases, the prevalence of diseases over large areas had to be deduced from indirect observations of regional differences in ecological conditions and variations in population. Learmonth's work already cited was designed to complement this overview by using admittedly inaccurate health data to the utmost.

Attempts have been made to study the area differences in nutrition and areas with low and high calorie content have been examined in relation to the type of food generally taken. Shafi used Standard Nutritional Unit as a measure of the self-sufficiency of food in some villages in Eastern Uttar Pradesh (23, 1960). A map of calories and proteins prepared on the basis of the data drawn from diet surveys brought out some areal differences which show correlation with the incidence of diseases and health conditions (10, 1956). It would be a major advance if Shafi's methods could be complemented by the diet survey technique pioneered from the nutrition research centre at Coonoor, and later at Hyderabad.

Areal Differentiation of General Health Conditions and Diseases

Maps are used as the tool for areal differentiation of health and diseases, both by geographers and medical workers. Yet the geographers' contribution is specific in the analysis of the complex relationship between *place, work and folk* and, in turn, its relationship to the social, economic, and general health conditions of the community.

By plotting the data on incidence and variability on the same map depicting the distribution of several diseases, Learmonth has identified their endemic and epidemic areas (13, 1958). Synthesis is also attempted using the areal distribution of mean incidence and variability of births, deaths, infant mortality and mortality from 'fevers', respiratory diseases, dysentery and diorrhoea, cholera, plague and small-pox. The map brought out significant regional differences. For example, the tropical rice-eating zone seems to be an area of several diseases of an endemic nature. This is in contrast to the northern zone of semi-arid conditions and variable rainfall with millet and wheat as important food crops. Here the seasonality of the diseases and infection by pests and water-borne insects seems to be common. These results have to be further tested by fieldwork in sample villages.

Unfortunately the studies so far made are restricted to very few cases and that too in urban centres like Bombay and Calcutta. There is thus a need to study regional differences in health and demographic trends in ecological terms as evidence of adjustment or equilibrium between population and environment.

Cartographic method of areal differentiation may be supplemented by statistical techniques. Rodger's correlation of absolute humidity in March with endemicity of cholera (21, 1928) and Russell's contemporaneous work with Sundararajan on using correlation coefficient as an index of statistically significant relationship (22, 1928) deserve special attention.

A recent summary of viewpoints on medical cartography is found in a special number of a librarians' journal (24, 1969).

Future Research

The regional ecological base is one in which the geographer has a primary interest and this might continue to be the basis for the analysis of the cause and spread of the disease and for taking preventive measures on a large scale. The evidence so far obtained is either too generalised to be of practical utility or too local for spatial differentiation.

There are however, certain limitations to the approach which would pose a formidable challenge to geographers employing traditional methods of studying man-environment relationship. Regional ecological conditions themselves have changed significantly as a result of economic development which has brought with it changes in socio-cultural characteristics. Food habits are changing and population mobility is not confined to the distance ranges of 5, 15 or 50 miles equivalent roughly to the walking distance to a market place or movement by bullock cart and buses of short distance-ranges. However, sharp regional variations in natural environment do exist and these could be used with caution, along with accurate data on the incidence and spread of diseases. The speed of change increases the need for recording of conditions, at various stages of development, on various scales of regional ecology.

Malnutrition and under-nutrition, particularly of younger age groups of the population, may continue for some time to be a problem in development planning. One of the problems for further work would be the analysis of the causes of malnutrition and under-nutrition and identification of areas and the strata of the community which suffer most. Data on consumer expenditure and certain health statistics already contained in the National Sample Survey and the dietary survey could be mapped and analysed along with related

aspects of regional economic development and demographic trends.

As a part of the studies in regional and area development for different regions within the states and districts, a locational study of the availability of medical facilities, education, water supply, etc. should be attempted and areas and population not served or inadequately served should be identified. This study would be a basis for analysing the data on the origin and spread of diseases and the measures to be taken to combat them.

Elsewhere in the developed countries efforts are being made in the construction of simulation models that would facilitate forecasting the spread of diseases. Statistical techniques of inter-relationship among the economic and social indices of development would also enhance our ability to understand the regional disparities in development and their impact on the health and socio-psychological characteristics of different strata of population.

Empirical studies in selected regions would be necessary in order to improve the methods of analysis and in building up the right type of data base for intensive studies.

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V

Political Geography

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Political Geography

A Trend Report

By

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Introduction

Political Geography has remained a neglected branch in most universities of India. It is true that elements of political geography are being taught in a number of universities, both at the post-graduate and the under-graduate levels, sometimes as a compulsory paper, but more often as a special or optional paper. The number of students offering the subject as an optional or special paper has, however, not been very encouraging. As a result, competent teachers of political geography have been less numerous, and researches in political geography have been too few. To substantiate this statement, one may cite Chatterjee's report on the progress of geography during the last 50 years (12, 1963) in which only three pages deal with political geography, as against well over 50 which deal with economic geography. In his supplement to this report (13, 1968), covering the period 1964-68, Chatterjee adds only one page and a half in political geography as against about 15 in economic geography. This review of research in political geography, therefore, remains understandably brief.

Political geography deals with "political systems" in the world in terms of "areal differentiation". Jackson defines it as the "study of political phenomena in their areal context". It analyses the fortunes and vicissitudes of the state as it has evolved on a particular part of the earth's surface, conditioned and moulded by certain environmental, both natural and human, factors. Its focus of attention is the politically organised area in the form of a nation-state. Its investigations thus begin with the genesis or "raison d'etre" of

nation-states and their growth through centuries and end up with the political tensions they are confronted with, both in their interior fabric and in their relations with the world at large. The earlier texts in political geography were often nothing more than mere regional geography "with a political flavour". It was Hartshorne who pleaded for a "more geographical political geography" in a paper in which he also emphasised a "functional approach" to the subject (28, 1950).

Early Writings

All regional texts of geography pertaining to the continent of Asia, or the sub-continent of India and Pakistan, or the Republic of India as such, contain important sections on political geography. The celebrated works of Lyde on the continent of Asia (42, 1933) and those of Holdich on India (31, 1904) belong to this category. Both these scholars were "imperial geographers" and always thought of the defence of the British Empire whenever they talked about any boundary or terrain or human problem in the frontier regions in India. Later authors of Asian geography, both British and American, have studied the continent on more sympathetic lines. The foremost among these are Stamp (73, 1962) and Cressey (20, 1944 and 1963). Their books on Asia contain valuable chapters on Indian geography and problems of frontiers, resources, minorities and languages are also lucidly dealt with in their true historical perspectives. Another author of this group is Ginsburg whose *The Pattern of Asia* (26, 1958) contains a critical but sympathetic analysis of the country's political problems. Spate's masterly work on *India and Pakistan* (71,1954) also has innumerable references to contemporary political problems.

A good bit of political geography is also contained in the accounts of exploration by wellknown travellers of the world like Sven Hedin (29, 1913), Younghusband (77, 1910) and Swami Pranavananda (62, 1950). Their works on the Himalayan and the trans-Himalayan regions contain many valuable accounts of terrain and geography which can be part of the study of the country's strategy itself. Similar, but much more sophisticated geographically, are the works of Kingdon Ward (76, 1934) who flew over the "hump" of Burma and wrote on the north-eastern part of India with a masterly knowledge of ground conditions.

In some ancient and classical accounts of India's political economy and philosophy also, there is a good blending of political geography. Celebrated among these is the work of the great Kautilya, whose masterly treatment of this subject is gradually coming

to light. One might even include in this group a number of books on the history of India, such as those of Vincent Smith, R. C. Ray Chaudhuri, R. C. Majumdar, U. N. Ghosal and others. The work of Mookerji (55, 1912) on Ancient Indian Shipping and Emigrations merits a special mention in this context. India's most well-known geopolitical writer, and perhaps the only one of his kind, was Sardar Panikkar whose work on *Geographical Factors of Indian History* (60, 1956) is real geopolitics. Similarly, Pandit Jawaharlal Nehru's *Discovery of India* has also a readable chapter on Geopolitics and Realism.

Aims and Limitations

Politico-geographical research in India can be conveniently grouped as under:

(a) Historical development and methodological studies.
(b) Political framework and body-politic.
(c) Frontiers and boundaries—external and internal.
(d) Population and resources.
(e) Adjacent countries, world affairs and area studies.
(f) Strategic research and military geography.

While several general books on the above subjects written by scholars of history, politics and current affairs are available, there has been very little first-rate research done by Indian geographers. S. P. Chatterjee's report categorised their contributions so far as "sketchy and lacking in depth". One reason for the relative absence of detailed and documented work on India's land frontiers—one of the most fertile areas of geopolitical research—is the inaccessibility of both terrain and information. Nevertheless, there have been some sporadic but significant politico-geographical studies by individual geographers, published mostly outside India. Spate's well illustrated article on the partition of India, Mayfield's study of the Kashmir problem, Karan's article on Dividing the Water of the Indus and H. P. Srivastava's work on Indo-Chinese boundary problems are good examples.

Historical Development and Methodological Studies

Chaudhuri (18, 1947) in tracing the evolution of ideas in political geography referred to the earlier concepts as thought of by Aristotle and Strabo and later modified and elaborated by Ratzel and Haushofer. Mookerjee (52, 1956) treated the same ground, mentioning in greater detail the ideas of Aristotle, Lucretius, Strabo, Ratzel, Mackinder, Haushofer and Hartshorne. A decade earlier he had

made out a case for geopolitics in international studies, showing his preference for the Taylorian term "Geopacifics" (53, 1946). The need for an intensive study and research in political geography, keenly felt since independence, has been pointed out, both by Tamaskar (74, 1962) and by Khan (39, 1962). Later Tamaskar and Bhattacharya gave their individual interpretations of political concepts of Kautilya (I.G.C., Nagpur, 1968).

Political Framework and Body-politic

Several scholars of history, politics or current affairs have dealt with the political framework of the Indian nation. The foremost name in this group is that of K. M. Panikkar who studied the land and sea frontiers of India and correlated a good deal of geography with such problems.

Venkatachar (75, 1955) named the Indus Valley as the gateway of India and held that whoever was able to pierce that stretch of land ultimately conquered India. Bhasin (7, 1968) has studied the "shifting of capitals" in India's past history. After the reorganization of states, Deshpande (22, 1957) analysed the new administrative framework of India and its regional geographical setting.

A recent book of considerable value is on Maratha geopolitics by Singh (67, 1966). This is a study of the Maratha people who had had a political consciousness of their own which culminated in the creation of Maharashtra State in 1960. Shreevastava's article on the political problems of India (66, 1962) contains both an analysis of the past and suggestions for the future.

Frontiers and Boundaries: External and Internal

Political geographers are interested in the study of frontiers as it affords them an opportunity to evaluate the naturalness of this piece of debatable land separating one state from another. There is a vast literature on this topic, both on theories and on actual disputes, mostly in Europe. But Indian geographers came out with no more than four papers on frontiers, during the last two decades. B. Basu has discussed the functioning of international boundaries as largely an outgrowth of nationalism in the context of changes in national frontiers in Europe during the first and second post-war periods. Pithawalla (61, 1944), in discussing the geographical factor in the strategy and progress of the Second World War, also refers to the frontier problems. He holds that unnatural, unsuitable and unreasonable frontiers were the bane of Europe's existence, and attempts to indicate the lines of action, from the geographer's point of view, for preventing world wars in future.

Understandably, a number of papers appeared on the eve of India's partition. Chatterjee (14, 1947) suggested a line of partition of Bengal into West Bengal and East Bengal from the geographer's point of view. He later (15, 1952) analysed the effects of partition on the economic geography of Bengal.

Karan (37, 1951), in his study of the fringes and frontiers of India and Pakistan, first referred to the old frontiers of undivided India, and then discussed the boundary problems arising out of the partition of India with particular references to the northern vulnerable zone. In a subsequent paper (38, 1953) he dealt, in greater detail, with the fixation, function and problems of Indo-Pakistani boundaries, based on the Radcliffe Award, the documentary materials issued by the External Affairs Ministry and the records of diplomatic negotiations between India and Pakistan. R. N. P. Sinha also studied Indo-Pakistan boundary problems in the Kutch Sector (IGC, Nagpur, 1968). The Sino-Indian border dispute was analysed by Misra (46, 1959) and R. K. Nigam (ING, Nagpur, 1968). In fact, boundary dispute studies with other countries figured in many semi-political treatises published after the 1962 and 1965 conflicts with China and Pakistan respectively.

Even the national boundaries of large countries like India have a profound influence on the cultural life of the inhabitants of the country. This topic also is, therefore, included in the subject-matter of political geography. Chatterjee (16, 1957) traced the changing national boundaries of India from the 18th century to the State Reorganization Act, 1956. The number of states and union territories has now greatly increased, making the states more homogeneous. But residual boundary problems remain and loom large in the background of regional imbalances of economic development.

Arising out of the partition of the sub-continent, several 'internal' boundary problems have come to the fore-front. Some of these have since been modified or even resolved by further reorganization of states. But the latter again brought into existence new problems of boundary adjustments. Significant studies can come out of these residual inter-state boundary problems consequent on frequent reorganization of states in India. The north-eastern part of the country presents a volatile situation in this respect. Already several new states have appeared on the political map within a short span of time.

Again, no solution has yet been found for the border problem between Mysore, Maharashtra and Kerala. Fluctuations of river channels also provide interesting examples of boundary problems between the states of the Indian Union. B. N. Chaturvedi's study

of the Godavari-Krishna water disputes is an example in point. Further studies are, therefore, needed on the North Indian rivers whose courses are ever changing.

There are several studies on Jammu and Kashmir. Bose (9, 1949) showed, on a sketch map, the ceasefire line as agreed to by the Governments of India and Pakistan. Mukerji (57, 1955) analysed the political geography of Jammu and Kashmir in the context of its integration with India, and then emphasised the role of Kashmir as a buffer state. Shrivastava (72, 1958) also discussed Kashmir from the point of view of its geopolitics, referring to the formal accession of the state to the Indian Union and the subsequent political development.

The northern mountainous frontier of India, which was hitherto thought of as impregnable, was victim of a recent Chinese aggression, adding another dimension to Indian geopolitics.

Population and Resources

Kuriyan (40, 1942) discussed the question of India's space relationship with other countries through successive historical periods. Lorenzo (41, 1943) dealt with geopolitics in his Atlas of India pointing out the immense possibilities which undeveloped resources of India offered to the eventual establishment of equilibrium between population and food supply. Chaudhuri (19, 1949) discussed the geopolitical problems arising out of the present uneven distribution of world population in different countries and consequent uneven sharing of world resources. This applied more to petroleum than to anything else and hence formed the subject-matter of a paper contributed by Krishnan (1961). Mukerji (1957) examined the disparities between natural resources of great powers like Britain, France, Germany, Italy, Soviet Union, and United States and their consequences on world politics.

Davis (21, 1951) made a comprehensive study of political impact on the migration of people in Punjab and Bengal. Chand's review of the population policy of India (10, 1960) suggested that, side by side with family planning, economic development should be adjusted to the rapid rate of population growth.

Mamoria's study of India's population problem (44, 1961) analysed the 20th century set-up of Indian population and the process of shifting of demographic forces from agricultural villages to the industrial urban centres. Deshmukh and Misra have respectively contributed papers (I.G.C., Nagpur, 1968) on Indian migrations, population and politics.

Gunervaty (27, 1967) narrated how food import is now a factor in international politics and mentioned, as an example, a direct link between the speech of the Prime Minister of India urging an end to US bombing in Viet Nam with the American President's subsequent decision to stop the shipments of grain to India at the very height of the food crisis.

Adjacent Countries, World Affairs and Area Studies

Studies deserving of more attention are essentially of post-independence origin. Of general, non-geographical writings, mention could be made of various studies of India's political posture against China, Tibet, Pakistan, U.S.A., and U.S.S.R., by S. Chandrasekhar (1961), W. A. Wilcox (1964), W. Norman Brown (1965), John Rowland (1967), A. Lamb (1964), R. N. Banerji, W. E. Garrett, Olaf Carre (1963), Paul Smoker (1969), Selig Harrison (1965), William Barnds (1968), Sheikh Abdullah (1965) and others.

On world affairs and area studies of Southeast Asia mention should be made of Roy's paper (65, 1959) on geopolitical situations in Asia, suggesting the importance of Bandung Conference for all-sided developments. He also referred to the significance of the "hinterland" to "world-island" on geo-economic and geopolitical grounds.

Janaki (33-36, 1962-67) contributed four papers on geography of the northern frontier of India, political situations in Indo-China, political geography of the Malaya Archipelago and the Gulf of Aqaba. Misra and Mahadev (47, 1966) published a monograph on the Chinese expansion in Southeast Asia. Qureshi (63, 1965) also contributed a paper on geopolitical instability in Southeast Asia. Earlier, Mookerjee (51, 1951) had written on political cross-currents in Southeast Asia, power politics of the second world war (49, 1945), the role of "strip-maps" in understanding new space-relationships (50, 1947) and on the political nature of the incredible Incaland (54, 1956).

Davare (23, 1966) discussed the political and strategic role of the Indian Ocean since the liquidation of imperial powers and the creation of a power vacuum and emergence of under-developed states in the region. Dikshit (24, 1966) had presented the historical physiographic, climatic and economic environments of the Maldive Islands and discussed their geopolitical and strategic importance, including the threat of a "cold war". He (25, 1967) later presented the historical background to political stability of the Indian Ocean till the appearance of colonial powers, and also discussed the present-day power alignments and political rivalries in the Indian Ocean. He also discussed the geo-strategy of the remote islands in the Indian Ocean

in the context of attempts for establishment of American and British military bases to fill up the power vacuum.

Following the trends of the sixties wherein much of geography has been quantified, the subfield of political geography has also not escaped its operation. Though on a modest scale, some studies have appeared on the resolutions of conflicts through mathematical models. The regional scientists, as well as scholars of the Peace Research Society (International) have shown the way. One recent article by Manas Chatterji (17, 1969) on the conflict between India and Pakistan is outstanding as the author seems to have revelled in mathematically deducting not less than 70 complicated equations to come to certain conclusions which are so common-place!

Strategic Research and Military Geography

Accounts of past and recent expeditions have disclosed considerable terrain information on India's Himalayan frontier. Younghusband (77, 1910) narrated the relations between British India and Tibet, and in the process, also analysed the Himalaya physique and the nature of the Tibetan people. Prashotam Mehra's account of the Younghusband expedition asked the specific question: "May not the Nathula be witness to a movement in reverse"? K. P. S. Menon's fascinating Delhi-Chungking diary was another example of this kind of writing. S. G. Bose's presentation (IGC, Nagpur, 1968) of the strategic significance of terrain along India's northern borders was excellent cartography. Besides, a few terrain-evaluation projects are under way—jointly by the Ministry of Defence and the universities.

After Thomas Holdich, there has been scanty progress in studies in military geography of the Indian arena. Basu of the National Defence Academy, Poona, has been the lone worker in this field, having to his credit a formidable list of published articles, mostly abroad. He analysed (1, 1965) the geographical realities of Pakistan's short-lived war on India in 1965 attempting to cause attrition of India's military resources. Subsequently, Basu (3, 1967) emphasized the importance of military geography on strategic operations in general and in mountainous terrain in particular and studied the importance of air-power. He (4, 1966) also carried out a study on geo-medical aspects of military operations.

International Understanding

At the Symposium on Political Geography and International Understanding held at Nagpur in December 1968 (as a Post-Congress

event of the 21st International Geographical Congress and organised and directed by S. Mookerjee) quite a few valuable papers on Indian geopolitics were presented.

This was, most would agree, a unique assembly of geographers, drawn from all over the world, to meet in India with the specific objective of linking political geographic research with promotion of international understanding. One of the sessions, significantly, was devoted to "Search for Peace".

Conclusions and Recommendations

The foregoing survey of literature indicates that there have been no planned attempts to study specific geopolitical problems of India along well-established, geographical lines, accompanied by modern cartographic techniques. The field of research in political geography seems to lie thus practically open.

The Chinese aggression of 1962 brought in its wake a number of interesting and hitherto unknown Government publications, including a White Paper and an Atlas of India's Northern Frontiers. There are competent cells in the External Affairs Ministry (such as the "China Division"), and also in the Survey of India (entrusted with drafting of "boundary reports") which can be pressed into service for similar, useful publications on all the aspects of our external boundaries, even in times of peace.

Among academic bodies, it is surprising that not much geopolitical research has come out yet of the Indian School of International Studies. There is no reason why the ISIS should not be developed into the foremost centre of geopolitical research in the country—first by instituting a (Panikkar) Chair in Political Geography there. India is yet to have her own National Institute of Geography which might include a Division of Politico-Geographical Research. But until then, the National Atlas Organisation could bring out an Atlas of Strategy or of Political Phenomena. It would also be desirable that one of the universities in the nation's capital should establish an Institute of Geo-Political Studies, (or of Geopacifics, in line with India's well-known foreign policy), where meaningful research can be conducted on the problems of external boundaries, internal resources, conflicting political interests, etc. with the source-material that exists in the archives of several ministries.

The above-named agenices can between them cover much of the open ground in politico-geographic research. The planning and coordination of this task could lie with the newly created Indian Council of Social Science Research. The "urgent research" programme in Indian Political Geography should, therefore, comprise the following:

(*i*) *Studies in international boundaries*: (a) The Himalayan frontier—Western Himalaya—Central Himalaya—Eastern Himalaya; (b) The desert frontier: in Rajasthan and Kutch sectors; (c) The International Frontier in Eastern and North-eastern India: Nagaland, NEFA, Mizo hills, etc; (d) India's exclaves and enclaves in the Eastern region; (e) The law of the sea: territorial waters and offshore-islands of the Indian Ocean.

(*ii*) *Studies in internal political framework*: (a) Inter-state boundaries—problems of their delimitation; (b) Inter-state movements of commodities; (c) The pattern of government in the states of the Union; (d) The framework of the Republic and the Centre-state and inter-state relations; (e) Democratic ideals of the state and the geographic realities.

(*iii*) (a) *Resource studies*: strategic, critical and essential resources. Their distribution, utilisation, conservation, procurement, stockpiling and substitution; (b) Questions of ideologies and economic development.

(*iv*) *Problems of demography, migrations and resettlement*: Overpopulated and under-populated areas, uneven population distribution, food and sustenance, immigration and rehabilitation.

(*v*) *Problems of minorities and of national integration*: Linguistic, religious and ethnic minorities and adivasis.

(*vi*) *Problems of partition and reorganisation of states*: Case studies on Telengana, Vidarbha, Saurashtra, Chattisgarh, Jharkhand, and others.

(*vii*) *Electoral geography and political leadership behaviour.*

(*viii*) *Relations with neighbouring countries*: Pakistan, Nepal, Ceylon, Burma, China, etc.

(*ix*) *Problems and policies on the international scene*: attitudes towards neutrality, non-alignment, aggressions, military pacts, regional groupings, economic alliances, international conflicts, etc.

(*x*) *Co-operation in the international sphere*: Work of the U.N., UNESCO, World Meteorological Union, International Geo-physical Year, International Hydrological Decade, etc.

(*xi*) *Peace research and conflict resolution* on a global scale.

(*xii*) Area studies and issue of politico-geographical bulletins, as is done in the Department of State, USA, by the office of the Geographer and Strategic Research.

The national seminar on Geography which considered an earlier draft of this report has recommended that the following researches should be supported on a priority basis:

(1) Terrain evaluation for strategic purposes;

(2) Geographical basis of the administrative divisions of India;

(3) India's relations with neighbouring countries and the study of boundary-disputes;

(4) Geopolitical influence of the Indian Ocean;

(5) Resource studies: strategic, critical and essential resources, their distribution, utilisation, conservation, procurement, substitution and technological innovations;

(6) Area studies—both in foreign countries and within the Republic;

(7) Political implications of international trade; and

(8) Problems of national integration and the geographical viewpoint.

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VI

Regional Geography

19

Regional Geography

A Trend Report

By

C. D. Deshpande

The Regional Concept

THE RECENT controversies on the content and scope of regional geography are too well known to stand a detailed repetition.[1] For our purpose, it would suffice to summarise the salient aspects of the more prevalent views and assess their relevance to the problems of research in Indian Regional Geography.

The 'regional' view of geography came as a reaction to the 'classical' view during the first two decades of the present century. So fascinating was its appeal in the hands of Vidal de la Blache and his followers that, during the subsequent years, regional geography came to be regarded as the apex of all geography.[2] While Herbertson and Unstead emphasised the 'natural' and 'geographical regions', the French geographers devoted their attention to an analysis and interpretation of 'landscape' in its dynamic aspects with Man and Nature forming a 'complicated amalgam'. *La tradition vidalienne* which highlighted the 'geographic personality' was a work of 'science and artistry'. The French regional monographs of the inter-war period represented the climax of this development and a challenge for emulation in other countries.[3]

Outside France, however, the late 1930's witnessed a search for classification and delimitation of the region rather than a mere acceptance of the 'uniqueness' of the region and its personality. Thus, we became familiar with the terms and concepts such as 'generic' and 'specific' regions, 'uniform' and 'nodal', 'single' and 'multi' featured, and Roxby's 'space relations'.[4] The attempts to apply inductive and deductive methods in classification of regions, speculations about

the region as a concrete object, and the quest for precision about the content and limits of the region, have, almost in despair and frustration provoked doubts about the adequacy of the regional concept. It is argued for instance that the concept is more 'a device for segregating areal features' than an entity; that it presupposes 'determinism'; that it is a static aspect of the reality, that it is incapable of developing generic concepts and principles; and that the concept is, at its best, suitable mainly for pre-industrial societies and areas. 'New Geography' with its quantitative methods and 'models' approach, challenges the claim of regional geography as an apex of geography. It is not surprising therefore, that recent workers are drawn more to those fields of geography where quantification yields some worthwhile results than commit themselves to a search for the region with all its implied 'totality' and subjective evaluation.[5] It may not be out of place to state that, in doing so, they have established a greater alignment and coherence between geography and other disciplines like sociology, economics, or regional science and that they expect the application of scientific methods and general system theory to yield more meaningful results.[6] But they have not altogether done away with our thinking on regions and regional synthesis. In fact, they tend to bring a more purposeful and precise cohesion to our ideas of the regional concept.

This opposition to the regional concept, however, seems more apparent than real. The critics of the concept, far from totally rejecting it, point out the imprecise nature of the concept, and they level their criticism more against the content and the difficulties in delimitation of regional boundaries.[7] This has been all to the advantage of the concept, which, of late, has received (a) refinement in the selection of 'objectives' in place of the 'totality' of man-environment relationship; (b) application of logic and scientific method, (c) a greater objectivity in spatial studies and 'regionalisation' through quantitative techniques, and (d) a significant impact from the theoretical and practical approaches to 'regional planning'. Though 'new geography' is thus reluctant to recognise the status of regional geography as the 'core' and 'apex' of geographical science, the regional concept appears to be emerging with a renewed vigour as a base for marshalling facts for analysis and interpretation. Like 'sovereignty' in political science, the regional concept promises to remain a basal reference in geography and a challenging theme in our academic continuum. A reference to the recent issues of *Geographical Abstracts* is enough to convince us of the unabated interest of geographers in regional geography.[8]

The Indian Context[9]

This reference to the dialogue between the upholders of traditional regional geography and the exponents of 'new geography' appears to have only a marginal relevance to our purpose. We have yet, metaphorically as well as literally, a large ground to cover and the controversies centring round the concept are likely to give us some valuable guidelines in the methodology and quality of our future work. The plain fact is that much of Europe is well covered with highly competent regional studies, and it is but natural that its growing fraternity of geographers is now in search for depth and precision. The U.S.S.R. and Eastern European countries are more committed to 'physico-regional planning'. The Anglo-Saxon geographers of the New World have covered their vast territories both at macro and meso levels, with micro work of specific areas. But North America and Australia, unlike Europe and ancient Asia, lack the historical imprint of man. This possibly denies them the spatial-temporal setting for discovering the 'personality' of regions 'in action'. The case of the countries of the 'thirdworld' is entirely different. Some of them are old civilizations and others are on the threshold of a new era; but both do not have a competent coverage at meso and micro levels. Although Western geographers have covered much of Asia, Africa and South America (and we owe a great debt to them for their highly competent work) much of it is at macro level. Hence arises the need for detailed competent regional studies in a country like ours. For this purpose, the traditional approach seems to be adequate and sufficiently exicting, and with the use of quantitative methods, the prospects of rendering such studies precise, meaningful and purposeful, are indeed high.[10]

Contributions to regional geography of India have been varied in approach, quality, context and the size of the unit of study.[11] The content of these regional studies varies according to the availability of data, maps and results of earlier works. The macro level studies of Reclus, Lyde, Stamp, Sion, Krebs, Spate and Learmonth are well-known.[12]

Problems relating to classification of regions have received some attention. Within the traditionally recognised physical framework of the three tectonic divisions of the sub-continent, attempts at further subdivisions are represented by the works of M. B. Pithawala, Kazi S. Ahmad and others. S. P. Chatterjee in his map of the physiographic divisions of India has recognised 7 divisions, 26 sub-divisions and 58 provinces of India.[13] Spate and Learmonth in their 'India and Pakistan' recognise 36 (inclusive of Andaman-Nicobar and Laccadive-Minicoy island groups) regions of first order, 74 of the second order and 225 further subdivisions.[14]

At a meso level Deshpande (9, 1967) apart from its being a work of pioneering nature in India, satisfies the requirements of a regional geography both in its approach and outlook, and in the portrayal on the time-space continuum of the regional synthesis of physico-climato-botanical framework and the human responses within it. Recognition of sub-regions with the help of traditional and administrative units, portrayal of the essential dynamism of the various subregions, suggestions for a framework of planning regions and regionalism, in this work aim at bringing out the personality of Western India as an entity and the regional diversities within it. Subsequently, a less intensive regional study of present Maharashtra has been attempted, with a regional division of Maharashtra into sub-regions, on the basis of a review of the physical environment and economic infrastructure (12, 1962). Same regional aspects based on agricultural characteristics and physico-climatic elements have been studied in a work in Tamilnad (20, 1949). Similar regional studies of other parts of India have been attempted.[15] A regional account of Bihar is already available (2,1965). In the 'Land and People Series' of the National Book Trust broad regional variations in different states of the Union have been studied; West Bengal, Rajasthan and Gujarat have been already published.

In a recently compiled work on 'India: Regional Studies,' a cross-section of the regional diversities within India is brought out by regional studies of 13 selected regions (25, 1968). Though not of uniform or comparable size (contrast, for example, Kangra Valley with 620 sq. kms. and S. Bihar with 1.2 lakh sq. kms), these studies aim at bringing out the uniqueness of each region and the inter-regional diversities. While the larger units like Telangana (3, 1968), Eastern U.P. (26, 1968) or South Bihar (23, 1968) have been studied in terms of regional patterns at meso level, smaller areas like the Kangra Valley (15, 1968), Meghalaya (7, 1968) and Marusthali (17, 1968) have been studied in terms of the socio-economic aspects of a long-settled community and the regional uniqueness of their habitat. The 'Calcutta Metropolitan Region' is a study in metropolitan economy and its problems of the conurbation set within the core of the eastern meso region (13, 1968). To this has been recently added another volume, *India: A Regional Geography (1970)*, consisting of 28 regional studies. However, true regional monographs both at meso and micro levels are still few and far between, though certain specific regional aspects like physiography and structure, climatic rhythm, agricultural and geographical divisions, resource diversities have each been studied in depth by individual geographers, and that too largely at meso level.[16]

Aims and Tasks of Regional Geography

It should be clear from the foregoing review that, in our context, there is a need for a systematic regional coverage of the entire country. For this purpose, a project based on a stock-taking of the existing situation and the tasks to be carried out within a time period, say the next ten years, is called for. The principal aim of this project should be (1) to locate the various centres and the personnel to carry out micro and meso studies of 'home' regions, (2) to provide for the necessary orientation in depth for younger workers by organising, at all-India and zonal levels, common workshops, seminars and field studies, and (3) to encourage the more responsive to select their areas and complete their commitment within a definite time period.

It is necessary to realise, in this context, that the muse of regional geography can be quite exacting in her demands. These, for a successful regional geography appear to be: (1) the author must know his area of study very well, not only through topo sheets and field visits, but also through a sustained and sensitive living over a major part of his professional career; and (2) the regional geographer needs to be thoroughly trained. It is not too high an expectation that our studies should present a competent portrayal of a region including its personality, aim at identifying and highlighting problems relating to the regional component of life and living of the community, and bring out aspects of space relationship. Even under the best of conditions, regional geography demands a high level of attainment on the part of its devotees.

The question of orientation thus seems to be basically important. A research worker in regional geography needs to be strong in (a) geomorphology, at least the surface geomorphology which at present is termed more aptly as geomorphography, if the regional analysis is to have a solid foundation leading to sureness in the feel for the physical landscape and its interpretation and a further appreciation in depth of its cultural facets; (b) ecology of plants, especially in techniques in mapping and analysis; (c) economic and social geography including its dynamic aspects (e.g. of land use changes and locations); (d) techniques of locating historical and social roots embedded in a region to appreciate the undercurrents of regionalism. (This, in regional geography, is inescapable but so much attended to, in our country); and (e) quantitative methods. Above all it appears necessary that a research worker in regional geography should develop the aptitude for browsing into what is "non-geography" for the very purpose of understanding geography. It is equally essential that some ability in clear and attractive exposition in

writing is required.

Quantification and Indian Regional Geography

A reference is necessary to this aspect of research methodology in view of the growing importance of 'quantification'. Rao and Bhat make an adequate reference to it in their report on 'Geography and Planning'.[17] To this, we may add the caution that quantification is not the end, but a valuable means to attain the geographer's goal. Quantification, which has proved to be a tool of increasing value in single purpose enquiries, also promises to be useful in regional geography. It can also play an important role in assessing the dimensions of the more significant elements in the regional 'milieu'. Nevertheless, it is neither possible, nor indeed desirable, to expect quantification to roll out 'objective' regional monographs from the assembly line of mathematical formulae and computers, as in an automobile factory, because the very nature of regional geography needs perception and understanding on the part of the research worker, and these are largely personal subjective reactions. These can however be fortified with an objective base through quantification; and this consideration applies with even greater force to the study of regions at meso levels where quantitative aggregation could reveal a clearer regional picture than a qualitative assessment. Quantification would thus come in handy as a powerful aid to fill in the discovered gaps and test significant aspects in their conclusions by 'closed circuit' tests. In the regional study of Marathwada, for example, a study of rural settlement hierarchy would reveal the nature of economic and social circulation, and would incidentally show the more favourable 'growth points'. The 'dry zone' of the plateau of Maharashtra awaits more keenly a sample based study to identify the hindrances to development of these poverty-stricken areas, standing out in bleak contrast to the flourishing 'sugar cane' belts in the Pravara and Nira Valleys and in the rich Krishna-Panchaganga-Varna triangle of Southern Maharashtra. It would be worthwhile studying, with the help of techniques of spatial analysis, the impact of land reform on productivity as a major aspect in the regional study of Vidarbha. The tribal areas of Maharashtra offer a rich field for diffusion studies in the innovations that are influencing the life of the tribal community. Another rewarding essay would be to try 'sampling' across the boundaries of tentatively accepted geographical regions such as the Tapi Valley and the Berars. These are some of the examples from Maharashtra which surely have their more dynamic and colourful counterparts in the rest of India. It cannot be overemphasised

that quantification in regional geography—as in other subfields—is an aid to be used, with proper planning, precision and definite purpose, in order to test the validity of a conclusion or to obtain a possibly more satisfactory result in regional enquiry.

The Operational Approach

In the context of the proposed plans of the ICSSR to promote geographical research in our country, it is now intended to suggest a programme of a practical nature that could be organised and implemented.

It is perhaps proper to relegate to the background the traditional controversy relating to geographical regions of India and their delimitation. Such frameworks are useful only as 'starters' and there cannot be any finality about them as the regional concept defies such an attempt. What is more important today is to make a worthwhile addition to our knowledge of the region. Perhaps the more practical way would be to start with the states of the Indian Union as they provide an administrative framework and easily available compiled data on population, economic and social elements and the like. The 'district', understandably, does not yield good results as it is too small in size as compared to a 'State' and not sufficiently varied in its physical setting. The 'District Surveys' as published tend to attract both the handicaps.

From what has been said above, it should be clear that meso level regions are likely to yield some results if they are of the size of a state. Our 'village studies' representing the micro approach have, by and large, gone into a static routine and have become, in many cases, a mere mapping exercise. What was perhaps something new thirty years ago has become 'stale and unprofitable' in the widening horizons of the present geography. Even the best studies among them usually represent a 'snapshot' or a 'still' of a rural landscape, and what one aspires to have now is a short documentary if not a full length portrayal, delineatnig the more dynamic aspects of rural life such as economic changes and their impact on land use, the farming community in its social as well as physical framework, and the like.[18] More urgently needed are the regional studies, of small but representative areas, which show evidence of intensity of application of the geographical method. This is what distinguishes the French regional studies from the rest. Here quantification might be put to good use in preference to case studies or transects.

It may be desirable to make a start with simpler regions and proceed to the more complex. The Kathiawar Peninsula is a museum for studying geomorphological features and their impact on the

colourful landscape of human response. So are the Siwaliks which offer almost a textbook example of a breached anticline. We know hardly of the Peninsular deltaic regions, apart from some general impressions. Our tribal regions have been partly explored by anthropologists but their precise regional base still awaits study. Though we know that the tribal life in the NEFA and Assam operates in a highly dispersed and intensely localised form in the deeply entrenched valleys, there are no detailed regional studies. Even in the more developed regions of the country, our effort seems to be more city-oriented to the detriment of the rural interior. India is still the land of villages. But we have hardly studied the villager in the context of his efforts to tackle the hard environment—his subsistence, his life in its social and economic framework, his 'spatial' participation in weekly markets, bazars, and periodic fairs and festivals, his social contacts, his health and nutrition, and other facets of his existence. An understanding of his problems and outlook, and of his joys and sorrows in life is equally important. Such dynamic regional studies of rural India are necessary and the field is vast and ubiquitous for a keen and competent worker to study.[19] Even in 'city regions' we have concentrated, rather unequally, on the more modern aspects like industrial locations and discovering the 'CBD' and other morphological facets, to the neglect of the precarious urban existence of the common man in slums and on sidewalks.[20] A good and balanced study of an Indian city region should rather concentrate on human values and suffering in crowded spaces, dwelling upon the theme of the 'territorial imperative' so well highlighted by a recent writer. Another fruitful line of regional research would be to study the inter-state boundary belts and present an objective picture of them. At all events, two considerations must pervade our quest for regions of India: (i) determination of regional hierarchies, for which purpose the recent techniques of "regionalisation" hold ample scope and (ii) discovery of, rather the re-discovery of, basal regions like 'Uttarkhand' and 'Karnatak' which are rooted in our ancient tradition and still current in common parlance in spite of a superimposed structure of modern administration. At no time has the need to orient our research through 'Indian eyes' rather than 'Western' been felt so keenly as it is today.

It is suggested that promotion of regional studies in India under the ICSSR could usefully include the following:

(1) Preparation of a national project indicating the areas covered so far in their relative level of achievement in regional studies, and the areas that need further study on the lines and terms of expertise as discussed earlier in this report;

(2) Institution of a strong committee for overall guidance and

supervision and for effective implementation of the project within the specified time period;

(3) Classification of areas to be studied from simple to complex, with an indication of the priorities to be adopted in studying them;

(4) An initial coverage of all the States of the Union with some indications of the depth in analysis and interpretation to be attained. Such a coverage should prove a challenge to further refinements on all-India basis as well as on the basis of 'geographical' regions. (At this stage it would be possible only to have some reliable criteria for discovering inter-regional limits or boundaries and for identifying the core characters of regions);

(5) Apportioning the tasks in regional studies to centres (University departments and other institutions with similar facilities) in different parts of the country, and identifying younger geographers and training them so that, as far as possible, they would take up the study of their 'home' regions (this would encourage simultaneously meso and micro coverage);

(6) Providing adequate funds for individual projects (these would be small amounts) because, unlike the more sophisticated projects, a regional study is principally the work of an individual scholar demanding for the major part personal application in the den and in the field, collation of the data, and reflection; and

(7) Making the sponsoring authority generally responsible for the project, over-all guidance and timely completion; and the publication of the findings.

It is more than likely that such a project would be advantageous to Indian Geography in at least two distinct ways: (i) regional geography is an orderly synthesising of geographical facts, and in that very process, it would be deriving a clearer picture of the Indian sub-continent than what is available in the best of the present studies; and (ii) such a coverage would undoubtedly help other sub-fields as well as allied disciplines. It is in the nature of regional geography that it gives as much as it takes.

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VII

Methods

20

Air Photo-Interpretations

A Trend Report

By

S. P. Das Gupta

Status of Aerial Photography in India

AERIAL PHOTOGRAPHY for the purpose of mapping was introduced in India as early as 1924 by a private agency: Air Survey and Transport Company of Dum Dum. Earlier in 1920, the first attempt at aerial photography was made at Agra. Dr. Dudley Stamp's "Vegetation of Burma", was based on aerial photographs of the forest areas made by this firm. In the thirties and forties, the Royal Air Force started taking photographs for use in the preparation of topographical maps by the Survey of India. During the Second World War, the U.S. Air Force covered a greater part of N.E. India for preparation of strategic and tactical maps. These photographs are no longer available in this country. Air photographs of several areas were taken even in these early years. These include: Chenab Valley, Gomati river basin, Orissa coastal region, Bhagirathi river plain, Malda district, etc. Some of these early photographs of Bhagirathi river at scale 1: 10,000 were used by Das Gupta (8, 1947) in preparing thematic maps for the first time. Biswas (4, 1965) discussed the present position of aerial photography in India. More recently (1968-70) a major part of India has been covered by aerial photographs at scale 1:60,000.

The earlier photographs used by Survey of India for the purpose of topographical mapping were usually at scales 1: 10,000 to 1: 30,000. For detailed work, particularly for mapping crops, settlement patterns and house types, urban patterns, vegetation, etc. scale at 1: 10,000 and larger are useful. For regional survey and mapping work, 1: 30,000 scale is most suitable. For rapid reconnaissance of a large tract involving study of general land use, geomorphological

patterns, etc., the scale 1:60,000 is an invaluable aid.

Use of air photographs in geographical studies is being gradually introduced in India. Various aspects of the use of air photographs have been studied by Ghosh (13, 1950; 14, 1958), Hore (17, 1950; 18, 1958), Krishnaswamy (20, 1959), Burman (5, 1962), Irawathy (19, 1962), Ghosh and Singh (12, 1966), Banerjee (1, 1968), Chansarkar (6, 1968) and Govinda Rajan and Moutappa (15, 1968).

Use of Air Photographs

Air photographs indicate every detail of tracks, creeks, trees, crops, transport facilities, bushes, huts, rock exposures, land boundaries and even smaller objects. They reveal all the intricate patterns of natural and cultural landscapes in a most detailed manner. Air photographs can be very fruitfully used in India to determine the size of fields, distribution of crops, extent of soil erosion, land use, forests, timber types and such other information which would otherwise take considerable time if collected solely from the ground. Air photography is indeed a great time-saving device to a geographer. Air photographs are an exact replica of portions of the earth's surface at a handy scale. With the help of a stereoscope air photographs can be utilised as excellent and accurate three-dimensional representations of the earth's surface, which can form the basis for detailed study and scientific scrutiny.

Till recently, geographers in India were greatly handicapped in carrying out field work on account of difficult conditions of travel involving time and money. The conventional type of field work requires much time and effort in this country. Aerial photographs are unparalleled tools for use as base maps and first rate aids to carry out geographical field work, because of the wealth of detail available on them. In the field, a geographer can use air photographs to locate his own position with reference to the surrounding terrain and identify various features, treating the photographs as field maps. Much information can be gathered from air photographs with a minimum amount of outdoor work. Close examination of air photographs in the laboratory often reveals details which have escaped observation in the field.

Air photographs, however, have certain limitations. The exact position of a point is not readily available on air photographs because of radial distortion of scale on them. As a result, correct distances and directions are not available on air photographs straightaway. But if the central part of a photograph is used, this error is generally too small for most of the geographical interpretation work and regional analysis. On air photographs absolute height of

any point is not readily available as on a topographical map. But it is quite possible to find out relative heights, local relief, local gradient and slope of ground on air photographs with the help of simple measuring instruments. Important features which can be emphasised on maps may sometimes lie obscured on air photographs having too many unwanted details. In any case, for fruitful and best utilisation of air photographs, they have to be supplemented by topographical maps for identification of places and features.

Air Photographs in the Study of Landscapes

Air photographs now serve as the best available tool in the study of landforms. Distribution and characteristics of peneplains, pediments, slopes and various types of erosional features come out much better in air photographs than on conventional topographical maps. Air photographs show vividly all forms of deposition and accumulation. Processes of erosion, deposition, diastrophic movement of the earth's crust are also clearly depicted. Various structural forms such as anticlines, synclines, cuestas, hogbacks, dykes, faults, etc., are clearly revealed in air photographs.

Rock outcrops, types of rocks and soils can be identified in air photographs with a little amount of field work. We all know that certain landscapes, land use patterns, forms of human settlement, alignment of transport lines are basically determined by geological formation, structural make-up and type of erosion. In air photographs, the lithological character of earth's surface and structure of rock strata are seen sufficiently clearly for close correlation with characteristic landscapes, and the morphology with characteristic human responses.

With the help of stereopairs of air photographs and height measuring photogrammetric instruments, it is possible to draw longitudinal and transverse profiles of streams with adequate precision leading to the detailed study of valley forms, grades and erosional chronology to a degree which is not possible with the help of existing one-inch topographical sheets. The processes of valley widening, the gradual development of grade in the river profile, the various landforms and phases of development associated with aggradation of rivers, and river deposits of various texture and composition, all stand out distinctively in air photographs.

Glacial and fluvio-glacial erosion give rise to extremely varied types of landforms. In India extensive glacial and periglacial features are located in the high Himalayas which are relatively inaccessible to geographers and other field scientists. Air photographs are most convenient tools for study of these areas. They will show equally

clearly the past moraine formation and phases of advance and retreat of glaciers.

Air Photographs in the Study of Economic and Human Geography

The imprints of all human activity on landscape come out in various forms in air photographs. It is possible to collect from air photographs an enormous variety of information about the economic and human geography of a country. Even minute details of settlements and their patterns, house types, buildings, their shape and styles, industrial sites, mines and quarries, transport network, farming activity and the crops produced, patterns of holdings, etc. can be traced out with a very high degree of precision in air photographs.

Air photographs have direct application in various types of economic surveys and in obtaining quantitative and other information on natural resources and land use. Studies of land classification, land planning, forest surveys, soil mapping and crop measurements have been carried out in various parts of the world with the help of air photographs. Air photographs are excellent tools in evaluating crop production. Relations between relief, aspect of land, water supply, soils, bed-rock and crops produced are brought out clearly in photographs taken from the air.

Air photographs show clearly the distribution of trees and plant communities, and the type of plants and trees. Air survey is now a recognised standard practice in forest management work in the advanced countries of the world.

Other Uses of Air Photographs

Aerial photographs reveal many details of human occupation of the land in earlier times, and are widely used in archaeological studies. Many details of land use and even areas affected by salinity can be clearly made out on aerial photographs. In certain localities aerial photographs have helped to reveal under-water features and submerged historical sites in the Mediterranean sea.

Aerial photographs in colours are also coming into use more widely. Many differences can be far more clearly and easily made out on these, e.g. difference in crops and stages of ripening and differences between tree species in forests. Coloured photographs are also taken by using special filters and by these means differences that are not noticeable otherwise are clearly revealed, e.g. diseased coconut trees are shown in a different colour from the healthy ones, and different species of forest trees are also shown in different colours. These methods have also helped in showing different kinds of soils.

Training in Photo-interpretation

Skill is required in interpreting air photographs for use in different fields of study. Till recently, there was no facility affording training in photo-interpretation. The Indian Photo-interpretation Institute recently set up at Dehra Dun is now catering to the needs of social scientists in India in this respect. A number of officers of the National Atlas Organisation have undergone training in this Institute for study of soils and vegetation from air photographs. The University of Roorkee and Indian Institute of Technology at Kanpur also offer courses in photogrammetry.

Where large-scale photographs of good quality are available, objects can be directly identified and the photographs interpreted by relatively unskilled persons using universal keys. In certain types of work, from the characteristics visible on the photographs, other associated characteristics of the ground which are of significance may be determined, or identified through association. This method is widely used in studies of vegetation, soils, and crops. From characteristics that are identified on aerial photographs deductions can be made about the nature of other characteristics. For example, from the shape of the land-surface and the river patterns, it is possible to deduce the geological structure and the river patterns, it is possible to deduce the geological structure and lithology. Highly trained personnel will be needed for the latter techniques to be effectively applied.

High-altitude Photographs

As noted by Das Gupta (9, 1967) space photographs can be fruitfully used for mapping certain natural and cultural phenomena. Photographs taken during the orbital flights of these satellites cover practically the whole earth, and Indian territory is particularly well covered. Photographs in colour will be very useful in geographical studies. A number of colour photographs taken by astronaut Cooper in May 1963 cover a large portion of India, on scale varying from 1:2 to 1:3 million, and show parts of India with striking clarity in spite of the great height, ranging from 160 to 267 km. One of the photographs shows parts of the Himalaya, the snow cover, the position of the snow-line and the glaciers and glacial moraines in the valleys, the contrast in vegetal cover on both sides of the Himalaya. On another photograph reproduced by Morrison and Bird (22, 1964), showing parts of lower East Bengal, the forested tracts on the Pleistocene uplands of Midnapore and Bankura districts stand out in sharp contrast to the cultivated stretches of the

flood plains of the Damodar and Hooghly rivers. The difference in the soil characteristics between these two contrasting regions, the silt laden and clean waters in the distributaries of the Ganga delta can all be clearly seen.

Weather recording satellites have been put into orbit by the Americans since April 1960 for obtaining continuous weather data within 55° parallels. Two recording stations for receiving the photographs from the satellites have been recently established in India (USIS 1965), one at Bombay and the other at Calcutta. The scale of these photographs from space is usually less than 1:1 million. These scales are convenient for geographical interpretation. In the weather satellite photographs taken from still greater heights, the scale is much smaller, between 1:100 and 1:200 millions. Raisz (23, 1968) and Guerra-Pena (16, 1968) have shown that these scales are convenient to work with in interpreting features which extend over very large territory. Being on much smaller scales, space photographs cover very large tracts of the earth's surfaces, covering 10,000 to 1,000,000 square kilometers in a single picture. In spite of their small formats, major features of the earth's surface covering wide areas are at once visible though minute details are lacking. Stereoscopic viewing affords no great advantage in the case of space photo-pairs, for the difference of levels between points on the earth's surface becomes very small compared to the great height of the camera stations.

Interpretation of High altitude Photographs

Space photographs show up broader physical features, lithological characteristics and structural patterns of land. De Souza and Sadashivaiah (11, 1969) have pointed out that features like mountain chains, plateaus, hill tracts, deserts, plains, etc., can be easily distinguished and demarcated. Sadashivaiah and De Souza (24, 1967) have correlated physical features with general lithological characteristics on a space photograph of Peninsular India.

Photographs taken from space for meteorological study and weather forecasting will be of value in the geographical analysis of the various climatic phenomena in India. Study of vegetation, its seasonal change, vegetal cover on land, etc., can also be noted on space photographs. Major land use tracts such as grasslands, cultivated areas, forests, swampy areas, irrigated areas, can be correctly recognised on coloured space photographs. Phenological characteristics such as periodical leafing and fall in deciduous forests in India, the appearance and depletion of grasses in deserts, etc., can be easily spotted in space photographs when taken at regular intervals.

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21

Field Work

A Trend Report

By

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Introduction

FIELDWORK IS important in geography in order to understand and evaluate man-environment relationship for which an area or a region becomes the framework of geographical studies.[1] The elements of the regional structure also have a spatial dimension. Fieldwork thus becomes necessary, both in topical and regional studies in geography.[2]

The *regional* concept in geography has some common ground with other disciplines such as sociology and economics in the concept of social or cultural area and regional economics. The design and the content of the fieldwork has, therefore, to keep in view the inter-disciplinary nature of the study. These involve the preparation of schedules for data compilation from secondary sources and questionnaires for local enquiry and imply considerable amount of work in the interpretation of topographical and other maps, preparation of base maps and a preliminary study of the selected area in its *regional* setting.

Regional Studies

Fieldwork in Indian geography prior to 1940 was largely exploratory in nature and lacked clarity in objectives as well as in analysis and synthesis of the observed patterns of geographical elements in the study area. Regional description formed the core of the studies undertaken during this period. The study of Meghalaya which is also a distinct geographic unit is, however, a departure from

the earlier practice of extensive or exploratory studies and represents an intensive study of the selected areas.[3] Ogilvie made a plea for intensive regional studies to be undertaken by Indian geographers in which fieldwork would fill in the gaps in the studies based on secondary data alone (31, 1938). He stressed the need for careful observation and plotting of such details as variations in landforms and soils which are not observable even in the large-scale topographical maps of the Survey of India. This would form the basis for the analysis of the relationship between physical factors and agricultural landuse. Also the rhythm of agricultural activities in different physio-agronomic regions in the country is so varied that fieldwork becomes necessary in order to understand the man-environment relationship in the study area. Analysis, interpretation and identification of the important topographical features from the large-scale maps sets the stage for filling in the related micro landforms and landuse features during fieldwork. The complementary character of fieldwork and analysis and interpretation of available maps and secondary data on landforms, landuse and settlements has been further elaborated and illustrated in a supplementary note to Ogilvie's paper and in the regional geography of Western India (10, 1953). In these studies an attempt has been made to blend field-observation and enquiry in selected villages and tracts into the regional framework provided by the survey based on published data and maps. The sampling of villages and tracts for fieldwork has been purposive but it does take into consideration the magnitude of regional differences within Western India (9, 1948).

The pilot regional survey of the Mysore State is an example of the combination of the use of secondary data for the survey and analysis of the regional structure, supplemented by specially conducted sample surveys which involved the collection of data afresh from local enquiry (28, 1960; 29, 1962). A sample survey of commodity flow by lorries was conducted for one week in which data were compiled by interrogating lorry owners on the commodities moved routewise and the places of origin and destination. This study provided a basis to understand, for the first time, the spatial patterns of movement, intensity or frequency and the patterns of nodality in the study area. Along with the maps of passenger flow based on secondary data, this study revealed the patterns of functional organisation of formal regions of the State.

Another field study was on the estimation of landuse potential in the Western Ghats region (Malnad). The study involved the evaluation of landuse potential by slope analysis and estimation of cultivated area as revealed by the topographical maps followed by local enquiry in sample villages regarding landuse capability

and the problems of reclamation, etc. The sample survey was necessary in view of the large size of the area. Regional generalisation of the findings from sample surveys was possible to the extent the design of the regional survey permitted.[4]

The *Damodar Valley Survey Report* (23, 1968) is yet another example of a meso-level regional study in which fieldwork provided the basis for the identification of settlement hierarchy and the space relations in certain parts of the study area.

A recent study entitled *India—A Regional Geography* (45, 1971) has made an attempt in consolidating some 28 meso-regional studies for the country as a whole based on the secondary data and maps and the details provided by fieldwork on agricultural landuse in selected regions. The fieldwork involved in these studies is mainly in the compilation of landuse data with 'field' as the unit for data compilation and mapping.

Comprehensive micro-regional studies are relatively few in Indian Geography, and where they have been attempted, there is often a variation in the scale of mapping and analysis and the unit area for compilation of secondary data.[5] In studies where rigorous interpretation of the topographical maps is followed by field-observation, local enquiry and mapping, the influence of natural environment on population and landuse and functional interaction between population and settlements is portrayed more realistically than in those based on secondary data alone. For example, in the contact zone between the sandstone uplands and the alluvial plain in the Krishna-Godavari delta, the influence of geological structure on water-supply is reflected in the intensity and variations in the cropping pattern and transhumance.[6] The latter establishes the organic relationship between the delta and the uplands. These regional details are very important in micro-regional studies and are often problem-oriented. Fieldwork in space relations at the micro-regional level provides a basis in understanding the relationship between settlements and landuse and is complementary to similar studies at the meso-regional level. This involves a preliminary study of the pattern of distribution of settlements and population, available services and amenities, and functions and landuse, followed by local enquiry on the mode of movement, frequency and distance travelled for various transactions by the people. From this it is possible to study the patterns of existing settlement hierarchy and space relations and to work out alternative patterns for the future. Fieldwork in such studies is preceded by the formulation of a careful design—whether it is a total or sample survey—and preparation of schedules and questionnaires. The studies of Muzaffarnagar District in Uttar Pradesh and of Miryalguda Taluka in Nalgonda District are two such

illustrations (38, 1969; 40, 1971). The need for fieldwork of this type is also brought out in a study of the patterns of movement and consumer behaviour and travel patterns in the tribal areas (49, 1970).

Systematic Geography (Topical Studies)

Among the different branches of geography where field-work has been or should be an essential part of the study, we might mention geomorphology, agricultural and urban landuse and settlements (rural and urban).

(a) *Fieldwork in geomorphology*: The macro-geomorphic features such as mountain ranges, peninsular plateau and plains have been studied both by geologists and geographers in terms of their evolution and structural relationships. The need for more intensive study of geomorphological problems in India was stressed early in 1951 (46, 1951). According to this study drainage and landform patterns in the Aravalli-Malwa area, evolution of the Peneplains of Chota Nagpur and Bundelkhand and their influence on the configuration of the plateau and troughs in peninsular India, and hydrology and geomorphological evolution of the coastal plains and the Ghats await detailed study by geographers. The genetic process of landform development often provides clues for understanding the variations in landuse and in the very patterning of settlements in certain areas as in the Ganges Plain (47, 1953).

Fieldwork is important in the study of surface morphology and in understanding the influence of climatic and ecological processes on landuse. A study of the Upper Panchaganga Basin (part of the Krishna Basin) provides some illustrations of mapping and identification of the micro-geomorphological features such as concave slopes, structural and alluvial terraces and pediplains within the broad framework of the landforms in the Deccan Trap area identified by the interpretation of large-scale topographical maps (14, 1956). This provided an area basis for mapping and analysis of landuse and settlement patterns.

Similarly identification and mapping of the residual landforms in Chandanapuri Valley (a part of the Godavari basin) revealed the inherent characteristics of the eroded landscape and the adaptation of landuse under such conditions (17, 1959). Similar studies involving fieldwork have been made in the coastal areas, the peninsular plateau and arid and semi-arid parts of Rajasthan.[7] Mapping the geomorphological features in the field often requires large-scale maps of 6″ to 8″ a mile with a corresponding enlargement of the relevant details from the topographical maps on the scale of 1″: 1 mile.

(b) *Agricultural Landuse*: Studies in broad landuse and cropping pattern involve fieldwork for the compilation of data on landuse and mapping through local enquiries. Such studies are carried out in almost all the Geography Departments of Indian universities and have been conducted at the village, tract (groups of villages) or a tahsil or district level or in relatively homogeneous regions identified by preliminary analysis of maps and secondary data. The procedure for such studies normally involves the preparation of base maps of appropriate scale, compilation of landuse data and the characteristics of soils and landform from published and unpublished sources and mapping and analysis.[8] This is followed by field observation and checking for accuracy on the extent to which areal patterns as revealed by maps, conform to the 'ground pattern'. Field tours are undertaken in different crops seasons in the selected areas with a view to studying seasonal variations in the cropping pattern, agricultural practices, etc. In some of the studies, landuse maps have been used as a basis for analysing adequacy or inadequacy of foodgrains and their nutritional value (41, 1960; 4, 1968). The landuse studies aimed at land-classification for landuse planning have emphasised on field work, not only in identifying different landuse patterns, but also in mapping and identification of different landforms such as elevation, slopes, soils, vegetation cover, water-logging, erosion, etc. (33, 1956; 34, 1957; 35, 1959; 16, 1957). In these studies reconnaissance tour of the area is undertaken with the help of the base map and the topographical maps and this is followed by intensive field-mapping in the selected area. The selection of such areas for detailed study is done mostly by purposive sampling, although systematic sampling is also carried out in cases where the objective of the study is to synthesize and generalize the observed patterns over a large area (30, 1962; 6, 1956; 7, 1971). Farm samples are often chosen within the study area with a view to filling in qualitative and quantitative information regarding agricultural practices during the growth phase of different crops, type and quantity of inputs used, etc. This is a field of overlapping interest and fieldwork properly designed and executed would improve the application of benefit-cost analysis and related techniques in crop planning at local and regional levels.

(c) *Urban Landuse*: The study of urban landuse i.e. landuse within a city or town has been the topic of study by geographers independently or in collaboration with town planners. The study involves both reconnaissance and intensive fieldwork for the preparation of landuse maps and for delienating different functional zones within the urban centre. A study of the layout of streets, structure and age of the buildings, multiple use of buildings, etc. requires

intensive fieldwork. Collection of data and information from historical records and a study of the growth of built-up area also involve field-visits and local enquiry. Such studies have been carried out in the course of the landuse study of a town and its hinterland and in the study of regional urban patterns.[9] Regional urban studies and the studies of city and its hinterland involve reconnaissance field-tours as well as detailed enquiries regarding the interrelationship between the city and the region.

(d) *Study of rural settlements*: An analysis of the factors influencing the location of village sites, layout of the buildings, and house types has been made by geographers through mapping and local enquiries in the villages. Such studies reveal the influence of topography, caste and community, and economic conditions on the layout of the village site (48, 1967). The settlement studies in a regional context reveal the man-environment relationship through the recurrence of similar patterns of settlement structure and socio-cultural characteristics (26, 1964). This is a field where geographers, sociologists and cultural anthropologists could contribute to a greater understanding and identification of cultural tracts as unit areas for academic and applied regional studies. Fieldwork is an essential part of such studies.

Observations and Suggestions

1. While it is recognised that fieldwork is an essential part of most of the geographical studies, there is a need to distinguish between a 'visit' to the study area for compilation of unpublished secondary data and information as distinct from a 'study tour' of the area for observation, mapping and correlation of the phenomena at different stages of the study. These are not mutually exclusive; but they do need different emphasis at different area levels or for different topics of study.

2. A reconnaissance study tour of the area with the help of topographical maps and specially prepared base maps, followed by an intensive study tour of selected areas for plotting and verification of the spatial distributional patterns of the phenomena is very essential in micro-regional studies or in the study of landuse or settlements in a relatively small area. In all these cases, the scope and objectives of the study will define the nature of the field work to be carried out.

3. The geographers' contribution, through mapping and analysis, is significant in agricultural landuse studies and helps to determine the factors influencing the existing landuse pattern as well as to analyse land capability for landuse planning. Geomorphological studies of selected areas (on the scale of one inch to one mile and

one inch to four miles) followed by mapping and analysis of the data on soil productivity, vegetation, etc. would facilitate a realistic assessment of landuse potential.

There is scope for standardisation and improvement in the methods of local enquiry with the farmers on agricultural practices and the rhythm of agricultural activities. Apart from the qualitative information that is collected and put into the analytical frame, an attempt should be made to work out quantitative norms of inputs to evaluate the cost implications in alternative landuse. This would require collaboration with agricultural economists. Such studies are becoming increasingly important in area planning at the District and Block levels.

4. The identification of the rural-urban fringe is important because of the intensity and changes in landuse that take place in the adjoining areas of large cities and industrial complexes. This study involves cartographic techniques (for a chronological study of the landuse changes) followed by field mapping and local enquiry.

5. Consumer behaviour and travel pattern is one of the fields where very little is known about the functional organisation of formal space which constitutes the basis of both academic and applied geographical studies. Apart from the compilation of secondary data, locationwise, on the available social and economic infrastructure, an enquiry has to be made with the help of specially designed questionnaires on the purpose and frequency of movement and the places of preference. Such an enquiry provides a basis for understanding the existing patterns of space relations and suggests clues in working out an optimal pattern of central places in a hierarchic manner. Micro regional studies in relatively homogeneous regions could be the basis for organising such studies systematically. Here again, the social and economic content of micro-regional studies require an inter-disciplinary approach in the design and execution of field studies.

6. The recent trend in geography is towards quantification and application of quantitative techniques in regional survey, analysis and synthesis. Here field-work both by sampling and total surveys—would provide a basis for building up the required data base for quantification and for the interpretation of the results of spatial analysis and synthesis arrived at by the application of quantitative and cartographic techniques based on secondary data. Moreover, a close familiarity with the area in all aspects of its geographical personality which is provided by the analysis and interpretation of topographical maps and observation and plotting of local variations during field-work and enquiry, has a distinct place in geographical studies.

7. Regional and topical studies involving field-work should form the core of the training programmes beginning from the graduation

level. Case studies in the application of field work techniques, particularly in micro-regional studies, should form part of the training in research methodology in geography. In view of the wide variation in emphasis and quality of fieldwork, there is a case for the preparation of a *Field-work Manual in geography.*

Notes

1. Man-environment relationship is best expressed in Le Play's formula

Place		Work		Folk
(Environment)	⟷	(Activity)	⟷	(People)

Here place has an ecological connotation and the generalisation of the idea expressed in the formula holds good at different regional levels.

2. These include physiographic structure, landuse structure (agriculture, industry and urban population), settlement structure and the space relations. They are often treated separately in different branches or sub-fields of geography, e.g. physical geography, economic geography, population geography, geography of industries, etc.

3. Chatterjee, S. P. (1936), *Le Plateau de Meghalaya Etude Geographique dune de l'Inde Paris.* Meghalaya is perhaps an unique example of a geographical region in India which has acquired the status of a separate state in the political-administrative set-up.

4. This is one of the important considerations in fieldwork in geography. As regions can be identified by generalisation of the locations and areas at the appropriate scale of areas, field-work properly designed and conducted would provide regional details for correlation and synthesis.

5. These types of studies of administrative districts or of geographical regions of similar size are characteristic of the dissertations at the post-graduate levels.

6. Thirunaranan, B. M. (1954). Also refer Deshpande, C. D. (1948), *In Western India—A Regional Geography* for several profiles of regional studies.

7. Deshpande, C. D. and Honrao, M. S. (1954) and Deshpande, C. D. (1955). The geography departments of the universities of Calcutta, Saugar and the Central Arid Zone Research Institute at Jodhpur have been conducting geomorphological studies for many years.

8. The Aligarh Muslim University is specializing in land utili-

zation studies, while the Calcutta University and the National Atlas Organisation have conducted land utilization studies in the lower Ganges plain.

9. Singh, R. I. (1955, 1964), Rao, V. L. S. P. (1964), Prabhu, V. R. (1953), Thirunaranan, B. M. (1957) and Alam, S. M. (1965, 1969). The geography departments of Banaras Hindu University and Osmania University have been specialising in urban studies.

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22

Quantitative Methods In Indian Geography: Achievements And Prospects

A Trend Report

By
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FOUR DIFFERENT but inter-related methods of spatial analysis have been traditionally used by analytic clusters in geography. Quantitative methods incorporating some of the methods of statistical analysis form essential components of these methods. Methods of cartographic compilation, of history and archeology and of qualitative description offer other techniques of geographical analysis.

Notwithstanding the continuing importance of all these methods in geographic analysis, the future of geography as a fundamental research discipline and as a progressive science appears to rest largely upon the development of appropriate techniques of quantification. For "when you cannot measure what you are speaking about, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thought advanced to the stage of a science, whatever the matter may be" (3, 1955; 6, 1891). A general quantitative analytic interest as evident from recent publications of American and European geographers is, therefore, well understandable.*

In comparison to American and European, Indian geographers have been far too conservative in the adoption of new techniques of research. In fact, the analytical techniques have yet to occupy their due place in Indian geography. It is more so in the case of quantitative techniques. This state of affairs is regrettable indeed because, if there is any scientific field in which India has never been behind any country of the world, it is mathematics. A basic course

* Important among these are Brian Berry, Peter Haggert, R. Chorley, T. Hagerstrand, Tobler, etc.

in mathematics does not form part of essential academic background for advanced training in geography in India.* It is true that several other sister disciplines like geology, sociology, and anthropology are not far advanced in this respect either. But such a situation cannot and should not give any consolation to Indian geographers. For no sensible person, leave aside a scientist, will compete for ignorance.

The purpose of this paper is to review the progress of quantitative geography in India. The paper also suggests the techniques and methods which need to be further developed, refined and adapted to Indian situations and problems. It is hoped that it will generate a meaningful discussion among Indian geographers and will induce at least the younger generation of geographers to move out of the traditional descriptive method of geographical analysis.

Achievements

The contribution of Indian geographers to the development of quantitative methods is too small to deserve a review through time. Partly because of the force of circumstances and partly because of the training of a number of geographers in American and European universities, it is only recently that quantification has been recognised as a valid aspect of geographical research. Still the number of geographers using quantitative techniques is far too small to have a significant impact on the national academic environment. In this review, the attempt has, therefore, been made to take specific areas of interest and discuss the contributions made by Indian geographers and the scope for further work in that area.

Three distinct and rapidly growing sub-areas of research are directly attributable to the growth of quantitative methods. These are:

1. *Studies of Spatial Structure*
   - (a) Spatial distributions
   - (b) Spatial associations
   - (c) Spatial interactions, linkages and networks
   - (d) Spatial hierarchies
2. *Studies of Spatial Organization*
3. *Studies of Spatial Processes*

I. Studies of Spatial Structure

(a) *Studies of Spatial Distributions*: Beginning with qualitative maps of distribution, geographers have progressively quantified the

* There are only few university departments in India which offer courses in quantitative geography.

cartographic representation of phenomena. Early attempts along these lines involved the use of dots for representing absolute values and ratios which were depicted on maps using either isopleth or choropleth techniques. Later, more complex indices of distribution and concentration, such as the location quotient participation ratio, were developed. The use of such methods of analysis is best exemplified in the maps produced by the National Atlas Organization and in the resources inventory studies conducted by the Regional Survey Unit of the Indian Statistical Institute and in the Atlases prepared by the Indian Census Organization.

Another approach to the study of spatial patterns involves the use of centrographic methods and nearest-neighbour techniques wherein the spatial distributions are points in area as opposed to the lines and areas in space. Employing the concept of nearest neighbour distances, attempts have been made to derive a method for locating clusters of settlements (18, 1968). The method involves the definition of critical distance, the distance separating settlements assuming a uniform grid pattern. Where nearest neighbour distances are less than the critical distance, a cluster is identified.

The technique has been applied for the analysis of settlement patterns in different regions, e.g. in Andhra Pradesh and in Assam (20 and 21, 1968). In Assam, the tendency towards aggregation of settlements in mountain and valley situations was in contrast to the uniform spacing in the plains. The study in Andhra Pradesh revealed a tendency towards random spacing of settlements in deltaic areas, while uniform patterns occurred in semi-arid regions.

(b) *Studies of Spatial Association of Phenomena*: Studies of spatial associations between phenomena form an important part of research in geography. In India, such studies have generally not gone beyond systematic cartographic comparisons and visual deduction of spatial associations. An alternative and a more precise quantitative technique does however exist in simple and multiple correlation and regression analysis. Mapping of residuals from regression is an important exercise in the analysis of spatial patterns, in identification of new parameters of association and in selecting problem areas.

The study of the towns of Mysore State by Prakasa Rao was the first systematic attempt in this direction. In this study, regression-correlation analysis was effectively used to unearth the underlying relationship between urban size and occupation, urban growth and occupation, growth of population and size of towns, industrial population and total population, etc. (14, 1964).

Correlation analysis has also been attempted by Lahiri (7, 1969) and Jayasankar (5, 1969) in the delimitation of planning regions,

and Pal (11, 1969). There is very little work on multiple correlation analysis, point biserial correlation analysis and surprisingly enough, on rank correlation analysis although, Alam (1, 1969) has used the latter very appropriately in his recent study.

(c) *Studies of Spatial Interactions, Linkages and Networks*: Another approach to the study of spatial structure is through models of interaction between places which are directly proportional to the product of their masses and inversely proportional to distance raised to an exponent. Potential models, on the other hand, specify the relative accessibility of places to all other places in an area and are very useful in constructing density surfaces of demand and supply of goods and services. A third base of analysis centres on the application of graph theory to the study of networks consisting of transportation routes and model centres. Yet another approach centres on the study of distance decay functions which explain such spatial interactions as consumer travel behaviour.

The approaches and techniques outlined above form the basis of two major studies of the spatial structure; one is of commodity flow of the Bengal-Bihar industrial area (19, 1967) and the other is a study of commodity flows and spatial structure of the Indian economy (2, 1966). In the Bengal-Bihar area, the potential model was used to explain commodity flows in terms of demand, supply and distance. The model was later modified to take into account measures of intervening opportunities. Apart from a number of significant generalisations concerning the flow paths of goods from the area, the study also outlines the alternative strategies for future development of the Bengal-Bihar industrial belt. The study of commodity flows cover the whole of India. It is based on data from *Indian Trade Accounts* covering movements of 63 major commodities between 36 trade blocks in India. The data are examined by factor analytic methods. For every commodity, a 36 x 36 matrix of origins and destinations was prepared. Factor analysis technique employed in the study revealed a division of the Indian economy into a set of regional economies.

The two studies reviewed here broadly cover spatial interaction patterns at a national or macro-regional level. Spatial linkages and interaction patterns at the meso or micro-levels as, for example, the patterns of relationship between town and country or the spatial interdependence between the hierarchy of urban centres starting from the local market town, are yet to be explored.

(d) *Studies of Spatial Hierarchies*: Another area of research that quantitative geographers have been concerned with is the ranking of places in an hierarchical system of interconnected and interdependent parts. Though studies of spatial interactions and linkages could

reveal the existence of hierarchies of centres, the problem has generally been approached in a different way by measuring the types of functions and number of establishments existing in urban centres. Much of the research in this area is carried on within the framework of Christaller-Losch Central Place Models.

By the application of rank-size rule, a hierarchy was established among the Indian cities (100,000 population). Statistical techniques such as location quotient have been used in the functional classifications of cities. The existence of hierarchies among smaller urban places has also been investigated (15, 1965). This study involved a complete enumeration of establishments engaged in 129 central place functions in 62 centres in the districts of Jullundur and Ludhiana in Punjab. Intercorrelations between pairs of functions for the 62 centres were computed. The functions were grouped by cluster analysis and 22 clusters of spatially associated functions were derived. The techniques of nearest neighbour analysis and grouping analysis were then employed to demonstrate the existence of three groups of urban centres at different levels of functional complexity. That these groupings were indeed different was also reinforced by analysis of variance.

II. Studies of Spatial Organization

Studies of spatial organization are essentially concerned with the problem of regionalisation and identification of regions. Traditionally, this has formed the 'core' of research interest in geography. Two fundamentally different approaches have been employed by geographers for the identification of regions. The first approach emphasises similarities between places within a region; a region is considered here as homogeneous with respect to any single criterion or a group of criteria. The second approach emphasises spatial interaction and linkages between places; within a region all places are inter-connected by paths to a focal point, usually an urban centre.

Attempts have been made in recent years to apply advanced quantitative methods to the regionalisation problem. A rather simple technique, involving only elementary statistical concepts, is Weaver's method of defining crop combination regions. This technique has been applied in delimiting crop regions of India. The problem of defining 'total' regions and compages is much more complex than delimiting a set of crop combination regions. In order to identify such regions, geographers use multiple factor analytic methods. This method is appropriate for identifying the nature of the relationship existing between relevant variables and to identify groups of variables that have a common underlying spatial pattern. Multiple factor

analysis was first used to identify groups of similar districts in Madras State. In recent studies of levels of economic development in south India and India, principal components analysis is employed to identify development regions (12, 1965). In these studies, the first principal component was used to construct an index of economic development. On the basis of values of the index, regions of low, medium and high level of economic development were defined. More complex analytical procedures were used to study the spatial structure of the Indian economy to identify economic regions within the broad framework of a general field theory (2, 1966). Multiple factor analyses were first used to identify groups of variables and this was followed by a dimensional analysis to evaluate the degree of similarity between pairs of places (in this case the various trade blocks in India).

The regionalisation problem would continue to attract considerable attention in the future. However, certain alternative approaches to the regionalisation problem still remain unexplored. Among these are graph theoretical approaches for defining nodal regions; the use of principal components or factor analytical methods to identify groups of similar areas as opposed to the identification of groups of variables. The application of those techniques to the regionalisation problem should greatly enhance our ability to solve problems relating to the identification of less-developed areas and problem areas and also in the delimitation of metropolitan areas and planning regions.

III. Studies of Spatial Processes

So far, attention was focussed on studies relating to static spatial situations, although in a number of cases, as in the identification of functional regions, or in the study of spatial interactions, linkages and hierarchies, there was a strong implication of process. The study of processes sharply focusses on such concepts as development, evolution, improvement, and progress. All these involve the two basic dimensions of space and time. Geographers have also focussed attention on spatial processes that lend themselves to mathematical analysis and through such analysis, to making predictions. The spatial processes generally considered here are diffusion processes, communication processes, urban growth processes and migration processes.

The stochastic models are by far the most powerful tools for such studies. Among the several models (with their computer programmes) available to geographers only one i.e. Monte Carlo diffusion model, has been used by Indian geographers to study (1) the diffusion of agricultural innovations such as agricultural coopera-

tives, tractors and improved varieties of seeds in Mysore State (10, 1968) and (2) the diffusion of pump-sets in Coimbatore district of Tamilnadu (16, 1969). The spatial distribution of hotels has also been examined (8, 1968). Attempts to simulate the location and growth of towns using historical data have been made.

Other Important Aspects of Quantitative Geography

1. *Input-Output and Linear Programming Models*: These techniques have acquired great importance in economic geography, especially if the analysis is of a static type. A Paper on inter-industry analysis in Regional Planning (17, 1969) indicates the scope of research in this field. Linear programming together with its non-linear variants can be of considerable use in locational studies (4, 1969).

2. *Testing of hypothesis*: Coming back to statistical techniques the significance of the results obtained from geographical researches must be invariably tested properly. The work done by Misra on diffusion of innovations in Mysore State suffers from this lacuna even though he has given reasons why testing was not attempted. Some of the very simple tests such as chisquare, T-test, etc., can be learnt by any researcher without mathematical background.

3. *Systems analysis*: A large volume of work has been done in India on urban geography. The methods used are mainly descriptive and the studies are intra-urban. Urban centres cannot be treated as isolated units. They are parts of a system of centres; and their internal structure, to a considerable extent, depends upon their external relations and fields. A study of towns has thus to be a systems study. But systems study can be done only with the aid of such tools as network analysis, information theory, input-output technique, nearest neighbourhood analysis, etc.

The Task Ahead

With so much to be achieved in the field of quantitative geography, Indian geographers face a great challenge, a challenge as applied scientists engaged in the by no means easy task of contributing to the solution of the developmental problems of their own country. Geography has yet to attain a position equal to that of allied disciplines in the nation-building efforts. Its inadequate theoretical base and the lack of mathematical training of geographers are the most important factors which retard the rapid advancement in geographic research. The fairly simple tools of analysis that have been in use so far, are no longer adequate and advanced techniques which are designed to handle complex problems should be applied.

It needs no mention that better techniques provide greater analytical capability. With a shift from just identification representation and explanation of the structure and regularities of the pattern of selected phenomena, to a study of the process underlying the pattern of development of phenomena and prediction, the need for the use of appropriate and improved quantitative techniques has become greater. It needs no mention that all phenomena are complex and multivariate in character. The segregation of unrelated variables from the total 'mix' and the selection of the most related variables to facilitate data analysis reducing arbitrariness to its minimum, need appropriate techniques (e. g. factor analysis). Here one caution is that techniques and computations by themselves are not enough, and in fact these should contribute to the formulation and evaluation of theories.

The rapid development of the field of quantitative geography makes it necessary to prescribe priorities and work out a phased programme. Along with better training in techniques, the whole philosophy and the types of research in geography need reorientation. Courses in quantitative geography incorporating statistical and mathematical techniques of spatial analysis should be instituted in selected Departments of Geography at the post-graduate level. There should be greater focus on research in techniques of spatial analysis.

Some of the quantitative techniques for spatial analysis and spatial models are listed below:

(1) In the analysis of spatial point patterns, such as settlement locations, the nearest neighbour technique has wide applications. The application of this technique should now be extended to sectoral and order near neighbour analysis and in the identification of spatial clusters or groups using the Clark's criterion or similar methods. Complementing such analysis, geographers should also strengthen the existing base in centrographical analysis of spatial patterns.

(2) Regression analysis in its simplest forms has been applied by Indian geographers for sometime now. However, the analysis of residuals from regression has not received the attention it deserves. Further, regression analysis may be applied to problems of numerical map generalization, identification of deviant cases and in regionalization. Another area where regression analysis can be fruitfully employed is in the computation of population thresholds in central place studies. Further research is indicated on problems of serial and auto-correlation and contiguity problems.

(3) Multivariate techniques are important for the analysis of complex spatial structures. The techniques most widely used are cluster analysis, principal components analysis and factor analysis. The technique may be employed in a variety of situations ranging from

the analysis of a city's internal structure to regional structure and regional identification and delimitation. Further work on the application of these techniques to spatial problems is suggested.

(4) Graph theoretical analysis is now indispensable in transport network studies. There is, however, need for relating the analysis of networks with socio-economic change and studying the impact of network growth in regional development.

(5) Simulation techniques offer a powerful tool in the study of spatial processes. Monte Carlo techniques and Markov chain models have been successfully employed by geographers. Studies employing these and related techniques need to be emphasised in the context of the shift from static to dynamic analysis in geography. Simulation techniques can be best applied in three specific research areas:

(a) Growth and spread of settlements
(b) Migration, and
(c) Spatial diffusion of innovations.

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23

Thematic Mapping

A Trend Report

By

S. P. Das Gupta

Though techniques of topographical surveying and topographical mapping have been well developed in India since the establishment of the Survey of India more than 200 years ago, preparation of standard thematic maps depicting socio-economic conditions in the country has only been taken up recently after the National Atlas Organisation was set up in 1956 as a specialized government agency responsible for production of thematic maps for incorporation in the National Atlas of India. A critical survey of the progress in India in this field has already been carried out by Chatterjee (29, 1964, 1968). The growing importance of thematic maps is now being realized gradually by specialists in different branches of social, physical and biological sciences.

Mapping Organizations

Organizations whose activities in the field of thematic mapping deserve special mention are: Survey of India; National Atlas Organisation; Map Unit of the Registrar General of India; Damodar Valley Diagnostic Survey; Regional Survey Unit of Indian Statistical Institute; Central Arid Zone Research Institute; and Calcutta Metropolitan Planning Organisation.

Survey of India

The Survey of India has been carrying out topographical surveying and mapping at various scales. Since 1905, coloured topographical maps are being prepared in modern style showing relief features by con-

tours. These topographical maps are usually on scales 1:63,360, 1:126,720 and 1:263,440 (that is, 1 inch to 1 mile, 1 inch to 2 miles and 1 inch to 4 miles respectively). More than 3 million square kilometres of India have been mapped at these scales and topographical survey of the remaining portion in modern style is in progress. Since the introduction of the metric system, the new scales adopted for topographical surveying are 1:25,000, 1:50,000 and 1:250,000 (that is, 1 mm to 25 m, 50 m and 250 m respectively). Some maps at scales 1:25,000 and 1:50,000 have already been published recently. Some 5,000 sheets at scale 1:263,440 cover the whole of India. The maps published by Survey of India are the basic sources of topographical information, and these maps provide the background geographical details required for plotting the results of various types of thematic surveys and for compiling small and medium scale geographical base maps used in analysing thematic data. Survey of India (123, 1961) has also brought out a School Atlas containing several thematic maps of elementary type for use of students.

Besides publishing topographical maps, Survey of India also serves as printers of thematic maps prepared by other Government Departments such as the National Atlas Organisation and Geological Survey of India. Survey of India is also responsible for maintaining records of all air photographs, which are important sources of information for thematic mapping. A new institute for photo-interpretation has been set up in Dehra Dun imparting training in thematic interpretation of air photographs, especially in soil, forest and geological studies of photographs.

National Atlas Organisation

The National Atlas Organisation was set up by the Government of India in 1956 with Professor S. P. Chatterjee as its Director The purpose was to compile and publish comprehensive thematic atlases of India comprising a series of maps depicting the physical base, economic resources and social structure of the country.

The first edition of the National Atlas, which came out in 1957, was in Hindi. It comprised 26 plates along with a detailed explanatory note for each map, both in Hindi and English. There are 21 maps of India at scale 1:5,000,000, 16 maps of India at scale 1:10,000,000, one map of the world at scale 1:50,000,000, and another at 1:60,000,000. There are 18 inset maps of India at scale 1:15,000.000 and 20 maps at scale 1:30,000,000.

The main edition of the National Atlas of India is in English. The Atlas is planned to comprise as many as 300 plates covering all

aspects of socio-economic characteristics of the country. The scales adopted for the Atlas range from 1:1,000,000 to 1:20,000,000. Certain important maps incorporated in the Atlas, such as population, land use and physical features are on scale 1:1,000,000 in conformity with the current international practice. Besides, three other maps are also at the millionth scale, namely, transport and tourism, administrative and state maps. The scale 1:2,000,000 covering whole of India in 5 plates has been adopted for 11 other maps such as general features, lithology, geomorphology, drainage, soils, population density, water resources, etc. Most of the remaining maps, however, are at 1:6,000,000 showing the whole of India on one sheet. Description of thematic maps of the two editions of the National Atlas Organisation has already been given by Chatterjee (29, 1964, 1968).

The National Atlas Organisation has recently taken up the task of preparing a new single theme atlas on irrigation of India on behalf of the Irrigation Commission. Preparation of a Tourist Atlas of India has also been taken up in 1970-71 as a part of the Fourth Plan scheme of the National Atlas Organisation. Besides, the Organisation has undertaken the preparation of a multi-thematic atlas of India on behalf of the National Book Trust.

Office of the Registrar General

The Geographic and Cartographic Division (formerly Map Unit) of the office of the Registrar General, India is bringing out the Census Atlas of India and of individual States and Union Territories. The programme for the Census of 1961 has been completed and State Atlases of Andhra Pradesh, Bihar, Gujarat, Kerala, Jammu and Kashmir, Madras, Orissa, Punjab, Rajasthan, Uttar Pradesh have already been brought out. The remaining Atlases such as of Assam, Madhya Pradesh, Maharashtra, Mysore, West Bengal and Union Territories of Delhi, Himachal Pradesh may be printed in due course Two administrative Atlases of Orissa and Rajasthan have been prepared showing useful information on administrative divisions and sub-divisions in the respective states for reference purposes. The Census Atlas of India, 1961, has also been released. This Atlas runs through 191 plates with interpretations and depicts demographic and economic patterns of the country through various cartographic techniques.

Besides these Atlases, some demographic maps of large cities of India, viz., Delhi, Calcutta, Bombay, Madras, Bangalore, Hyderabad and Ahmedabad have also been taken up for mapping on the basis of 1961 and 1971 Census data.

The Division has now taken up the preparations for bringing out atlases as a part of the 1971 Census Programme. In this programme, the atlases of States/Union Territories have been proposed for depicting various aspects on orientation, physiography, occupational structure, migration, socio-economic demographic and socio-economic regions. Some specialised maps for Standard Urban Areas (S.U.A.) will also be prepared indicating various aspects of Census data which would be available on the 100 per cent sample in the 1971 Census. The compilation of maps for 1971 India Atlas will be taken up on 1:4.5M, 1:2.5M and 1:200,000 which will subsequently be printed in a suitable reduced size. The atlas series of 1971 Census of India will thus present various population patterns and problems from the smallest unit level of taluk/tahsil/sub-division/police stations in various states to the district level for the whole of the country. Besides, the Geographic and Cartographic Division has taken up the preparation of Census Monographs on population and land resources for various parts of the country as an inter-censual project of the Census of India, 1971.

Apart from the preparation of the Census Atlas, maps of many cities of India and Census monographs at the regional level, the jurisdictional maps of States at Tahsil/Taluka/Sub-division/Police Station levels are being up-dated and compiled, showing the location code of villages, population, size of villages, roads (State/National highways), railways, amenities like medical facilities (hospitals, dispensaries and child and maternity welfare centres), important mandis and rural markets, etc. Separate district maps showing population and areas of urban centres, roads, railways and administrative/sub-divisions within the districts will also be prepared and incorporated in the District Census Handbook of 1971, of all the states of India.

Other Mapping Organisations

Amongst other mapping organisations dealing with specialised thematic maps, mention may be made of the Damodar Valley Diagnostic Survey, Calcutta Metropolitan Planning Organisation, Geological Survey of India, Central Arid Zone Research Institute, Indian Statistical Institute, French Institute at Pondicherry and several university departments of geography.

Recently, the Joint Committee for Diagnostic Survey of Damodar Valley, under the guidance of Professor S. P. Chatterjee, has brought out the Planning Atlas of the Damodar Valley Region (32, 1969) comprising 30 plates showing various economic and social characteristics of the Valley from the point of view of planning. The Calcutta Metropolitan Planning Organisation has been busy in carrying out

thematic mapping of different aspects of Calcutta metropolitan region and of other regions of West Bengal. The Organisation (1959) has brought out an atlas of Burdwan district comprising 27 maps showing physical features, soils, rainfall, irrigation, population, transport, employment, industries and facilities available in different parts of the district.

The cartography and geomorphology sections of the Central Arid Zone Research Institute carry out thematic mapping and geomorphological survey of Rajasthan desert. Detailed geomorphological and integrated survey of the Luni Basin in particular has been carried out by the Institute. The Institute has also prepared a thematic atlas of Rajasthan which is under publication now. The Regional Survey Unit of the Indian Statistical Institute has been busy in carrying out integrated thematic surveys. The Atlas of Resources of Mysore State is the outcome of a survey. A review of this atlas has been made by Chatterjee (29, 1964).

The Geological Survey of India has been carrying out systematic geological mapping throughout the country and is responsible for bringing out large-scale maps showing formations, distribution of economic minerals and ground water resources. In 1962, Geological Survey brought out the sixth edition of the Geological Map of India at scale 1:2,000,000, a Tectonic (1963) and a Metallogenic-Minerogenetic (1963) map of India at the same scale. Earlier (1949) the Geological Survey also brought out a geological map of Asia and Far East covering the ECAFE region at scale 1:5,000,000 in six sheets. The map was prepared under the sponsorship of the United Nations Economic Commission for Asia and the Far East and the Commission of the Geological Map of the World of the International Geological Congress.

India Meteorological Department is responsible for publication of daily weather charts for India and for different regions. The Climatological Atlas of India prepared by Elliot (64, 1905) of India Meteorological Department is now long out of print. The Department is planning to produce a new National Climatological Atlas of India in collaboration with National Atlas Organisation. Earlier, the Meteorological Department brought out a Climatological Atlas for Airmen (1943), especially for use in air navigation in India.

The French Institute of Pondicherry has brought out an excellent set of vegetation maps of India at scale 1:1,000,000. Some seven plates along with explanatory monographs have been brought out. Each plate has a number of insets showing bioclimate, soils, physiography, etc. Detailed explanatory monographs accompany each plate of the map.

The departments of geography in Indian universities are engaged,

as a matter of course, in thematic mapping of various types. The department of geography of Calcutta University under Professor S. P. Chatterjee was perhaps one of the pioneers in this field. As early as 1947, the department brought out a coloured map of Bengal showing distribution of population by communities, which later helped in delineating the boundary between West Bengal and what was then East Pakistan. Later in early 1950's, the department carried out land use survey of Howrah district and prepared maps. The department of geography of Karnatak University at Dharwar under the guidance of Dr. B. N. Sinha has taken up preparation of the regional atlas of Mysore State at scale 1 inch to 12 miles comprising some 30 maps.

Thematic Mapping

Though cartography is being taught in the university departments of geography in India for three decades, much progress could not be made in the field of research on thematic and geographical cartography. There is immense scope for further research on mapping techniques and on various problems of preparation and compilation of thematic maps showing physical base, economy, population, settlement and other aspects of the social structure of the country.

Mapping Techniques

The work of this author (37, 1957; 41, 1959b; 45, 1961a; 46, 1961b; 48, 1964b) on various problems of thematic mapping has already been reviewed by Chatterjee (29, 1964, 1968). Besides, he has also taken note of the papers on thematic mapping by Ganguli (67, 1962), Sen (110, 1960) and Learmonth (93, 1956). This author (52, 1968a; 53, 1968b) has discussed the problem of classification and models in thematic cartography and the problem of cartographic generalisation as applied to thematic mapping. Recently, Masood (95, 1968) has emphasised the importance of design and layout of maps. Map design is an especially important aspect in the field of thematic cartography on which further work is urgently needed.

Use of aerial photographs in mapping of various thematic details is being gradually introduced in thematic studies. The work of Burman (14, 1962), Ghosh (73, 1950; 74, 1968), Hore (79, 1950; 80, 1958), Irawathy (88, 1962), Krishnaswamy (91, 1959) and Ghose and Singh (72, 1966) has been reviewed by Chatterjee (29, 1964, 1968). Recently, Banerjee (11, 1968) contributed a paper on geomorphological analysis based on aerial photographs with reference to the Rishikesh area of Uttar Pradesh. Chansarkar (25, 1968)

has evaluated the role of the interpretation of air photographs in terrain studies. Govinda Rajan and Moutappa (76, 1968) discussed the use of air photographs in mapping soil erosion. Pal (101, 1968) and Singh (112, 1968) contributed papers discussing the application of aerial photographs in geomorphological studies.

Since the advent of space travel and exploration, a large number of photographs of the earth are being taken from high altitudes by Soviet and American astronauts and by remote control satellites. These space photographs are going to play an important role in thematic mapping in the near future. The extent to which such photographs can be of use in geographical studies, especially in the field of thematic cartography, has been emphasised by Das Gupta (51, 1967). Recently, a centre for automatic reception of space photographs covering the Indian region, transmitted through television system from the American weather satellites has been set up by the Indian Meteorological Department in Bombay.

Indian cartographers have not yet been able to achieve much progress in the field of map projections. Survey of India (122, 1943) published tables for graticules of maps published by them. Chatterjee (29, 1964, 1968) has already reviewed the present status of research on map projection in India and has cited the work of Ali (3, 1941), Prasad (103, 1955; 104, 1956), Kayastha and Prasad (90, 1957), Betal (12, 1962), Singh (111, 1962) and Dwivedi (61, 1967) in this regard.

While preparing the National Atlas of India, the lack of base maps on projection especially suitable for depiction of thematic information was keenly felt in the National Atlas Organisation. The very first map of India and the world incorporated in the Hindi edition of the National Atlas of India (100, 1959) has been especially drawn on oblique Molleweides projection, keeping India at the centre to emphasise India's geographical and political relationship with other countries of the world. It is well known that for showing distribution of any thematic information on a map, it is important that geographical areas are shown correctly. The small scale maps of India prepared earlier by Survey of India are on projections which do not depict geographical areas true to scale and hence are unsuitable for adoption in thematic cartography. National Atlas Organisation had to prepare their own base maps at scales 1:2,000,000 and 1:6,000,000 on conical equal area projection with two standard parallels. The standard parallels are so chosen as to reduce the linear scale error to absolute minimum. Further research has to be carried out on problems of map projection suitable for thematic and geographical maps of India.

Mapping of Population Characteristics

Chatterjee (29, 1964, 1968) has already reviewed the papers on various problems of population mapping brought out by Ali (4, 1954, 1955), Das Gupta (42, 1960a; 43, 1960b; 47, 1964a) and Chatterjee (21, 1965). The opportunity provided by the detailed data available in 1951 census to map the population of the villages has been utilized by the National Atlas Organization in preparing a map of India showing distribution of population of each village and hamlet of India at the millionth scale. The original map had in fact, to be drawn on a much larger scale of 1 inch to 4 miles, while the villages were actually located on some 5,000 sheets of 1 inch to a mile map. The method used in preparing this most authentic thematic map has been described by Das Gupta (42, 1960a; 43, 1960b). Another map showing density of population in India at scale 1:2,000,000 based on villagewise population falling in each 15 minutes square grid is under preparation in the National Atlas Organisation.

There is a vast scope for further research in the field of mapping the teeming millions in India. Several technical and methodological problems involved have to be solved for accurate depiction of the various characteristics of population. The Census Atlas of India which has been prepared in the Map Unit of the Registrar General's Office deals with various demographic aspects.

Mapping of Economic Characteristics

So far, the problem of land use mapping seems to have drawn greater attention of thematic cartographers in India. In this respect, the work of Chatterjee (28, 1962), Das Gupta (40, 1959a), Sen and Chakravorty (109, 1958) and Gupta (78, 1965) has already been noted by Chatterjee (29, 1964, 1968). In other fields of mapping of economic characteristics, not much work appears to have been done so far. The work of Sen (107, 1967a; 108, 1967b) and Janaki (89, 1968) have already been reviewed by Chatterjee (29, 1968). Recently Dutt (59, 1968) has contributed a paper on the cartographic techniques adopted in the preparation of some socio-economic maps at scale 1:6,000,000 for incorporation in the National Atlas of India and has discussed the merits of several methods of representation of thematic data on maps.

In the National Atlas of India (100, 1959) a large number of economic maps at scales 1:5,000,000 and 1:10,000,000 showing land use, food crops, industries, railways, roads, ports, irrigation, livestock, mineral resources, etc. have been included. A new technique has been used to show both absolute distribution of economic

activity by symbols as well as their relative distribution per unit area of land or per capita by colour tints. Each economic map is, therefore, of a complex character and is supported by insets in relevant topics at smaller scales.

In the English edition of the National Atlas a much larger number of economic maps mainly at 1:6,000,000 scales are being incorporated. Some of the basic economic maps will, however, be at large scales of 1:1,000,000 and 1:2,000,000. The map on transport (1:1,000,000), for instance, provides a composite picture of the infrastructure of the economy available in different parts of the country. Besides, maps on minerals (1:2,000,000), water supply (1:2,000,000), land use (1:1,000,000) and soils (1:2,000,000) will provide fundamental background for study of economic resources of India.

Thematic Atlases

During the last 50 years, a number of thematic atlases covering India as a whole or some regions of India or a single theme were brought out in this country. Chatterjee (29, 1964, 1968) has made a comprehensive survey of all the available thematic atlases relating to India published since 1909.

Atlases with National Coverage

The first thematic atlas covering the whole of India comprising maps on various topics is the atlas volume of the Imperial Gazetteer of India (1909, 1931). The Hindi edition of National Atlas of India (100, 1959) is more comprehensive and complex in character. The maps of the English edition of the National Atlas (100, 1959) are still more detailed and exhaustive. Earlier, the Government of India published India in Maps (82, 1960) for popular and general use, The scope and contents of all these atlases have already been discussed by Chatterjee (29, 1964, 1968).

Multi-thematic Regional Atlases

A number of regional atlases and statistical atlases of different states have been brought out in India from time to time, especially after the publication of Bengal in Maps by Chatterjee (26, 1949). Chatterjee (29, 1964, 1968) has reviewed the scope and contents of this atlas and other regional atlases, such as, the Statistical Atlas of Madras (117, 1949), Economic Atlas of Andhra Pradesh by Ramanadhan and Prakasa Rao (105, 1949), Bihar in Maps by Dayal

(54, 1953), Statistical Atlas of Bombay (115, 1950), Madhya Bharat in Maps (96, 1951), Statistical Atlas of West Bengal (120, 1953), Statistical Atlas of Kutch (116, 1954), Mysore State in Maps (98, 1958), Statistical Atlas of Rajasthan (119, 1959), Statistical Atlas of Orissa (118, 1959), Mysore—An Atlas of Resources by Learmonth and Bhat (94, 1961), Hyderabad by Chaturvedi (33, 1956), Economic Atlas of Madras by National Council of Applied Economic Research (63, 1962), Orissa (1964, 1965), Andhra Pradesh (1966), Punjab 1966), Uttar Pradesh (1966), Rajasthan (1967), Bihar (1966) and Gujarat (1968). Recently, the Planning Atlas of Damodar Valley Region has been brought out by the Technical Advisory Committee of the Diagnostic Survey of Damodar Valley under the guidance of Chatterjee (32, 1969) comprising 30 thematic maps of the valley especially designed for use in planning.

Mono-thematic Atlas

In recent years quite a large number of atlases on crops and other individual themes have been brought out, and these have been reviewed by Chatterjee (29, 1964, 1968). These publications include Atlas of Livestock and Livestock Products of India (6, 1950), Indian Agricultural Atlas (83, 1958), Agriculture Atlas of Madhya Pradesh (1, 1959), Indian Cotton Atlas (84, 1959), Atlas of Indian Lac (5, 1958), Indian Oil Seeds Atlas (86, 1958), Indian Jute Atlas (85, 1959), Coconut Atlas of India (35, 1959), Indian Tobacco Atlas (87, 1959), Diet Atlas of India (56, 1964), Agro-economic Atlas of Madhya Pradesh (2, 1965) and Atlas of Northern Frontier of India (8, 1960). Since then a few other atlases dwelling upon single themes have been brought out. These include atlas showing tracks of storms and depressions in the Bay of Bengal and the Arabian Sea by Indian Meteorological Department (1956), Agricultural Atlas of Punjab by Duggal (57, 1966), Soil Geographical Zones of Haryana also by Duggal (58, 1970), Gujarat State Agricultural Atlas (77, 1968) by Director of Agriculture of Gujarat and a new edition of Mysore State in Maps (98, 1958, 1966).

Mappable Information

For preparing thematic maps, it is absolutely essential to have easy flow of mappable information. Perhaps one of the reasons why thematic cartography could not develop in India till recent times is that collection of up-to-date and detailed data had been difficult. The existing official machinery for collection and dissemination of basic data like those on land use, crop production, crop yield,

livestock, etc. are hardly adequate. Mode of collection of information in different states in India usually vary as a result of which the information obtained is not uniform for all states. Moreover, a great bulk of official data is not made public and are kept in manuscript records only. It is necessary to find ways and means of obtaining unpublished official data for use in thematic mapping by different official and non-official cartographic organisations. It is essential that a suitable data bank be established which will collect, compile, and store, in a systematic manner, all types of mappable information. The National Atlas Organisation has, since it was established in 1956 collected a vast amount of thematic data on all facets of Indian economy and social characteristics available either in published or unpublished form. This may serve as a nucleus of the data bank if it is developed further and proper arrangements are made in this regard.

Economic Data for Thematic Mapping

The statistical departments attached to most of the State Governments in India usually compile and publish data relating to the resources and economic activities of the states concerned. At an all-India level, different Central Government Departments such as Ministry of Food and Agriculture, Central Statistical Organisation, Ministry of Irrigation, Forest Department, Ministry of Commerce and Industry, Ministry of Transport, and Planning Commission, compile publications giving various types of statistical information covering the whole of India. But the published materials are often not detailed enough for use in mapping. For thematic mapping, detailed information at the lowest possible level is essential and this is not readily available in most cases. Information on certain social characteristics such as literacy, age and sex structure, housing condition, languages etc. is available from census records.

Information on Settlements

There is a dearth of information relating to urban and rural settlements. Large-scale maps of towns and villages are not usually available. The Survey of India topographical maps at scale 1:63,360 are not detailed enough to be suitable for mapping and classification of settlements. The only reliable source of information is air photographs at various scales, larger than 1:50,000. Unfortunately, these are not readily available, even to official organisations. It is essential that rules relating to issue of air photographs should be sufficiently flexible so that the vast amount of thematic information collected

through them becomes available for the compilation of thematic maps. Besides, the unpublished information collected by different departments of the State and Central Governments needs tapping for use in thematic cartography.

Demographic Data for Thematic Mapping

Collection of data relating to characteristics of population is well organised and centralized. The census of India conducted every ten years, by the Census Commissioner of India and published by the Registrar General is an extremely useful document. The publication of census data is well organised, although the publication of detailed information sometimes takes a long time. The census data also reveal certain economic characteristics of population as brought out from the occupational structure of population.

Conclusion

From the foregoing review of the status of thematic mapping in India it will appear that more intensive research is required to fill the gaps existing in several aspects in this field. For instance, there is a great need to carry out systematic survey of land use and to bring out land use maps at a sufficiently large scale. This necessitates team-work and a large survey organisation. The existing thematic mapping agency, the National Atlas Organisation, should be sufficiently strengthened and upgraded into a geographical survey and research organisation to fulfil this requirement.

At the university level, various types of field surveys are being carried out by research scholars and advanced students under the guidance of university teachers. However, the mapping part of such studies is rather neglected, mainly because of paucity of funds. Preparation of maps based on thematic surveys entails substantial expenditure of money. Results of thematic surveys carried at universities and by individual geographers if brought out in a systematic manner through funds made available from some sponsoring body, will be of great value in compiling various types of complex thematic maps of India.

Research on the following aspects of thematic cartography is needed to bridge the existing gaps and to fulfil the future requirements of thematic maps in the country.

(1) *Scribing methods*: The new improved technique of drawing thematic maps developed in western countries, known as scribing method, has not yet been introduced in India, mainly because of lack of know-how, equipment and raw materials needed for the

purpose. It is necessary to carry out research on (i) development of suitable scribing instruments, (ii) production of drawing sheet of required type of plastic base suitable to stand Indian weather conditions, and (iii) preparation of a correct type of costing medium. Scribing method in drawing thematic maps can be introduced in India if these three items are properly standardised after extensive trial and experimentation. Once this is done, drawing and reproduction of thematic maps will be much easier and maps will be reproduced at a much less cost (see Das Gupta 41, 1959b).

(2) *Use of air photographs*: Much work has been done in the U.S.A. and other western countries about the use and interpretation of air photographs for thematic mapping. A greater part of India is now covered by air photographs at different scales, and hence it is now possible to establish a series of keys of photographic images of different types of landscapes as recorded from the air. More field work with the help of air photographs is now needed to be carried out in different parts of the country and in different seasons and results brought out so that further work of thematic mapping based on air photographs becomes easier.

(3) *Use of space photographs and remote sensors*: Photographs of the earth taken from high altitude in the space are now proving to be of invaluable aid in rapid compilation of small-scale thematic maps. Hundreds of such photographs are being taken every day, a number of them covering substantial portions of the Indian region, from weather satellites put up in space by the U.S. Space Administration authorities. It is now up to us to make use of them for mapping out various thematic aspects of India. An interesting study of rock structure in South India has recently been made by D'Souza (46, 1968) based on colour photographs taken by Gemini astronauts. Such studies could be carried forward on other thematic aspects of India.

Sensing of environment by various sensitive devices placed on aircrafts and space vehicles has been in vogue in the U.S.A. and Soviet Russia. This is a new field of research in which Indian thematic cartographers will find much scope to break fresh ground.

(4) *Map projection*: Though there is hardly any scope to make fresh contribution in the mathematical aspect of map projection which is a well-developed field already, there is a great need for developing several projection grids suitable for depiction of thematic details with minimum error in scale and shape at different parts in the maps of India.

(5) *Map design*: Not much work has been done on the design or appearance of a map. Much depends on the shape and lay-out of the details of a map for its successful utilisation. There is a need to

develop further the theory of map design and methods of representation of thematic data suitable for depiction on maps of India.

(6) *Computerisation and automation in mapping*: Conventional map-making is a slow process. As a result, a map is invariably out of date as soon as it is published. It is, therefore, necessary to carry out research on rapid processes of map compilation and printing. If we are to deal with the vast amount of thematic data now piling up and covering the whole of India, some sort of automation will have to be introduced in the mapping technique. The only answer to this problem is provided by use of computers and other mechanical aids specially adapted for producing maps. In England, several such devices have been brought to use (see Das Gupta 49, 1964c) and the computer has already been pressed into service in the U.S.A. for producing thematic maps involving synthesis of extensive and complicated series of statistical processing and plotting of data. Research on this line, especially on problems of geographical programming of computers suitable for use with mappable data available in India, is a growing need.

(7) *Problem of generalization*: In the field of thematic mapping, the question of generalisation of topographical detail and problems relating to application of cartographical generalization effected through transformation of thematic data into mappable form are of utmost importance. More attention now should be directed towards solution of different problems of map generalization. The question of generalisation leads to the problem of classification of thematic data into significant mappable form. Fundamental research is yet to be carried out in the basic theory of map generalisation and theory of classification of mappable information (see Das Gupta 52, 1968a; 53, 1968b).

(8) *Population mapping*: As already mentioned, National Atlas Organisation of India has brought out, for the first time, a map showing distribution of population based on villagewise data. Nevertheless, there is a need to prepare specialised maps showing various other characteristics of population in exhaustive detail. Now that very detailed population data for each village are already available for 1951 and 1961 and will be forthcoming for future censuses as well, it is necessary to take up research as to how best this enormous amount of information is to be mapped. It will be necessary to attempt the preparation of complex maps showing different aspects of population characteristics correlated with various geographical factors obtaining in different parts of the country. In this particular field, thematic cartographers will have much to contribute to the understanding of regional and local patterns of human ecology and social infrastructures in India.

(9) *Settlement mapping*: Another field where thematic cartographers can play a decisive role is the mapping of various aspects of human settlement, both urban and rural. Now that a large part of the country is covered by aerial photography, it is possible to deal with this problem in detail.

(10) *Economic maps*: Under the conditions of a developing economy as obtaining in India now, it is important to make accurate maps of the changing pattern of productive forces. Preparation of resource inventory in the form of economic maps is a fundamental requirement for carrying out any plannig for resource development or for transformation of the physical environment. Thematic cartographers will be required, for this purpose, to carry out detailed survey and mapping to show the various uses to which land, water and human resources are being currently put. It is, therefore, necessary to establish, through research, the techniques of resource mapping and eventually to take up a systematic programme of complex economic mapping at a large scale. Preparation of land use maps, as mentioned earlier, is a fundamental requirement leading to complex economic mapping at a later stage.

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VIII

Training In Research Methodology

24

Training In Research Methodology

A Trend Report

By

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Introduction

The training of post-graduate and Ph.D. students in research methodology has an important role in the rapid advancement of geographical research. It is not merely the number of professional workers in a field and the number of institutions that offer research facilities but also the quality and variety of courses of training and research that have an important bearing on the growth of a discipline. This is particularly true of geography.

In order to obtain factual information on existing facilities for training and research in geography, the ICSSR appointed a sub-committee in April 1970. The sub-committee prepared a draft questionnaire which was circulated among 48 universities and research institutions. Responses from 31 of these institutions formed the basis for the sub-committee's draft report which was again circulated for eliciting opinions and comments. In the light of the above, a Working Group was set up to review training in research methodology in geography in August 1971. The terms of reference of the working group are as follows:

(i) To review the existing training programmes in various institutions in the country,

(ii) to suggest modifications needed to improve the programme
  (a) at the undergraduate level
  (b) at the post-graduate level
  (c) at the doctoral level, and
  (d) for in-service training of teachers at various levels,

(iii) to outline a programme of action to implement the sug-

gestions given under (ii) above; and

(iv) to suggest a programme of publication of literature relating to research methodology in geography to help implement the programme of action suggested under (iii) above.

The Working Group, consisting of V. L. S. Prakasa Rao, S. Chakravarthy and R. P. Misra, met in Delhi and after full discussions designed a questionnaire to collect data on training in research methodology in geography.

The questionnaire sought information on the following aspects:

(a) Levels of teaching/research programme
(b) Faculty structure
(c) Teaching and research facilities including Laboratory facilities, Cartographic equipment and Library facilities.
(d) Courses of study relating to research methodology
(e) Research training background of teachers
(f) Research projects completed and on hand
(g) Ph.D. research completed during the previous 5 years; and
(h) Comments on gaps in training in research methodology.

In all, 31 university and college departments of geography responded to the questionnaire survey. The first survey carried out in 1970 and the resurvey of 1971 provide valuable factual information and it is on the basis of these that this report has been prepared. It is organized into four sections:

(a) Training facilities;
(b) Programmes of training in research methodology;
(c) Employment opportunities; and
(d) Suggestions for improvement of training in research methodology.

Training Facilities

The existing facilities for training of geographers are reviewed in terms of: (a) levels of teaching in various institutions, (b) faculty strength and structure, and (c) teaching and research facilities.

(a) *Levels of Teaching*: Of the 31 institutions responding to the questionnaire, 15 are university departments of geography and 16 college departments. While all the 15 university departments had training programmes leading to the Ph.D. degree, one college also offered this facility.* However, the great majority of the college departments (12 out of 16 responding to the survey) offer instruction only at the bachelor's degree level.

*In a number of universities, training facilities exist only in the affiliated colleges in all subjects including geography.

TABLE 1

Institutions by Levels of Teaching

Levels of Teaching	*Number of Departments of Geography*	
	*University**	*College*
Ph.D. and M.A.	8	
Ph.D., M.A. and B.A./B.Sc.	7	1
M.A. and B.A./B.Sc.		3
B.A./B.Sc. only		12
Total	15	16

*One university department also offered an M.Litt. course in geography.

(b) *Faculty Strength and Structure*: The university and college departments together had a total faculty strength of 156 teachers. The ratio of professors, to readers and lecturers was approximately 1:2:8; the ratio was more favourable in the case of the university departments, but only slightly. The university departments, had an average of 7 teaching staff members, while the colleges had only 3.

The non-teaching staff number 44 in the case of the university departments and 13 in the case of the colleges, an average of 3 non-teaching staff in the university departments and one in a college department.

TABLE 2

Institutions by Faculty Structure and Size

No. of Positions	*Professors*		*Readers*		*Lecturers*		*Non-teaching Staff*	
	U	C	U	C	U	C	U	C
0	5	13	2	12	—	—	1	6
1	10	2	9	4	0	2	2	7
2	—	1	3	—	2	6	3	3
3		—	—	—	2	5	4	0
4			1	—	3	2	3	0
5					3	0	—	—
6					3	0	2	0
7					—	1		
8								
9					—	—		
10					2	—		
Total	15	16	15	16	15	16	15	16

(c) *Teaching and Research Faculties*: Laboratories, equipped with topographical maps, atlases, drawing instruments for prepara-

tion and analysis of maps, form an essential and integral part of facilities for training geographers. While no attempt is made to evaluate the quality of such facilities, the survey revealed the extent to which such facilities existed. Laboratory facilities existed in all the 15 university departments responding to the questionnaire, while 4 out of the 16 college departments had no laboratory facility at all. On an average, a university department has three laboratories, while a college department had only one laboratory. Further details of laboratory facilities in universities and colleges can be had from Table 3.

TABLE 3

Institutions by Number of Laboratories

Number of Laboratories	*Number of Geography Departments*	
	University	*College*
0	Nil	4
1	3	10
2	5	1
3	2	1
4	2	Nil
5	2	Nil
6	1	Nil
Total	15	16

Another important facility for training of geographers is the availability of technical journals. The journals are classified into two categories: (a) Indian, and (b) Foreign. The data relating to subscription of journals belonging to the two categories are presented in Table 4 below:

TABLE 4

Number of Colleges and Universities Subscribing to Technical Journals

Number of Technical Journals	*Number of Departments Subscribing to*	
	Indian Journals	*Foreign Journals*
Less than 5	18	23
5-10	8	6
10-15	2	1
15-20	0	0
20 or more	3	1
Total	31	31

While every institution subscribed to one or more technical journals, the vast majority subscribed to less than five Indian and five foreign journals. More significantly, only two institutions out of the 31 responding to the questionnaire subscribed to more than ten foreign journals and only five institutions subscribed to more than ten Indian journals.

The questionnaire did not attempt to obtain information on data processing equipment, such as calculating machines and computer facilities. These are becoming increasingly important in the training of research scholars. However, in another sphere, namely, cartographic equipment, with only three exceptions, all institutions have some equipment, though this was invariably considered as being inadequate.

Programmes of Training in Research Methodology

Training programmes in research methodology in geography may be categorized into two types: (a) formal programmes and (b) informal programmes.

(a) *Formal Programmes*: Formal training in research methodology is introduced through specific practical courses, or theory courses involving a methodology content or by way of optional or compulsory project reports.

Practical courses, which include instruction in cartography, elements of quantitative geography, map analysis and field work, are considered as a must in the training of geography students in every institution. However, the degree of emphasis on practical courses varies considerably, as revealed by the allocation of marks to practical courses in relation to all courses of reading. The percentage marks allotted to practical courses vary from 20 to 50 with an average of 25. It may be emphasized here that an undue weightage to practicals could lead to a weakening of the theoretical basis of training which would be most undesirable. Likewise over-theorising is equally undesirable.

Apart from practical courses, students at the Masters degree level are encouraged to undertake dissertation work on selected topics and this invariably involves library and field work. While the field surveys and project reports are not compulsory in all Geography Departments, they do in fact constitute an important form of training. In institutions where project reports are optional, only the best students are encouraged to undertake such a programme.

In addition to the above, seven out of the 31 institutions responding to the survey also offered specific courses in research methodology for post-graduate/or doctoral students.

(b) *Informal Training in Research Methodology*: Included within this category are two types of training: (a) guidance of Ph.D. research and (b) on-the-job guidance in research projects. In addition to this, many institutions also hold periodic research seminars and workshops.

As mentioned earlier 16 out of the 31 institutions offered Ph.D. level training. In all 59 Ph.D. theses were completed during the last five years in these institutions. This works out to an average of three Ph.D. theses per institution during the 5 year period. The number of students benefiting from this type of training is very limited. Nevertheless, there are significant differences in the emphasis on the Ph.D. programme in various institutions as indicated in Table 5.

TABLE 5

Number of Ph.D. Theses Completed in the Preceding 5 Year Period

No. of Ph.D. Theses Completed	*Number of Departments of Geography*
0	15
1	1
2	4
3	4
4	1
5	3
6	2
7	1
Total	31

In the light of the increasing tendency for undertaking project research in academic institutions, it is not surprising that on-the-job training in research projects forms an important aspect of training in research methodology in geography. As many as 15 departments of geography had undertaken project research during the last five years as shown in Table 6.

Project research is primarily carried on in university departments although 4 out of 15 university departments had no research projects during the last five years. Among the various sponsors of research projects are the University Grants Commission, the Planning Com-

TABLE 6

Number of Research Projects Completed or in Hand During the Last Five Years

No of Research Projects	*No. of Geography Departments*	
	University	*College*
0	4	12
1	3	1
2	2	1
3	2	2
4	2	0
5 or more	2	0
Total	15	16

mission, the ICSSR, and the concerned universities themselves. This is shown in Table 7.

TABLE 7

Sponsorship of Research Projects

Sponsoring Institutions	*No. of Research Projects*
U.G.C.	7
University	6
College	4
Planning Commission	2
ICSSR	2
Others	9
Total	30

Employment Opportunities

The ultimate objective of academic institutions is to train geographers for teaching, research and professional work. While full information on the number of trainees obtaining M.A. and Ph.D. degrees in geography is not available, it is roughly estimated that about 1000 M.A. and 20 Ph.D. students in geography take their degrees every year in the country. There is also an additional source of manpower in foreign trained M.A.'s and Ph.D.'s in the field. Nevertheless, there is a strong case for strengthening the training of geographers in India at the Ph.D. level. This need is clearly reflected in the ratio of Ph.D.'s to M.A. degree holders, which is roughly of the order 1:5. This only suggests that the Ph.D. programmes should be strengthened through more scholarships and fellowships.

In recent years the supply of geographers (particularly post-graduates has become alarmingly large in relation to specific opportunities that are open to geographers only. However, in this context, it should also be mentioned that geographers could and do seek opportunities in government and private sectors that are open to graduates and post-graduates in all disciplines. Nevertheless, there are certain institutions where geographers are preferred, even on an exclusive basis, as for example, in the National Atlas Organization. In addition, several research organizations in the country have geographical units, such as the Indian Census Organization, Indian Statistical Institute, Central Arid Zone Research Institute, and the National Institute of Community Development. Geographers are also employed in the Town and Country Planning Organization and in the Town Planning departments of the various state governments. By far the largest opportunities for geographers are found in the educational field. There is certainly an increasing demand for geography teachers at the higher secondary level and in the colleges.

Recent experience indicates that geographers are gaining wider acceptance in research and development organizations but there is an urgent need for improving the technical skills of geographers so that they can be effective and justify their role in the new avenues of employment.

Suggestions for Improvement of Training in Research Methodology

There is perhaps a notable unanimity of opinion in regard to the need for improving training facilities in geography. The responses to the questionnaire survey highlight the major bottlenecks of inadequate funds and lack of physical facilities. Yet, there also emerges, in the comments of some of the respondents, the need for innovative programmes, which would result in the optimal use of existing physical and man-power resources. In the light of the responses to the questionnaire survey, the following suggestions are made with a view to improving the training in research methodology in geography:

(1) There is certainly a need for introducing formal pre-Ph.D. training courses in research methodology. The existing training facilities do not adequately prepare M. A. candidates to undertake serious research at the Ph.D. level. Since a candidate with an M.A. degree is under pressure to seek a job, any pre-Ph.D. programme would not yield results, unless a fair amount of financial support is given to the trainees.

(2) To meet the needs of those geographers who already have a job/position and who cannot spare an entire academic year, short courses in research methodology of a duration of less than three months is suggested.

One important drawback of short-term courses is that they are often organised at an institution just for one year. The experience gained in a short-term course is not taken advantage of. There is a need for organizing short-term courses on a continuing basis for 3 to 5 years in the same institution which has already gained experience and has the necessary skills.

(3) Training in research methodology in geography should have a bifocal emphasis as far as research techniques are concerned: (a) cartographic and field methods and (b) quantitative methods. The former have been rightly emphasized in all institutions training geographers. There is certainly a need for introducing new courses on quantitative and field mapping methods at the B.A., B.Sc. and M. A. levels.

(4) Much of the training that geographers receive is ingrown in their own discipline. Geography students at the M.A. level should be allowed to take one or two courses in disciplines like economics, sociology, political science, psychology, to mention a few.

(5) Another important aspect of training in research methodology is the shortage of trained teachers. It is appropriate that steps should be taken to facilitate inter-University exchange of teachers for teaching specific courses in research methodology. It must be emphasized here that an agreement in principle is just not enough.

(6) It is a fact that physical facilities existing in certain departments of geography are absent in others. There are inter-departmental disparities. This is particularly true in the case of data processing facilities, which are necessary for the use of advanced techniques. To take maximum advantage of these facilities, consideration may be given to the inter-university movement of students at M.A. level for short periods of less than a month, (which could very well coincide with the vacation period). Special lectures on methodology could be integrated with the normal field excursion programmes, which could be planned for a longer period.

IX

Summary And Recommendations

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Summary And Recommendations

By

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V. L. S. Prakasa Rao

THE SURVEY of Research in Geography has been organized into twenty-four chapters, each of which is devoted to a review of research in a subfield of geography. What follows is a summary of each of the review reports. It also includes a few suggestions for the development of research in the subfields concerned.

Agricultural Geography

The review of research in agricultural geography focuses attention on four major areas of research: regional agriculture, food and commercial crops, agricultural problems and planning, food supply and population studies. Regional agriculture attempts to analyse the influence of the physical environment on agricultural practices and the distribution of crops in selected regions. Topical studies of the distribution of individual crops on a wider regional canvas have also been well explored. Research on agricultural problems and planning has emphasized the organizational aspects and role of specific elements of the agricultural infrastructure such as irrigation and has dealt with problems of spatial differences in agricultural efficiency. In relation to the above, considerably less research has been done on the relation of food production to population and the related aspect of nutrition.

Recommendations for future research include: studies on the possibilities of marginal and sub-marginal lands; case studies of changing crop patterns at different regional levels; and detailed studies on the identification, delineation and development of dry farming regions at the macro, meso and micro levels.

Landuse Studies

Landuse studies range from inventories of landuse surveys to isolated topical or regional descriptive accounts of landuse variations, both in time and space. The research review of this subfield considers three areas of research: landuse planning and methodology; case studies; and changing landuse and recent trends. Considerable work has been done on the methodology of landuse surveys, particularly in relation to their role in planning. Case studies of landuses comprise a major share of research in the subfield and these range from micro or village level studies to regional evaluation of landuse problems. The application of quantitative techniques has been particularly noteworthy in the studies on landuse changes and the delimitation of crop combination regions.

The construction and testing of agricultural landuse models should receive priority in future research in this subfield.

Forest Resources Geography

The study of forest resources has attracted the attention of geographers since the 1920s. Early work in this area tended to touch on the ecological aspects of forests, emphasizing the climatic, edaphic and biotic factors. Later studies focussed on regional aspects of forest resources, each study concentrating on a specific part of India. Work has been done on the classification of forest types and on the division of India into botanical regions.

The areas of research recommended for future development are: studies of forests at the micro-regional level; regional studies to estimate the potentials in forest resources; studies on the relationship between forests and such problems as soil erosion, flood control and development of forest-based industries; and further work on the ecological aspects of forestry and forest management.

Resources Geography

Review of research in this subfield includes studies on agricultural, animal, fish, and water resources, soils and soil erosion and mineral resources. Although substantial and sustained research has been carried out in this subfield, the majority of the studies reviewed are descriptive in character and contain primarily data on resources potentials and their regional distribution. Systematic regional studies of resources provide only partial coverage of the states and regions of India and a notable feature is the absence of emphasis on conservation problems. Specific recommendations for future research in

this subfield include: studies on evaluation of regional resources potentials; and the delineation of resource regions.

Industrial Geography

Research in industrial geography focuses on spatial distribution of industries, geographical factors operating in their location, and aspects of the industrial landscape. Studies reviewed in this subfield include both general regional studies and systematic studies on specific industries. The areas of research reviewed are: location in industries; mineral-based industries; agriculture-based industries, forest-based industries; and small scale and cottage industries. A dominant trend in this field is the analysis of concentration and dispersal of industries on a regional basis.

The topics recommended for future development include: studies of industrial growth points for underdeveloped areas; studies of industrial satellites; and studies of regional industrial patterns.

Industrial Complexes

The study of industrial complexes is a new field of research in geography and as such only four studies have been located. These relate to the Bengal-Bihar industrial belt, the Hoogly-side industrial complex and the Kulti-Burnpur and Durgapur steel complexes. The studies of industrial complexes involve a consideration of inter-industry dependence, resource base, input output characteristics, infra-structure and marketing relationships which eventually affect regional growth.

Priorities in research will include: studies on the structure of industrial complexes and the role of agro-industrial complexes in area development.

Geography of Transport and Marketing

The early studies in transport geography were mainly descriptive and many were limited to individual districts. Later, different States have been examined and accessibility has been dealt with but still only descriptively. Regional contrasts and problems of traffic flow were brought out in certain areas. Disparities in the transport system have been examined as part of the work in the National Atlas Organization. Marketing studies were also descriptive in the early stages and dealt with either particular commodities or particular marketing centres. Trade passing through certain port towns has also been studied. The internal structure of urban markets, and the

relations between market centres and their hinterlands have also received some attention.

The mapping and analysis of flow data on a systematic basis is suggested as a priority topic for future research.

Geography and Metropolitan Planning

In metropolitan planning, the contributions of geographers have been more or less of a supplemental nature. Systematic metropolitan regional studies are available for only a few Indian cities such as Delhi, Calcutta, Kanpur and Hyderabad. In each of the above, geographers have played a significant role, both in the surveys and in the preparation of plan reports.

Priorities in research in this field include: division of the country (or state) into metropolitan regions by means of traffic flow analysis; the relationship between metropolitan centres and these regions, namely, "spread effect" and impact on landuse and land values; the social areas of metropolitan cities; urban morphology and the processes and patterns of urbanization.

Regionalization and Regional Planning

The review report in this subfield highlights the contribution of geographers in four major areas of research: regional surveys for planning; regionalization for planning; sectoral (topical) studies for planning; and quantitative geography and planning. The report also identifies important areas where further research is necessary. These include: studies on regionalisation for planning at the national, State and regional levels and the study of boundary anomalies; central place studies; studies on regional spatial development models; studies on landuse models; studies on simulation of spatial processes; studies on transportation network models; and area development studies.

River Valley Development Planning

The review first considers research on the Damodar Valley Region which is the forerunner of all the multipurpose river valley projects in India. The studies in this subfield adopt either the comprehensive regional approach or the systematic/topical approach. In the latter approach, such aspects as erosion and deposition problems in drainage basins, irrigation, study of population and towns, landuse, and the study of industrial areas have been emphasized. Studies on river valleys, other than the Damodar valley, have been carried out using

the topical rather than the regional approach. In addition, work has also been done on two major problem areas: study of floods and flood control and study of power development.

Recommendations for future research in this area are: studies on the impact of river valley projects in settlement structure and growth; studies on changes in landuse in river valley projects; studies on industrial development; and studies on environmental modification and its consequences.

Historical Geography

The review of research in historical geography emphasizes three major aspects: the nature of the source material; aspects of the natural and social environment; and spatial differentiation and the regional framework. Research in historical geography based on specific source materials are reviewed comprehensively under the following headings: religious texts; epic and literary sources; travel accounts; classical geographies; classical histories; dynastic archives and chronicles; revenue records; narratives of military campaigns; temple records; and old maps. Studies on aspects of the natural and social environment focus on such topics as geomorphological change, climatic change, changes in river courses, ethnography, migrations, economic geography, and urban geography. Research has also been done within the spatial differentiation and the regional framework. This covers studies on regionalism through a study of regional divisions of the country at different points in time and studies on historical geography of different regions of the country.

Future work on historical geography should include: the preparation of historical atlases on national and regional/state levels; comprehensive documentation of source materials of relevance to the study of the historical geography of India; preparation of volumes on past geographies of India at selected points in time; and the study of historical-geographical processes.

Population Geography

The distribution of population in India as a whole, and in different parts of the country, has all along received the attention of geographers, at first outside India, and later within the country. In addition to the comprehensive reports produced after each census, the geographical aspects have been examined and salient features pointed out by geographers, e.g. by Jules Sion after 1921, Hoffman after 1941, and S. P. Chatterjee after 1961, on the basis of the population sheets compiled for the National Atlas. The Census Atlases produced

after 1961 have all had the advantage of a competent geographer being in charge of the Geographic division of the Census Organization. Population studies of individual districts and of states have also been made by Indian geographers over the last 40 years. However, comprehensive studies of all aspects of population have been the special feature of the research work done in the Punjab University, deriving their guidance mainly from Trewartha. The studies made so far have varied significantly in the amount of details incorporated in them. The aspects of population geography in which research has been reported include: distribution and density of population; population growth and migration; sex composition; literacy; occupational structure; religious composition; urbanisation; and comprehensive area studies. The studies also show great variations in the amount of details incorporated.

The recommendations for future research in the subfield are: the pressure of population on physical and social resources and the spatial patterns of internal migration in India; detailed studies in the population geography of small areas in different states (using village data), with special attention to the relationships between population characteristics and other phenomena at local levels; and the study of the border areas of the various linguistic states, their population characteristics and changes therein (using village data).

Geography of Rural Settlements

The review of research in this subfield lists the following areas of research: research on methodology; evolutionary studies; morphological studies; studies on tribal and caste settlements; functional studies; studies on house types; studies on field systems and field patterns; studies on cultural landscapes; and studies on place names.

Rural settlements in different parts of the country have been studied now and then by several geographers having easy access to the concerned areas. Nevertheless, inadequacy of field work and paucity of data based on field study have characterised most of the work. Enayet Ahmed and Learmonth, Buschmann and N. K. Bose have attempted to cover the whole country. Spate and Deshpande have also had the whole of India in their view in describing the "Indian village". Individual rural settlements in various parts of the country have been described. Several papers deal with the settlement types and patterns in various parts of the country, but there is no comprehensive account of rural settlement patterns for India as a whole. Many studies deal with tribal settlement, largely following the patterns adopted by anthropologists and give only secondary consideration to geographical aspects. Studies of house types have been somewhat

similar. Individual types of different parts of the country have been described, but there has been no study of house types and their variations over India as a whole. Even the chapter in Spate's *India* is largely based on house types in some parts of the country only. A few studies of other aspects of the cultural landscape have been done here and there. The priorities for future research in this subfield are: systematic study and mapping of rural settlements in all parts of India; cultural and historical aspects of population studies; changes in rural settlements and regional differences in such changes; study of cultural patterns through the analysis of the form and structure of rural settlement; preparation of detailed monographs on individual rural settlements; and studies of settlement complexes and of regional variations in their characteristics.

Urban Geography

Studies of urban centres have been very popular with Indian geographers. The earliest centre for such studies was Madras until the Second World War. Later, studies of urban centres became the main feature of the research at Varanasi. A large number of urban studies have also been carried out by urban geographers at Calcutta. Until recently, most of the studies tended to be descriptive and only recently have analytical and quantitative methods been used. Studies of towns in particular regions and other aspects of urban-rural relations have also been examined. These trends have largely followed the lines developed by American geographers interested in India. Lately, methods developed by Christaller and Losch which have contributed to the development of Central place theory and its varied implications have also come into use. Urban-rural relations were studied at first in terms of the urban hinterland or umland, i.e., tributary areas of one kind or another. The present trend is to examine the urban-rural relations in considerable detail taking note of the various structural aspects, e.g. urban hierarchy, linkages, services, etc. These new trends are yet in their infancy and need to be adopted much more widely. The problems of urban growth, the economic base of urban centres, classification of towns, urban land use or other aspects have received little attention. But all these new lines of urban study require to be more widely pursued before a clear all-India picture of the urban situation can emerge.

The areas of priority for future research are: comparative studies of various aspects of towns; size and spacing of towns; the regionalizing characteristics of urban places; changing urban landuse structure and the rural-urban fringe; and morphological evolution of Indian cities, in relation to the theory of urban growth. On the methodo-

logical side, better cartographic techniques and more precise studies involving quantification will help in reaching sound generalisations.

The Concept of Umland with reference to Indian Cities

The concept of umland was introduced in Indian geography in 1955 and has stimulated considerable research in this area since then. Apart from a closer examination of the concept and its implications, research has been carried out highlighting the methodology and problems in the delineation of umland, and the choice of criteria to be used in defining and delimiting the umland. Umland boundaries have been delineated for more than a dozen Indian cities. The methodology in most cases involves the super-imposition of zones of important functional linkages. A variety of criteria has been selected and tested for the study of umland with varying degrees of success.

The major recommendations for future work in this subfield are: standardisation of criteria to be selected for study of umland; studies using questionnaire surveys of villages for collection of primary data on umlands as opposed to the present practice of collecting data from the city; studies on directional bias in umlands. and investigations on umlands for purposes of planning.

Man and Environment

Two aspects of the relation between man and his environment have been reviewed; the first views man as facing natural hazards which he is as yet quite unable even to foresee; and the second sees him moving about recklessly damaging, destroying and defiling the environment in various ways. The destruction of forests for the sake of the timber or for cultivation, excessive irrigation where canal water is available in abundance, soil erosion brought about by cultivating sloping land, and unregulated grazing by cattle and goats, have all contributed in varying measure to the permanent deterioration of land and its resources. On the other hand, more especially around towns and industrial establishments, man has been indiscriminate in the use of water, polluting neighbouring streams and rivers by the discharge of sewage from towns and waste water from the factories. Similarly, but without its being so obvious, men are steadily bringing about the deterioration of the atmosphere, especially in the larger urban centres. This is taking place partly as a result of the increasing amount of smoke and soot and noxious gases discharged from factories, exhaust gases from the ever-increasing number of motor vehicles, but also from the continuously increas-

ing quantity of smoke and soot discharged from domestic establishments. In addition to these, on account of the ever-increasing traffic on roads and man's activities in quarries and other establishments, large quantities of dust particles are also discharged into the air and its dust content is being steadily raised to levels that are harmful to human health.

Priorities for future research in this field are: mapping of flood affected areas to provide a base for regional zoning; the location and exact extent of favourable areas within drought-affected tracts; mapping of areas liable to earthquakes; the problems of reclaiming ravine lands and the proper use of water for crops; survey of areas where pollution of water and air is serious; sources of pollution; and utilisation of treated effluents in agriculture.

Medical Geography

Indian geographers have yet to develop a general interest in this field, most of the work done so far being the contribution either of medical men or of foreign geographers specialising on studies of India. Several aspects of population studies partly overlap with this field, e.g., study of population trends, on birth and death rate, etc.

Political Geography

Most of the research and other papers in this field are concerned with a few aspects such as geo-political factors, boundary problems dealing with either the international or the inter-state boundaries of India, and political situations in the neighbouring regions of Asia.

Fields recommended for future research are: terrain evaluation for strategic purposes; geographical basis of the administrative divisions of India; India's relations with neighbouring countries and the study of boundary disputes; geopolitical influence of the Indian Ocean; resource studies (strategic, critical and essential resources, their distribution, utilisation, conservation, procurement, substitution and technological innovations); area studies, and problems of national integration from the geographical viewpoint.

Regional Geography

Studies of regions have been a regular feature in the growth of Indian Geography from the very beginning. This is partly because the pattern of study is quite familiar and can be easily adopted. Various parts of the country have been covered and attempts in recent years to achieve systematic coverage of the whole country have produced

two volumes of regional studies of varying length and detail and having a large range even in the area covered by each. The National Book Trust series on India and the various states will provide, when completed, separate studies of every one of the states as well as on different aspects of the geography of India as a whole. Regional geographies by individual authors and groups of authors have also appeared on Maharashtra, West Bengal and Bihar.

Several geographers have from time to time reviewed the problem of the sub-division of India into regions and this exercise will continue to interest geographers and others in spite of the schemes of division yielding several hundred sub-divisions, arranged into groups at varying levels. Certain aspects have been reviewed during the preparation of the National Atlas, e.g., physiographic divisions. These attempts will necessarily have to be revised and repeated at intervals as more material and research findings accumulate. For instance, the approach to the studies of urban-rural relations and re-structure involved in them is found to yield new insights. Regional geographical studies of high quality comparable to the French monographs can come only when they are based on the author's intimate personal knowledge of the region, acquired through what Deshpande has indicated as "sustained and sensitive living in the area of study". Studies of regions in India must also take note of the historical and cultural background and seek to relate this to the conditions existing at the time.

It has been recommended that the study of a region should elicit norms for determining regional hierarchies and re-discovering basal regions which are rooted in Indian tradition and consciousness, and the evaluation of their role in the present-day administrative framework and national setting. It has been emphasized that regional studies should present a competent portrayal of a region, including its personality; bring out aspects of space relationships, and aim at identifying and highlighting problems relating to the regional component of life and living of the people belonging to the region. 'Regional tensions' and 'Transhumance' as an aspect of human socio-economic mobility have also been recommended as themes of national importance. The group has also recommended that a Standing Committee be constituted for effective coordinated implementation of the scheme suggested by it within a time period; and that regional studies should be simultaneously encouraged at meso and micro levels.

Airphoto Interpretation

Aerial photography came into use in India about 50 years ago

and a large amount of photographic work has been done in several parts of the country, mainly in connection with irrigation projects and urban and industrial developments. During the Second World War, aerial photography was used greatly to produce up-to-date maps of North Eastern India and the India-Burma frontier regions. A large amount of aerial photography was done by the British Royal Air Force and the US Air Force during these years. Most of this material is no longer available in this country. Subsequently, most of the country has been photographed from the air and the new maps of the survey of India are now largely based on these photographs. On account of the restrictions placed on the supply of these photographs, airphoto interpretation as a technique in geography still awaits development and has not come into general use. The Photo Interpretation Institute at Dehra Dun provides a full course of training and this is given to the personnel of various scientific departments of the state and central governments, as well as to the staff of the Survey of India and the Survey and Engineering Departments of the states. A similar course confined to the interpretation of aerial photographs has to be developed to meet the requirements of geographers in India.

Recommendations for future research in this subfield include the extensive use of aerial and space photographs in mapping and interpretation.

Field Work

Field work in geography has been reviewed under two major sections: field work associated with regional studies, and field work in systematic (topical) studies. In the former case, research has been done by combining detailed micro-level field work with the use of secondary sources of information within a broader regional frame of study. This approach is best exemplified in the studies on Meghalaya, western India, Pilot Regional Survey of Mysore, the Damodar Valley Survey and the work on 'India—A Regional Geography'. Included in the second category of field work are a large number of studies focussing on aspects such as geomorphology, agricultural landuse, urban landuse, and the study of rural settlements. Much of the research involving field techniques has tended to follow a stereotyped pattern. Although sampling techniques have been used, by and large, field survey techniques are yet to develop into advanced procedures.

The future development of field work techniques should involve a consideration of standardisation of the techniques used in field work at different levels; preparation of a model proforma for field

surveys; the use of quantitative techniques in conjunction with field survey techniques; and a preparation of a field work manual in Geography. Field work techniques should be further developed for research in areas such as agricultural landuse studies, urban fringe; and studies on consumer travel behaviour.

Thematic Mapping and Analysis

Though topographic mapping started in India even before the Survey of India came into being, the production of thematic maps received scanty attention, until the National Atlas Organization was set up. Till then maps and atlases were produced even by Government departments on an *ad hoc* basis, and there was no effort to organise or coordinate thematic mapping in a comprehensive way. In connection with the 1961 Census a comprehensive scheme of mapping has been adopted for the production of the Census Atlases of the States and of India, and similar Atlases to be brought out for the 1971 Census. After 1947, a large number of atlases have been published on a variety of special topics, e.g., agriculture, livestock, an atlas of the Northern frontier, Agricultural Atlases for several states, a Diet Atlas of India, Atlases for Cotton, Oil seeds, Jute, Coconut and Tobacco. But in all these cases, each one was designed and published without any effort to relate it to the others. The production of the maps comprising the National Atlas is a continuing project, and progressively improved methods of mapping and comprehensive utilisation of data are a part of the programme.

The recommendations for priority in this field are: supply of adequate cartographic equipment to geography departments in universities; manufacture in India of the tools and materials needed for scribing; development of the use of computers in mapping; landuse mapping for the whole of India and the establishment of data banks and stores. The theoretical aspects of thematic cartography must also receive more attention.

Quantitative Studies

It is only in recent years that more rigorous, mathematical and other quantitative methods have come into use. A small number of the younger geographers scattered over the country have been using a few of these techniques to study various aspects of Indian geography.

The application of quantitative methods has a bearing on all branches of geography. However, the techniques of analysis vary depending on the kinds of spatial problems studied. These may be

categorised as: techniques for the study of spatial structure; techniques for the study of spatial processes. The techniques that have been developed so far in the study of spatial structure include the nearest neighbour analysis, centrographic analysis, correlation and regression analysis including mapping of residuals from regression, and use of distance decay functions. The techniques of factor and principal components analysis have been used in the regionalization problem along with more sophisticated techniques of discriminate and grouping analysis. Spatial processes have been studied using Monte Carlo simulation models.

It has been recommended that geographers in all parts of the country should acquire early an adequate knowledge of the new quantitative methods which are specially suitable to deal with various dynamic aspects. This is one of the main trends in current geographical thought where, instead of considering the spatial patterns as end-products, the aim is now to seek out and understand the processes that have given rise to the patterns. The study of dynamic aspects becomes urgent and important from the point of view of planning, where the objective is to understand the phenomena in order to control and regulate them. Training courses in quantitative techniques may be given high priority, as they will help to make research results more precise and statistically acceptable.

Training in Research Methodology

Training in research methodology plays an important role in the growth of geographical research. In order to obtain factual information, a questionnaire survey of existing facilities and programmes of training in research methodology in geography was undertaken. In all, 31 universities and colleges responded to the survey. The findings of the survey are reported under the following heads: training facilities including levels of teaching, faculty strength and structure, teaching and research facilities; programmes of training in research methodology including formal and informal programmes; employment opportunities; and suggestions for improvement of training in research methodology. The last category includes introduction of formal pre-Ph.D. training courses, short-term courses (workshops) in research methodology; training of geographers in sister disciplines; programmes for movement/exchange of teachers and students to make the best use of existing training facilities.

Future Development

The future development of the discipline of geography as a

social science cannot and should not be envisaged and planned in isolation from at least the immediate past. A major thrust to the development of geography at the professional level was given with the starting of the National Atlas Organization in the early fifties. The decade 1960-70 has been significant with reference to the contribution of Indian geographers, particularly in applied geographical studies. It opened up at least two distinct frontiers: inter-disciplinary research institutions in regional and national planning and the use of the map as a tool in regional analysis as a basis for the formulation of regional development problems. This required greater emphasis, not only on quantitative techniques and thematic cartography but also on the conceptual and theoretical framework. The increasing demand for geographers trained for carrying out applied research made the university departments review the structure and pattern of geography teaching at the post-graduate and Ph.D. levels. This led inevitably to proposals for strengthening geography teaching at the under-graduate and school levels also.

The disparity in the levels of training and research between different universities, between universities and colleges as well as between under-graduate and post-graduate levels need to be minimised. Periodical refresher courses, seminars on specific themes and workshops, etc. will certainly contribute to the upgrading of teaching and research levels. Post-doctoral and project research need special emphasis as these will set the pace of academic work and open up new horizons in geographical research. In addition to a good library of books, journals and micro-films, the special requirements of a geography department are maps, air photographs and national atlases. There is a strong case for a map bank. At least in selected departments, there should be facilities for map reproduction, map transformation and compute mapping. Audio-visual facilities need to be strengthened.

Research project grants, scholarships and fellowships given by the UGC and ICSSR have certainly invigorated research in geography, as in other social sciences. But the quantum of assistance needs to be increased.

Research in Indian geography suffers from lack of coordination. To a large extent, work is done in isolation and in the traditional descriptive style, without adequate theoretical and conceptual framework. Empirical research based on depth studies and using rigorous methods needs to be developed. The Standing Committee on Geography set up by the ICSSR should give special attention to the coordination of geographical research and indicate priorities in new and emerging fields, organize a plan for training in quantitative methods and thematic cartography, work out special training programmes in

research methodology to upgrade the research skills of the research scholars and junior teachers, and organize seminars at an advanced level on specific themes/topics.

The "Lone Wolf" approach to geographical research and even to geographic training is being replaced by inter-disciplinary research and training. A department in a discipline or a single discipline is ceasing to be an isolated and water-tight compartment and instead, schools covering a number of disciplines such as the School of Social Studies or the School of Earth Sciences are developing. Conforming to this trend, inter-disciplinary research and training should be promoted in all ways possible.

With the increasing recognition of the problems arising out of the dis-equilibrium between man and his environment, both natural and cultural, and the divergence between the factors for unity and sharp diversity in the country, geographers in India have to meet a special challenge to demonstrate their professional contribution to the understanding of emerging problems. They can do so mainly by their proficiency in training and research. It is for this effort of the geographers to attain the highest level of excellence possible that the ICSSR, UGC and the Universities themselves should provide the necessary assistance. Here the most successful strategy could be to develop a few centres of excellence in the specific subfields which have potential for development.

Geographical Index

* Irt = In relation to.

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