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Philippine Geographical Journal, Vol. 35, Nos. 3 & 4
(July-December, 1991)

EDITORIAL

SUSTAINABLE DEVELOPMENT: A GEOGRAPHIC VIEWPOINT

The growing concern for sustainable economic development and environmental quality in the Philippines should bring about a challenge to destructive strategies of resource use and management. Considerations must take into account a reasonably realistic appraisal of the social, economic and political costs associated with environmental deterioration. These costs should reflect the awareness that man is an integral part of nature rather than a separate force.

Many of the natural resources in the Philippines which are limited both in quantity and quality are being rapidly depleted. Current systems of resource utilization appear more often than not to be directed toward the permanent undermining of the environment. There are widespread evidences of extensive and irreversible destruction of forests, accelerated soil erosion, agricultural land impoverishment, land degradation by mining activities, river and lake pollution through silting and chemical processes, and the expansion of sub-quality settlements.

The degradation of the environment has increased as a result of population growing at an exponential rate. The increase in environmental problems, however, is not directly proportional to the increase in population as it is likewise affected by technology which facilitates the utilization of less suitable or lower grade resources. Economic decisions, buttressed by unrealistic political policies, particularly those which underscore development at all costs have likewise contributed their share in undermining the quality of the environment. Under such conditions environmental problems in the form of man-induced geophysical and biochemical hazards have become much more extensive. Furthermore, naturally-occurring hazards are accelerated by man's interference.

How can sustainable economic development and environmental integrity or stability be made compatible in the Philippines given an archipelagic structure with definite physical and natural resource limitations? Can man in the Philippines approach a kind of equilibrium with his environment, in the pursuit of economic development, so as to avert destructive imbalances in his habitat? To approximate an answer to this question, it is necessary to ask what resources are vital to the Philippine economy now, which are likely to be essential in the future, what substitutions and technological innovations might modify resource priorities, and what limits are placed on population and material growth by resource availability and recovery. Also to be considered are the consequences of limited supply of resources and of varying ethnological and economic concepts that affect their use and adequacy. In the planning process the management of many resources and the impact of their utilization on the environment must be viewed simultaneously although an extensive analysis of alternatives will be needed to develop comprehensive policies of long-term validity.

The quality of life which is equated with flexibility of choices and freedom of action is threatened by the demands of an economy that needs to be expanded and that of a rapidly increasing population in the Philippines. This happens in three major ways: (1) through the restrictive and harmful effects of pollution; (2) through the increasing frequency and complexity of unconstructive and unavoidable human contracts; and (3) through the necessary increase of regulatory measures. All of these is a consequence of the increasing use and competition for resources, space, recreation, transportation, housing and even educational facilities.

Ultimately, the achievement of sustained development depends on the size of the population. The probable increase in resource utilization and the continued production of goods necessary for survival on a sustained basis is not indefinite. Resources must be used wisely and that population and demand must level off at some reasonable point. Better technological methods of production or systems of utilization and recovery of exhaustible resources and replaceable but sensitive resources must be introduced, developed and availed of in the Philippines now and in the future. At present, the country continues to rely primarily on its land-based resources. Although the utilization of its marine food resources has been in tandem with the land resources, it was not but a few decades ago that other marine resources, in particular oil, have been explored and produced. There is little basis though for assuming that even when the surrounding sea, making up the country's exclusive economic zone, is tapped mineral and fuel resources of large usable volume or quantity would be economically feasible to recover. Much work is still in the offing in the exploration and discovery as well as recovery of marine minerals and fuel resources.

Sustainable economic development and environmental integrity in the Philippines can be achieved though not without attendant problems. Space resources and certain other resources have finite limits, a condition that has even graver implications in an archipelagic framework when compared with continental regions. This can be made more meaningful if it is remembered that the availability of resources at any given time is the result not only of the physical occurrence of the resource and the means of producing it but also the nature and size of man's requirements which in turn is a function of population, and in the Philippines the end of a rapid population growth of less than two percent per annum is not yet in sight. Therefore, the formulation and implementation of a policy is inevitable whereby both population control and better environmental and resource management are mandatory and should be effected with as little delay as possible.

TELESFORO W. LUNA, JR.

Philippine Geographical Journal, Vol. 35, Nos. 3 & 4
(July-December, 1991)

ARTICLES

TRANSPORTATION, PRODUCTION, AND REGIONAL DEVELOPMENT

Arturo G. Corpuz*

THE CIRCULATION OF PRODUCTION

The importance of transportation to the capital accumulation process has long been viewed in terms of its role in the physical or spatial movement of manufactured goods — the circulation of production. Marx, for example, emphasized that "the more production comes to rest on exchange value, hence on exchange, the more important do the physical conditions of exchange — the means of communication and transport — become for the costs of circulation." The development of transport organization, technology, and operations is therefore inevitable, according to Marx, given the inherent tendency of capital to drive beyond every geographical barrier, towards "the annihilation of space by time," and the creation of a world market, (Marx, 1973:524). As a result "there is a simultaneous growth of that portion of social wealth which, instead of serving as direct means of production, is invested in means of transportation and communication..." (Marx, 1967:251).

It is not surprising that the transport industry, with its crucial role in the circulation of capital, is included in most analyses of accumulation and space more than any other industry. Often, while most other industries are referred to in aggregate terms, the transport industry is singled out because of its specific accumulation and space-related attributes. Adam Smith, for example, categorized the use of capital according to 1) the purchase of raw materials, 2) manufacture, 3) transportation (wholesale), and 3) retail distribution (Smith, 1978:459). Marx (1973) also devoted portions of his critique of capitalism to discussions about transportation and communication. They include those on cooperation, the labor process, machines and modern industry, wages, and general laws of capitalist accumulation (vol. 1); costs of circulation, fixed and circulating capital time of circulation, and turnover time (vol. 2); turnover and the rate of commercial profit (vol. 3); as well as parts of his chapter on Capital.

More recent studies of accumulation, space, and regionalism likewise refer specifically to the transport industry. David Harvey devoted the

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second part of his essay on the geography of capitalist accumulation to "Transportation Relations, Spatial Integration and the Annihilation of Space by Time" (Harvey, 1977). Massey (1978) cited developments in transportation and communication as one of two influencing changes on the spatial division of labor (Massey, 1978). Castells (1980), in discussing elements of the urban structure, categorized transportation as a major element of exchange. And Lipietz (1980) viewed "the state of the transport and telecommunications system," along with "the inter-regional division of labor, the pre-existing materialized fixed capital, the location of markets... the structure of legal space (ownership of land)" and socio-economic space in general, as the given factors from the point of view of the individual capitalist (Lipietz, 1980).

THE PRODUCTION OF CIRCULATION

While the development of the transport industry is linked easily to the spatial circulation of capital, its direct, productive side is less emphasized. In most modern accounts, transportation is considered part of the service sector thus acquiring a non-productive image (Heilbroner and Thurow, 1981:49). This contrasts with the classical contention that "economically considered, the spatial condition, the bringing of the product to the market, belongs to the productive process itself... the product is really finished only when it is on the market," and "the movement through which it gets there belongs still with the cost of making it" (Marx, 1973:533-534). It is important to elaborate on these statements because they summarize the theoretical foundation of transportation as a productive industry.

In general, an activity is considered productive if it results in the creation of value — value measured in terms of labor time and labor expended according to social norms. Value is embodied in an object, as the product of labor, and consumed by users of this object. In capitalist society, this object is a commodity which is bought and sold in the market. In more specific terms, an activity is productive if it creates value which can be used: "the labor process, resolved... into its simple elementary factors, is human action with a view to the production of use values, appropriation of natural substances to human requirements" (Marx, 1967:183). This means that an activity is productive only if it creates use value. For example, labor spent on making a sandbox in the middle of the desert is an unproductive activity for obvious reasons. If that same labor fashioned a tent, however, it would then be a productive activity since the tent may be used for desert shelter.

Capitalist production does not alter the previous condition for productive activity. The capitalist's orientation shifts from use value to exchange value (from C-M-C to M-C-M)* but labor's productivity continues to be based on the creation of value which can be used according to socially acceptable norms: "What the capitalist sets the laborers to

* From the commodity-money-commodity or C-M-C to the money-commodity-money or M-C-M capital circuit. (See Marx, 1967:146-155)

produce is a particular use value... use values are only produced by the capitalist because, and in so far as, they are the material substratum, the depositories of exchange value" (Marx, 1967:177, 186; 1970:27). The drive for capital accumulation requires that production include the creation of surplus value but this does not affect the condition for productive activity, i.e., a commodity may have use value, and hence the labor spent on it is productive, but it does not necessarily mean that it has surplus value.

Even with the capitalist's obsession with the exchange value of the commodity, this exchange value exists only through the buyer's anticipation of the commodity's use value. A sandbox in the desert, therefore, continues to have no use value, in so far as it is to be used as a sandbox. If a craftsman purchases the sandbox, intending to use the wood to make a table, then the sandbox loses its character as a sandbox and enters a new labor process as a raw material.

The output of the transportation industry, movement, can be consumed only at the same time it is produced. Expressed in another way, you can not put movement in a storehouse. Its value disappears if it is consumed individually, such as in personal travel, but if it constitutes a part of another production process (bringing a finished product to market, for example) its value is added on to the value of the transported commodity (Marx, 1967:52, 55). The transport industry augments the value of a commodity by an amount corresponding to the value imparted "to the transported products, partly by transferring value from the means of transportation, partly by adding value through the labor performed in transport" (Marx, 1967:150). It is a productive industry because its final output, movement, has a socially recognized use value; people need to transport themselves, their possessions and other objects through space. Aside from this need, which constitutes individual consumption, the movement of an object for its own sake or the circulation of production, the transport industry is also engaged in productive consumption or the movement of an object in order to produce an object distinct from the original ("the product... of individual consumption is the consumer himself, the result of productive consumption is a product distinct from the consumer") (Marx, 1967:183). Productive consumption, however, is likewise determined by socially acceptable use values. For example, if the desert sandbox is transported to a city playground, then it would have a use value and the additional value created by the transport industry will be added to the original value created by the original labor. A capitalist will therefore be able to realize the value (including surplus value) of the sandbox through an act of exchange. However, if the desert sandbox is transported to another part of the desert or to another desert, then the transport activity and the labor expended in the process is unproductive (assuming the new location still offers no use value for the sandbox as a sandbox).

The productivity of the transport industry is better appreciated if we keep in mind that production processes occur in space. As such a production process may be divided into different components corresponding to different locations. In this case, M-C...P...C'-M' is transformed into M-C...P_1,P_2,P_3...P_n...C'-M' where P_n indicates different production components in space. The movement from P_n to P_n+_1 involves the use value of movement and its consumption within the production stage of the accumulation process illustrates the productive character of the transport industry.

In simple production processes, the movement from P_n to P_n+_1 may be represented by the movement of a single worker, e.g., the cutting of wood in the forest, its transport to the craftsman's shop, and its transport to the town market. In more advanced production processes, P_n to P_n+_1 may involve the movement from the point where raw materials are extracted, their transport to a factory, their movement through an assembly line, and the transport of finished products to wholesale and retail centers. In more complex production processes, each phase in the assembly line may take place in different sites such that several factories are involved in the assembly of commodities — all of which may lie in different locations.

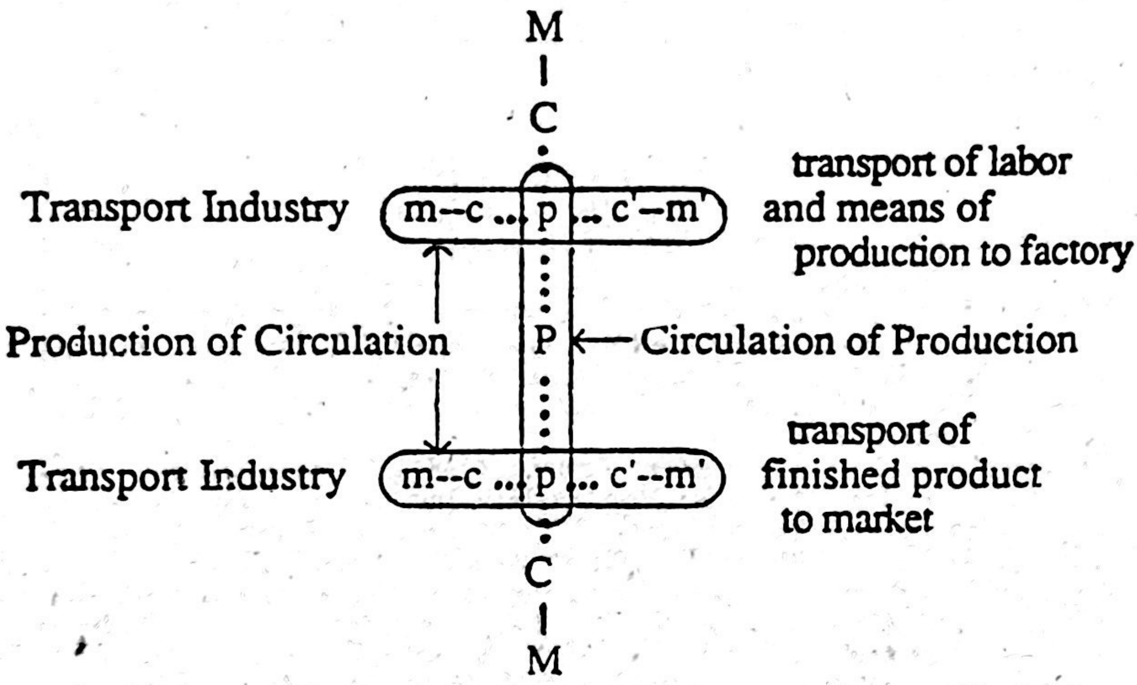
The transport industry is similar to other, more obvious productive industries (such as manufacturing) in the sense that its productivity is determined by the ability of its finished product to satisfy human wants. This use value is determined historically by society's existing and changing norms and by the evolution of transport technology. The transport industry differs from other industries, however, in its ability to be involved simultaneously in the circulation process and production stage of accumulation. This is better appreciated if the money-capital circuit is expressed in symbol form as in Fig. 1. The transport industry, as a productive industry, engages in the production of circulation where circulation refers to movement through space. At the same time, with respect to other commodities which consume the commodity of movement, those transported to and from the market, the transport industry takes part in the circulation of production. Harvey (1982:377-379) has summarized some other distinguishing features of the transportation industry:

1. Technological revolutions which cause the expansion of production in other sectors necessarily result in revolutionary changes in the means of transportation and communication.
2. Immediate overproduction and devaluation is a technical impossibility because the commodity "movement" is produced and consumed at the same moment.
3. Only fixed capital of the transport industry can be devalued and this is always place-specific.
4. The large amount of capital required for most transportation

fixed capital makes such investments unattractive and inaccessible to many capitalists and fosters state-regulated or state-owned monopolies. Competition in the transport industry is therefore restricted.

5. Because competition is restricted and owing to the tendency for greater state participation, the transport industry is more susceptible to "speculative and political mechanisms" than the usual market forces.

Fig. 1. Schematic relationships between the transportation industry and other industries showing the production of circulation and the circulation of production in the Money-Capital circuit.



Harvey concludes by citing some major contradictions in the transport industry. First, because the industry typically uses a higher proportion of capital than labor — diminishing its profit-making abilities based on the difference between wages and output — other sectors served by the transport industry need to compensate in order to maintain aggregate rates of profit. This contributes to the non-productive or service sector image of the transport industry. Second, the expansion of capital requires the expansion of the transport system to overcome spatial barriers. This requires large amounts of fixed capital — roads, canals, railroads, airports, etc. — which cannot be moved without being devalued or rendered useless. However, the expansion of capital requires capital mobility. The value embodied in transportation infrastructures, those intended to facilitate capital expansion, therefore, become obstructions to such expansion by being immobile (Harvey, 1982:379-380).

The dual nature of the transportation industry, involved simultaneously in the circulation of production and the production of circulation, offers a unique approach to the study of accumulation and regional development. It has the potential for a wide and flexible coverage involving other sectors simply because almost all commodities need to be transported. Transportation is also easily related to regional or spatial issues; it implies movement which in turn implies space. In short, the transportation industry is a recognizable manifestation of regional capital accumulation, as part of the circulation of commodities and as a direct productive activity engaged in the creation of value. Theoretically, therefore, the transportation industry allows for the simplicity of a single-industry approach, as far as the production of movement is the basis of analysis, but it also permits a logical inquiry into the spatial circulation of other production processes which may be key to regional location.

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CORRELATION OF RIVER CHANNEL RECLAMATION AND LIQUEFACTION DAMAGE OF THE 16 JULY 1990 LUZON EARTHQUAKE IN DAGUPAN CITY, PHILIPPINES

R.S. Punongbayan and R.C. Torres*

INTRODUCTION

At 4:26 PM of 16 July 1990, central Luzon was rocked by the strongest quake to hit northern Philippines this century. The earthquake registered a magnitude of 7.8 on the Richter Scale wth epicenter in the town of Rizal, Nueva Ecija. Another major shock followed three minutes later and its epicenter was located near Kayapa, Nueva Vizcaya. A 125 km-long ground rupture was consequently formed along the Gabaldon (Nueva Ecija)-Kayapa (Nueva Vizcaya) segment of the Philippine Fault-Digdig Fault system (Fig. 1). The measured displacements along the ground rupture range from 01 to 06 m horizontally and from 0.1 to 02 m vertically.

The 1990 Luzon Earthquake was felt in many places at Intensity VIII (based on a modified version of the Rossi-Forel Intensity Scale of I to IX currently used in the Philippines). The partial isoseismal map shown in Fig. 1, however, is provisional as there were areas like Dagupan City, Baguio City and the town of Rizal which seemed to have experienced the earthquake at Intensity IX based on observed wave-like motion of the ground surface and documented occurrence of thrown-out boulders.

The severe and unusually long groundshaking caused widespread destructions in the form of collapsed manmade structures, liquefaction and lateral spreading, and slope failures in places near and far from the ground rupture and epicentral area. In Baguio City, several multi-story buildings collapsed, including the exclusive Hyatt and Nevada Hotels. Groundshaking also triggered extensive landslides in the nearby mountain ranges, especially along steep-sided valley walls, steep slopes with deep roadcuts and outer curves of river bends. This widespread occurrence of landslides during the earthquake and those induced later by the monsoon rains effectively isolated many places in central and northern Luzon for several

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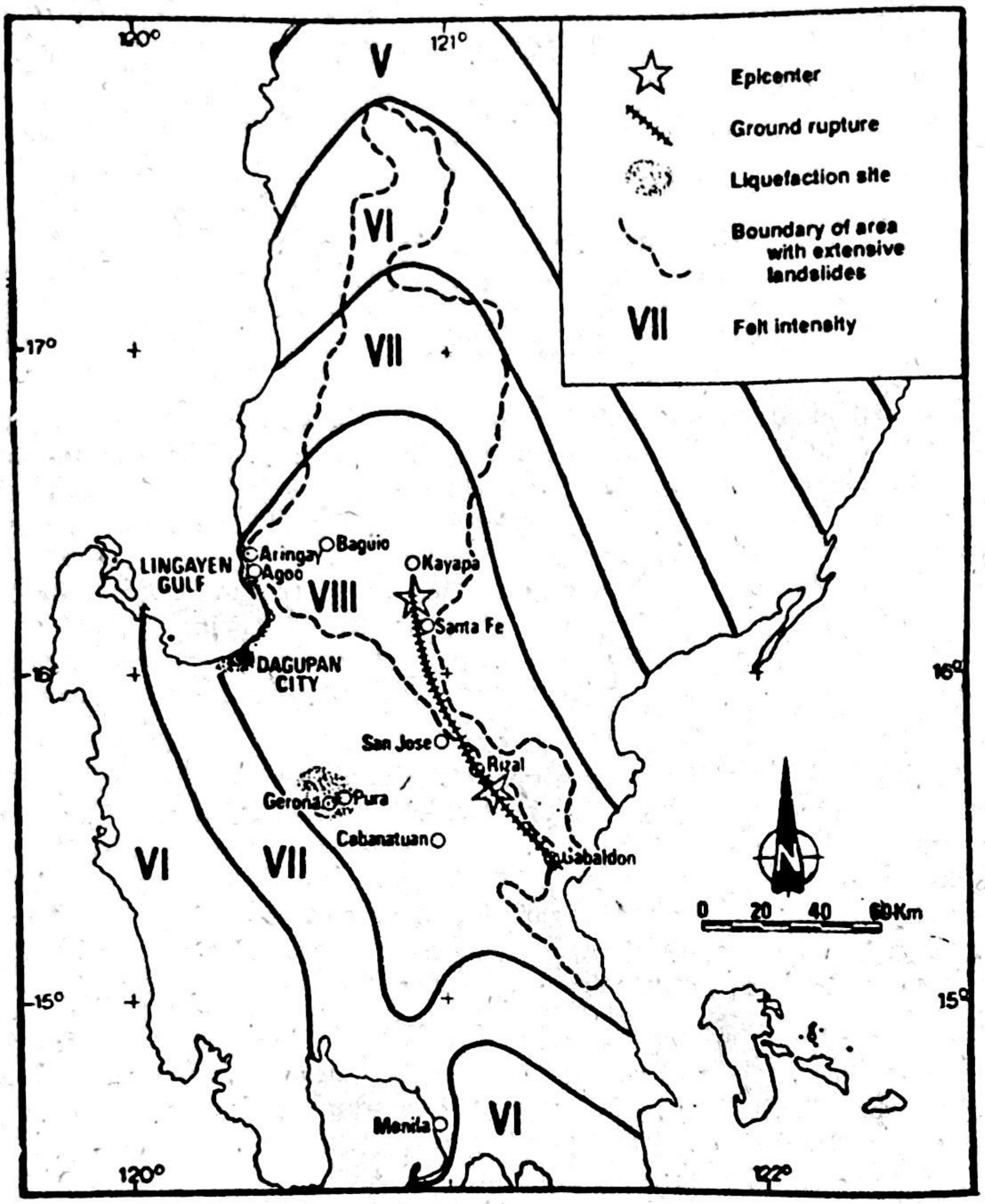

FIG. 1. SUMMARY MAP FOR IMPACTS OF THE JULY 16, 1990 LUZON EARTHQUAKE.

weeks to several months. Dagupan City and the rest of low-lying areas in Central Luzon, which experienced the earthquake at Intensity VIII, suffered largely from liquefaction-related processes. Based on the distribution and characteristics of areas affected during the 1990 Luzon earthquake, three general types of site vulnerable to liquefaction were recognized: (1) beach zones and sand spits as in Agoo, La Union; (2) alluvial fans as in Gerona, Tarlac; and (3) river deltas as in Dagupan City, Pangasinan. Although Dagupan City is located 95 km away from the Rizal epicenter and 65 km from the Kayapa epicenter, the damage wrought by the earthquake is many times more severe here than in the areas nearer the epicenter.

A Quick Response Team (QRT) of the Philippine Institute of Volcanology and Seismology (PHIVOLCS) was dispatched on 17 July to Dagupan City and vicinity to investigate the impacts of the July 16 earthquake and to set up a seismic station for monitoring and locating the expected aftershocks. Follow-up surveys were conducted to characterize the nature and extent of earthquake damage within the city and to be able to explain why some parts of it were severely damaged and others were spared. The survey involved measurements of the tilt magnitude and direction and relative subsidence of buildings and mapping of ground fissures and sand boil distribution.

Geologic interpretation of aerial photographs taken by the Philippine Air Force three days after the earthquake yielded vital information for the conduct of the study. Another set of aerial photographs taken within the period 1966-74 provided insights on the rate of physical developments in the city and made possible the identification and delineation of some critical geologic features now obscured by man-made structures.

Definition of Terms

Liquefaction is a process that transforms the behavior of a water-saturated deposit from solid to liquid. The vulnerable deposits for liquefaction are sand layers which are below the water table and poorly densified. During strong groundshaking, a liquefying sandy deposit loses its resistance to deformation and undergoes compaction. The attendant decrease in the volume available for interstitial fluids causes an increase in pore water pressure. This pore water pressure buildup is a product of several factors, e.g., earthquake magnitude, ground acceleration, distance from the seismic energy source, duration of shaking, grain size characteristics and sand density (Bennet, 1990). Liquefaction occurs when the pore water pressure equals the weight of the overburden.

A deposit exhibiting liquefaction undergoes unlimited deformation, yielding readily to overlying man-made structures. Severe tilting and subsidence and extensive sand boil occurrences are commonly observed, most noticeably at places with heavy concrete structures. Since shear waves are unable to effectively propagate through the liquefied layer, effects of groundshaking are not very pronounced.

GEOLOGICAL SETTING OF DAGUPAN CITY

Dagupan City is located in the northern part of Pangasinan and along the southern shores of Lingayen Gulf. It has a total land area of 37.4 sq.km. in a predominantly flat terrain within the Agno River delta. It lies just a meter above sea level and is traversed by Pantal River, a major tributary of the Agno River.

Macro-setting: Wave-dominated delta

Dagupan City is situated at the eastern margin of the delta of Agno River (Fig. 2). The present active channel of Agno River traverses the western boundary of Pangasinan and empties into Lingayen Gulf. However, based on interpretation of Landsat imageries, Agno River seems to have undergone several episodes of channel avulsion, the latest of which occurred within the vicinity of Urbiztondo where a river course flowing along the east side of San Carlos City and towards Binmaley was abandoned.

Although a high-energy environment prevails along the shores of Lingayen Gulf, the delta front of Agno River continues to prograde slowly due apparently to the confinement of sediment redistribution within the Lingayen-Dagupan shoreline. Delta front progradation maintained in this high-energy environment most probably via barrier-beach accretion. Strong wave action redistributes most of the sediments supplied to the delta front by Agno River and its distributaries to form multiple elongate coastal ridges aligned parallel to the Lingayen-Dagupan shoreline. Discrete groups or bundles of parallel coastal ridges separated by discontinuities indicating the changes in channel positions (Psuty, 1967) most probably exist within the delta with the bundles occurring in pairs and symmetrically disposed with respect to the active emptying points of distributary channels. Thus, beneath Dagupan City, these bundles of coastal ridges are very likely to be found.

Micro-setting: Meandering river environment

The meandering Pantal River flows through Dagupan City and reworks the marine deposits of the Agno River delta. Its sediment supply comes from reworked volcanic materials of Quaternary volcanic cones dotting the southeastern plains of Pangasinan and from detrital materials brought down by Agno River from the highlands of Nueva Vizcaya and Benguet. The high inflow of sediments from these sources into Pantal River, especially during its flood stages, induces increased fluvial sedimentation at places where there exist recently abandoned coastal ridges along the course of Pantal River. Formation of channel levees attests to the high sediment competence of Pantal and high frequency of flooding in the study area.

Because of the non-entrenched meandering pattern of Pantal River, dynamic lateral shifting of its channel is to be expected. This lateral shifting of Pantal River in the recent past left numerous abandoned

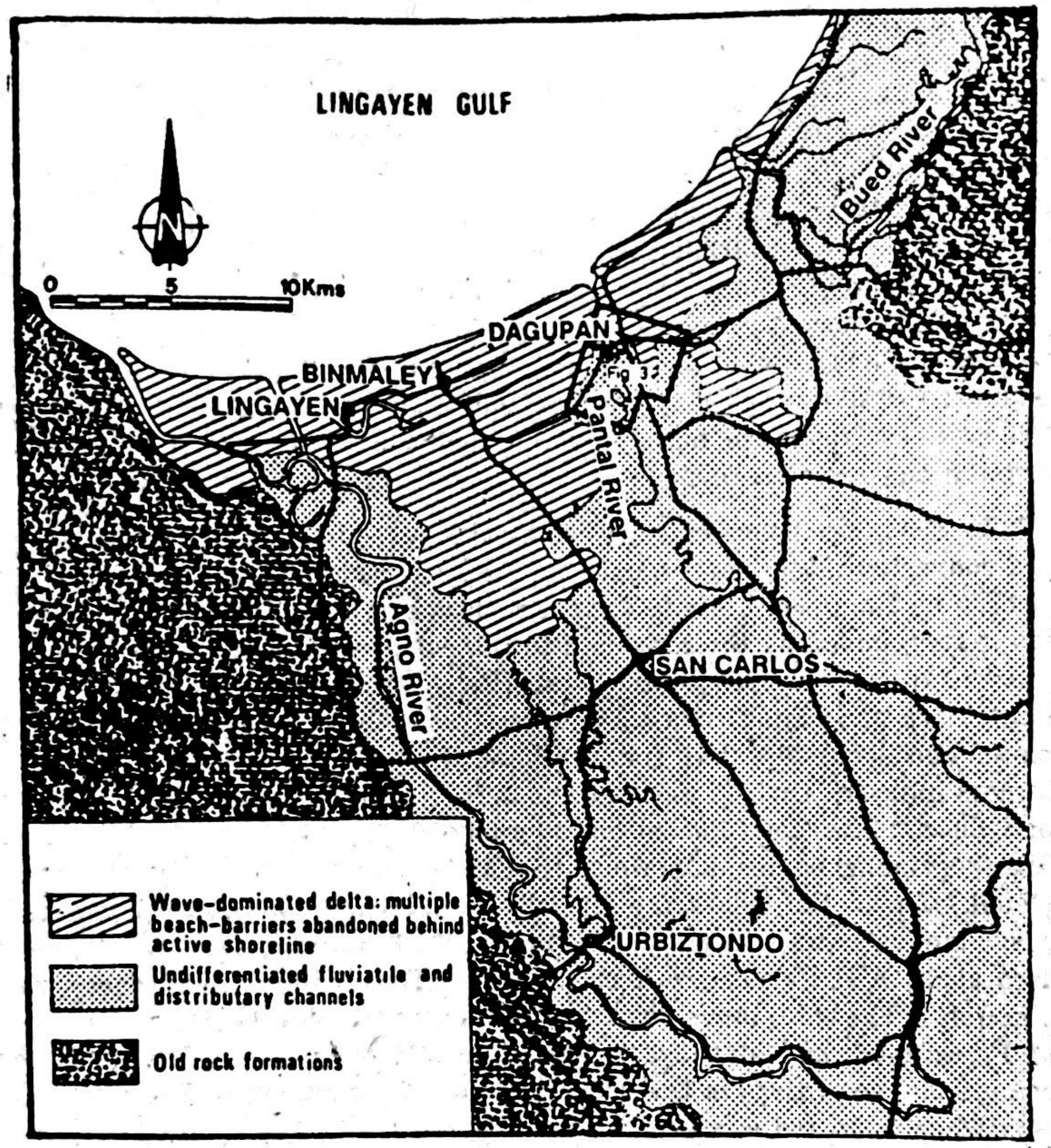

FIG. 2. AGNO-RIVER DELTA-FLUVIAL COMPLEX

channels and created a low-lying terrain made up of levees and backswamps (Fig. 3). Many of these backswamps and other depressed grounds found within Dagupan City become inundated during floods and high tides.

Development of Dagupan City

Spanish writers described Dagupan as an extensive marshland with rich alluvial soil. It was thickly covered with mangrove and nipa palm trees which served as habitat to many marshland wildlife species. Early settlers lived in small clusters of houses along the shoreline and river banks of Calmay, Pantal, and Bonuan (Fig. 4). Later migrants moved inward occupying the agricultural lands of Malaued, Lasip, Pogo, and Bacayao. Pantal and Bonuan became the fishing, salt-making, and "bangus" (milkfish)-raising centers and Malaued, the agricultural settlement area. Travel was mainly by "bancas" (dugout canoes) and sailboats through the river channels.

In 1590, the house clusters were resettled into compact communities and converted into a town named initially as Bacnotan and renamed later in 1720 as Dagupan. A site for town plaza was constructed along Pantal River surrounded by the town hall to the east, public market to the north and the catholic church to the west (Pangasinan Folio, 1970). In 1780, Pantal, as its original name Pantalan (port) implies, became a trading center and docking station for merchant ships. At about the same time, bangus industry thrived and more mangrove swamps were converted into fishponds. The development of Dagupan as a commercial center was firmly established in 1891 when the Manila-Dagupan railway was completed. Up to the 1900's the site of the present public market was still a swamp with waist-high water level. Much of the present downtown area along A.B. Fernandez Ave. (formerly Torres Bugallon Avenue) was a marsh. The continuous growth of the city necessitated the construction of Perez Blvd. and Magsaysay Bridge in 1948 to create more space for commercial activities via the usual practice of reclaiming and constructing on swamplands and less productive fishponds.

Historical earthquakes that had affected Dagupan City

A review of the history of major disasters in the Philippines would easily established the fact that Dagupan City and other places in central and northern Luzon had been repeatedly visited by very destructive earthquakes. Many of the church buildings, which were damaged by the recent earthquake, and old ruins had been similarly leveled by strong quakes in 1645, 1789, 1796, 1799 and 1892.

Dagupan City has been perennially experiencing strong earthquakes. The most vividly described ones were the 1796 and 1892 Luzon earthquakes which were probably triggered by the movement along the Philippine Fault-Digdig Fault complex. Familiar features such as "sinking" grounds, cracks and outpouring of water and black sand were also observed

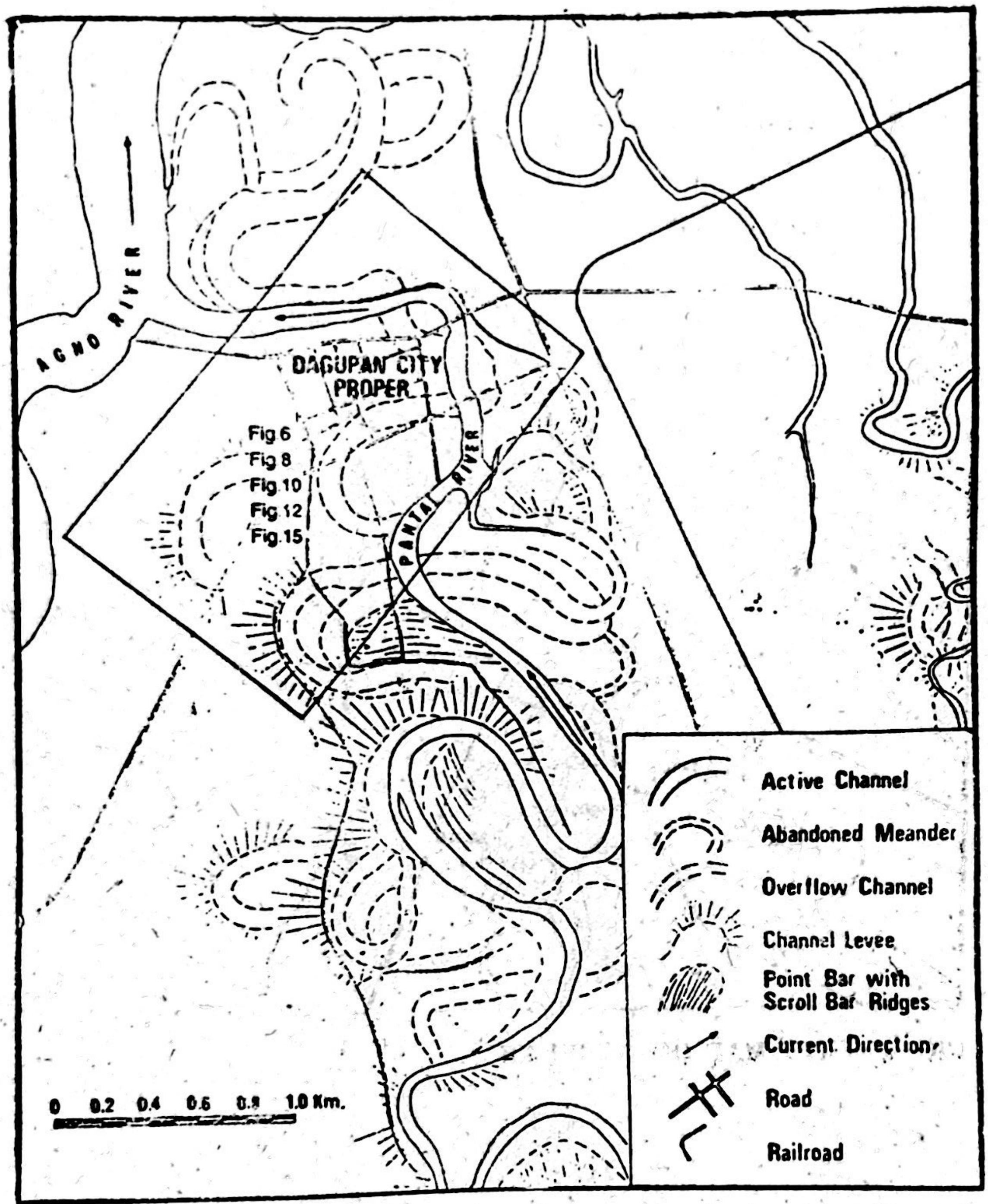

FIG. 3. CHANNEL PATTERN OF PANTAL RIVER SHOWING ABANDONED MEANDERS, POINT OF BAR DEPOSITS AND CHANNEL LEVEES.

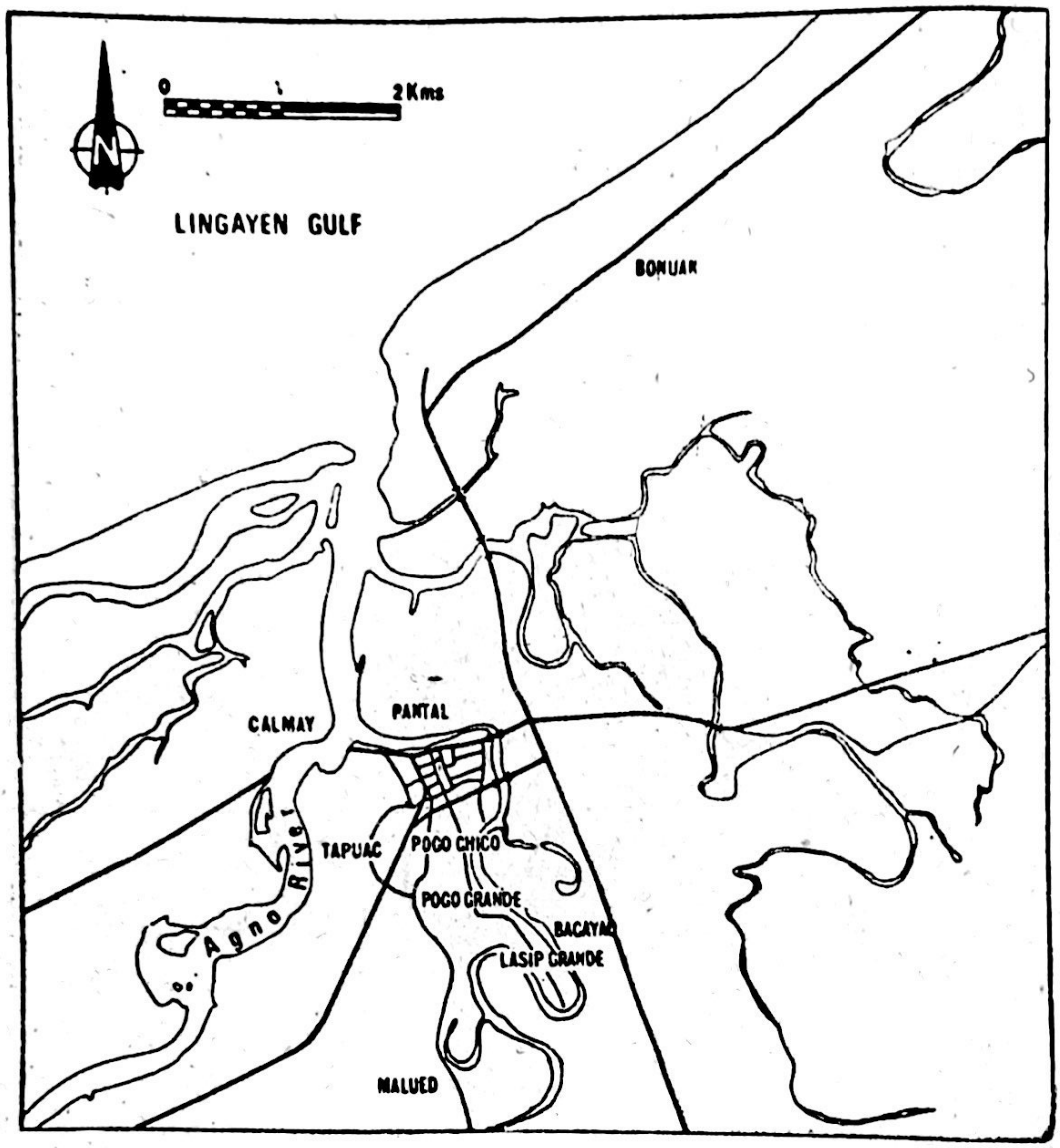

FIG. 4. CITY MAP OF DAGUPAN

in Dagupan in 1892 (Repetti, 1946) and are probably analogous to ground subsidence, tension cracks due to lateral spreading and sand boil during the 16 July liquefaction phenomenon.

THE EFFECTS OF 16 JULY 1990 EARTHQUAKE AT DAGUPAN CITY

In contrast to other areas devastated by the earthquake, Dagupan City sustained only a few collapsed structures. The effects of ground-shaking were limited to the damaged unreinforced old catholic and protestant church buildings (Fig. 5). Most of the destructions noted in the city were attributed to liquefaction hazards triggered by an estimated peak ground acceleration of 0.18g (Midorikawa, 1990). Observable effects of liquefaction include sand boil, lateral spreading, land subsidence and upheaval, and ground undulation and fissuring. The commercial district, located west of Pantal River and between A.B. Fernandez Ave. and Perez Blvd., was severely damaged. Residential houses in Pogo Chico, Pogo Grande and Lasip Grande were partially to totally damaged. At Pogo Grande, some mango trees were uprooted. The blocks enclosed by Gomez, Burgos and Zamora streets, which contain the old and new Catholic Church buildings and the town plaza, were largely unaffected (Fig. 6).

Sand boils were the most extensive effects of liquefaction in Dagupan City. During the earthquake, sand boils were erupted through cracks at the sides of buildings, ruptured pavements, and covered concrete roads with dark gray fine sands and muddy waters (Fig. 7). Drainage systems were clogged by the accumulated sand causing temporary flooding of the main thoroughfares. The ejected sandy materials were sorted and poor in fine components and consist of sub-prismoidal to sub-spherical grains (Torres, et al., 1990).

Sand boil distribution in Dagupan City, as delineated from aerial photographs taken three days after the earthquake and ground truthing, is shown in Fig. 8. Based on standard penetration test data of the Department of Public Works and Highways, the source layers are up to about 5.0 m below the ground surface. In some places, however, the source layers are shallow seated enough to be directly observed through open fissures. For example, the deposit found inside the Divine Word Academy adjacent to Nazareth Hospital appears to have originated from a layer less than a meter below the ground surface.

Although limited in scope, lateral spreading accounted for most of the destruction of structures which had been emplaced closed to open channels and swampy areas in Dagupan City. Buildings and other man-made structures were damaged when river banks slid into Pantal River and dry lands slid into the swampy areas during the earthquake.

Lateral spreading along the banks of Pantal River appears to have occurred at portions where its channel is notably narrow or constricted.

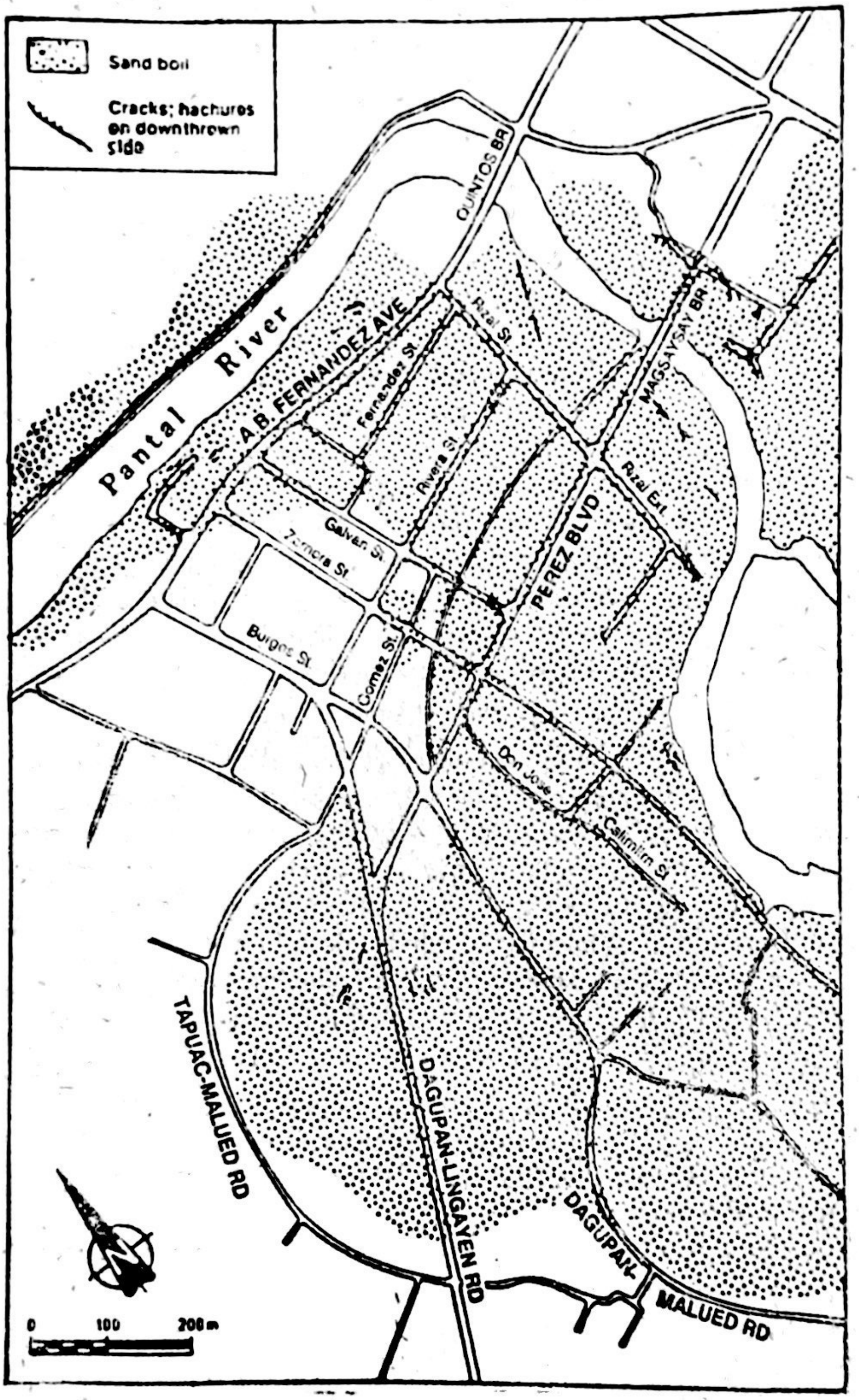

FIG. 5. AREAS SEVERELY AFFECTED BY SAND BOILS (from Punongbayan & Torres, 1990)

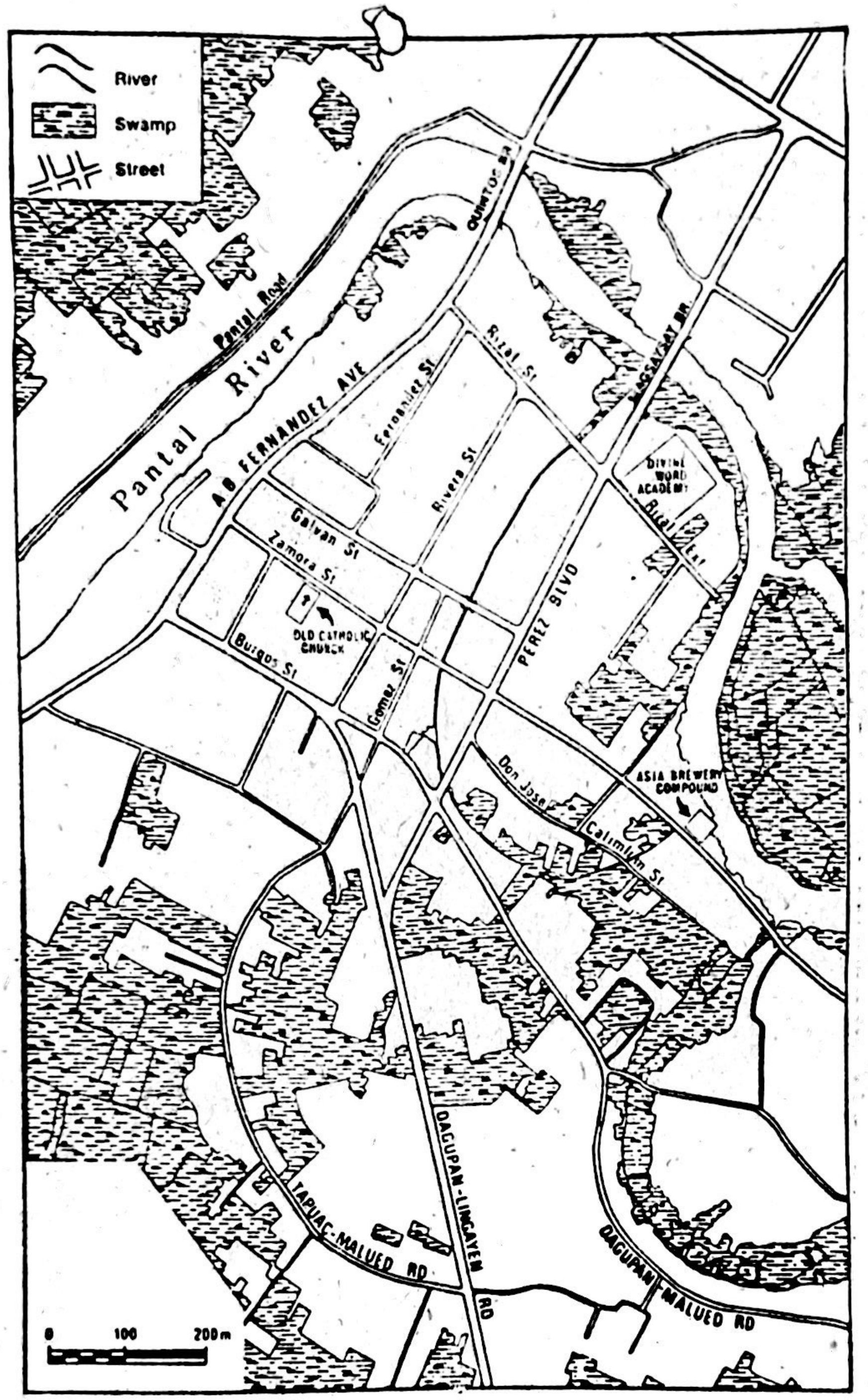

FIG. 6. STREET MAP OF DAGUPAN CITY PROPER, THE OLD TOWN PLAZA IS LOCATED TO THE EAST OF THE CATHOLIC CHURCH.

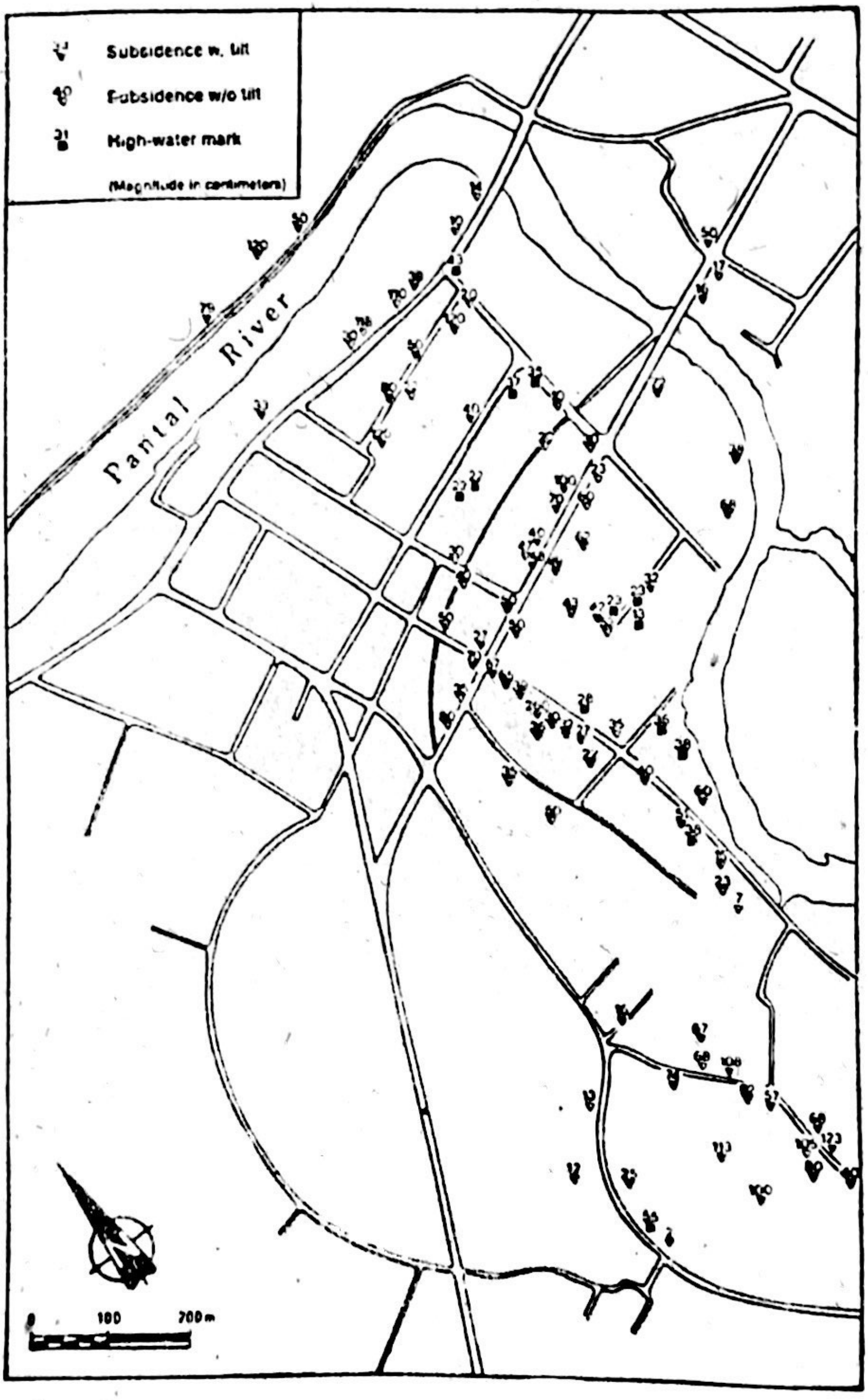

FIG. 7. **DISTRIBUTION OF BUILDINGS AT DAGUPAN CITY PROPER EXHIBITING RELATIVE SUBSIDENCE (from Punongbayan & Torres, 1990).**

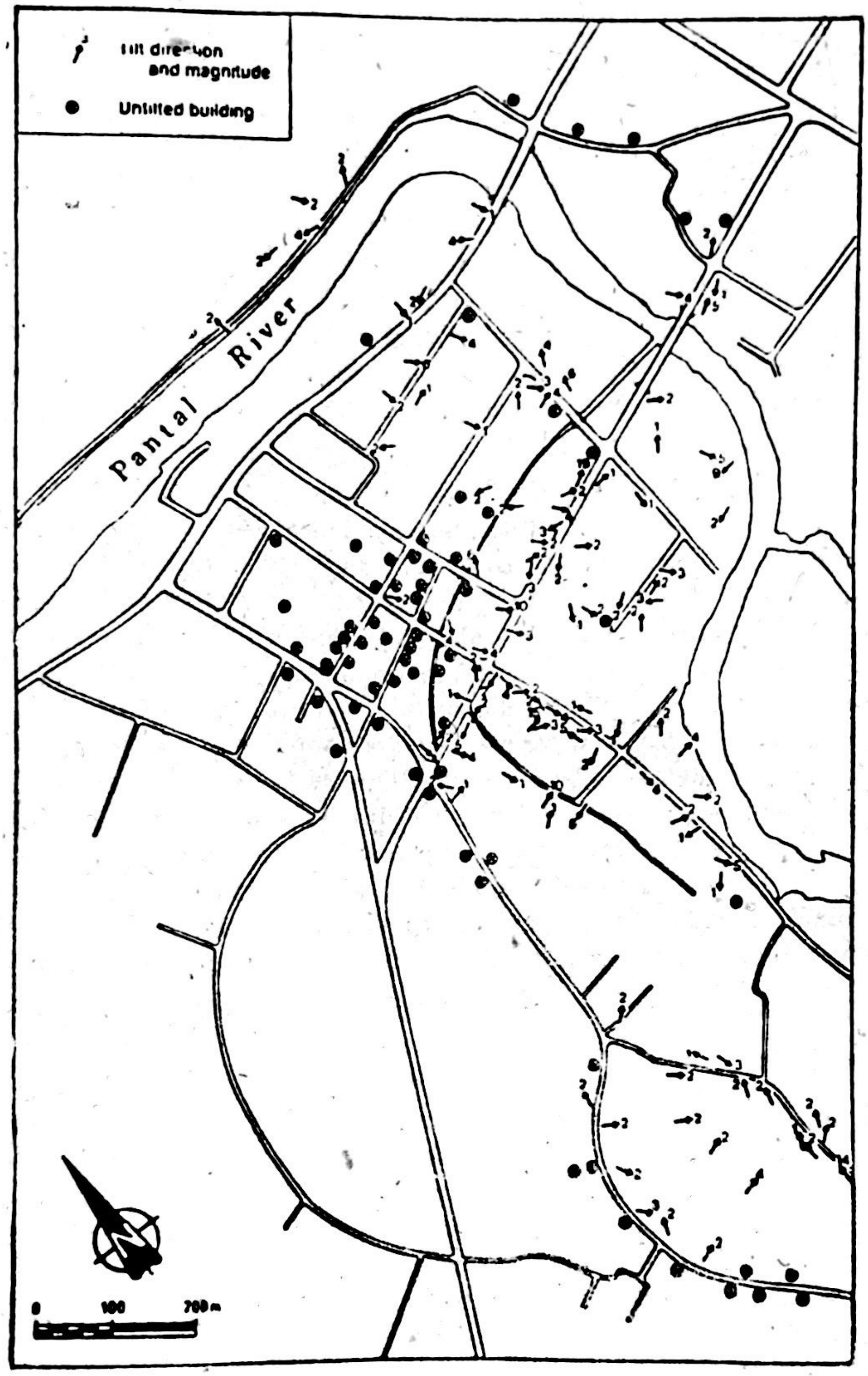

FIG. 8. DISTRIBUTION OF TILTED AND UNTILTED STRUCTURES AT DAGUPAN CITY PROPER (from Punongbayan & Torres, 1990).

Magsaysay Bridge is located across one of these constrictions and its collapse was brought about by lateral spreading on both sides of Pantal River. During active lateral spreading of opposing banks of Pantal River where Magsaysay Bridge abutted, the generated local compression directed towards the bridge swept away its piers at the same time when the river-bed was liquefying. As a consequence, the bridge was broken into several segments like an accordion (Fig. 9), although the portion close to the west abutment collapsed horizontally onto the riverbed. The segment abutting against the east bank was thrust westward under the adjacent segment and the middle pier underwent subsidence and tilting towards the east. A similar compressional phenomenon was observed where a road pavement of Galvan St. overlying an open canal was thrust over a resisting abutment.

Ground subsidence is a direct consequence of liquefaction. However, this effect is different from relative subsidence, which is the magnitude by which the ground yielded to the loading pressure of the overlying structure. Relative subsidence in Dagupan City was determined by measuring the amount affected buildings had sunk with respect to a reference plane, such as road surface or sidewalk. In cases when even relative subsidence cannot be determined due to the absence of a reference point, high-water marks were measured to provide a minimum estimate of relative subsidence. The measured amounts of relative subsidence, however, would not yield a definite picture on how much ground sinking have taken place in Dagupan City as buildings, because of their weight, are expected to sink more and faster than the surrounding land surface. Determination of absolute subsidence requires the reoccupation of geodetic benchmarks and this was not done during the period of the survey.

Subsidence phenomena are notable within the commercial district where some buildings sank by as much as 2 meters, but most of the affected buildings in Dagupan City subsided by less than a meter (Fig. 10). Adjacent concrete pavement dips towards the subsided structures and ground cracks are disposed perpendicular to the direction of subsidence. The resulting subsidence in Dagupan City becomes more evident when the affected areas got flooded by rainwater, high tide incursion and jetted-up groundwater. Flooding was aggravated by the alteration, disruption and clogging of both the natural and man-made drainage systems. Some houses remained underwater by 30-50 cms. for several months. The whole stretch of Don Jose Calimlim St. and swampy areas and fishpond communities such as Bgy. Lasip Grande, remain underwater even during low tide conditions.

In a more severe form of liquefaction, relative subsidence is usually associated with the tilting of heavy structures (Fig. 11). Badly tilted buildings are concentrated along Perez Blvd. Some are tilted by as much as 19 degrees, but generally the magnitude of tilt is within 2-5 degrees (Fig. 12).

Buried buoyant structures such as gasoline storage tanks (Fig. 13), septic tanks and drainage pipes exerted upward pressure resulting to the upheaval of the ground and breaking of pavements. This effect disrupted the operation of most gasoline stations and caused water supply problem, especially the availability of potable water many weeks after the earthquake.

An eyewitness described a rolling ground surface during the earthquake as "a jeep parked along the road appears and vanished from his line of sight." Evidence of rolling ground seems to have been preserved in the deformation of some fences and roads. Along the portion of Dagupan-Lingayen road enclosed by Tapuac-Malaued diversion road, cracks developed in the concrete fence coincide with the crests and troughs of undulations (Fig. 14). The cracks which formed at the crests are characteristically open and tapering downwards — an extensional feature — and the ones that formed at the trough exhibit shortening feature in the form of tight fractures. Using this observation as basis for determining the wavelength of ground undulation, the amount of separation between the extensional and the shortening cracks was measured along a deformed residential fence and a ground undulation wavelength of about 25 meters was obtained. Observable effects of ground undulation did not extend beyond the junction of the Tapuac-Malaued and the Dagupan-Lingayen roads.

Fluvial Sedimentation and Artificial Channel Cutoffs

Bathymetric data provided by the Dagupan City Engineer's office revealed a depth of 5-6 meters at the thalweg, the deepest portion along the river channel. The thalweg generally forms close to the concave side of a river channel and this is exemplified by the Pantal River segment near the Asia Brewery compound along Zamora Street. As it approaches the Magsaysay Bridge, the thalweg becomes subdued to almost indistinct. A map from the City Engineer's office also disclosed an eastward lateral migration of the river banks. Along the Magsaysay Bridge, the position of the present east bank shifted by about 60 meters and the west bank by about 90 meters.

Looping configuration of swampy areas and natural drainage represents the position of former river meanders (Fig. 15), which had been abandoned by the dynamically shifting channel of Pantal River. These abandoned river meanders are very prominent and are, therefore, identifiable from aerial photographs covering Dagupan City. In some cases, several meander loops are intertwined and coalescent. The relative ages of abandoned meanders could be inferred from its depth, distance from the presently-active channel and cross-cutting relationships. Most of the meander scars exhibit well developed point bar deposits and scroll bar ridges. However, some point bars were already obliterated by cross-cutting meander loops and are covered by channel levee deposits. Very young active meanders, particularly those within the vicinity of the city proper, are characteristically without distinct levees. Based on these observations, it is very likely that some of these meander scars have been artificially made, probably during the development of the city.

Channel abandonment along Pantal River was a consequence of natural shifts of its meandering course and construction of artificial cutoffs. Slow sedimentation of suspended materials and episodic influx of flood-borne sediments would eventually fill up the abandoned channels. These natural reclamation materials, which are largely uncompacted and water-saturated sediments, are highly susceptible to amplified ground shaking and liquefaction. At some later stages of natural reclamation, the abandoned channels are transformed from oxbow lakes into swamps or marshlands.

Artificial cutoff and reclamation have long been employed along Agno River for two primary reasons: (1) to shorten travel time around meander loops and (2) to diffuse floodwater especially at constricted portions. One exceptional case was the famed Limahong Channel, named after the Chinese pirate who established his colony in Lingayen during the late 1500s. According to historical accounts, the combined Filipino and Spanish forces laid siege on his fortress by blocking the river outlets. Limahong broke through the siege by secretly digging a channel from the Agno River to Lingayen Gulf (Callanta, 1989).

Man-made alteration of the fluvial environment of Dagupan City becomes more evident with the abrupt change in the sinuosity of Pantal River as it meanders around the city proper. Based on the ratio of the channel length and meander wavelength, the sinuosity of the active and abandoned channels of Pantal River lying south of Dagupan City proper has an average value of 2.31 and 4.19 respectively. In contrast, the meander character around the city proper was calculated at 1.40 for the active channel and 2.14 for the abandoned channels. These sinuosity measurements distinguish straight and meandering channels at boundary ration of 1.5. Therefore, the channel character of Pantal as it approaches the City proper transforms from a meandering channel to a straight channel. Furthermore, the similar sinuosity of the abandoned channels passing through the city with the active meanders at the southern continuity of the river suggests that these abandoned meanders were not yet primed for natural cutoff but were artificially severed from the main channel.

The degree of destruction along A.B. Fernandez Ave., which largely lies on a reclaimed swampland, is generally less than that in the Perez Blvd. area except within a stretch near its intersection with Rizal St. where there occurred pronounced relative subsidence and structural tilt. The heightened ground response to liquefaction along this 100 m stretch of A.B. Fernandez Ave. can be traced to modification of channel path of

Pantal River. Prior to northeastward expansion of Dagupan City, Pantal River used to pass around the area now partly occupied by A.B. Fernandez Ave. and Rizal St. before bending westward parallel to Pantal Road (Fig. 15). Thus, the segment of A.B. Fernandez exhibiting severe liquefaction-related damages coincides with the crossed-over area of the old Pantal River and is underlain by young deposits of similar age as those in the Perez Blvd. area. The rest of A.B. Fernandez Ave. which was built on a reclaimed swampland suffered less damage via liquefaction because it is basically underlain by relatively older deposits.

CONCLUSION

Dagupan City, being situated on a delta, is indeed highly vulnerable to liquefaction hazards. However, the level of vulnerability to liquefaction hazards of the various parts of the city can be assessed by determining their location in relation to ancient and recent abandoned river channels. The study has pointed out that built-up areas on abandoned river channels, along the banks of the active river channel and on young point bar deposits are most vulnerable to liquefaction hazards. This explains the spatial distribution of damages in Dagupan City and clearly demonstrates that the line separating the damaged and undamaged areas is a geological boundary.

The plan to rebuild Dagupan City and to even constitute it into a larger commercial area as a metropolis would have to consider its unique geological environment and high vulnerability to liquefaction hazards. Various structural works soon to be emplaced within the city must be properly designed and made compatible with the existing geological conditions. Detailed geologic and foundation studies will have to be conducted to delineate the boundaries of areas which are likely to liquefy during the next earthquakes. These dangerous grounds in Dagupan City, once delineated and presented in an easy-to-understand map format, should be shared and discussed with the public and potential land users for the purpose of minimizing losses from future major earthquakes. For towns and cities in other countries of the world which lie within the earthquake belts and share a similar setting with Dagupan City, the same sort of studies and public awareness campaigns should be done to avoid what Dagupan City experienced during the 1990 Luzon Earthquake.

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EMPLOYMENT GENERATION THROUGH RECLAMATION OF ALKALI SOILS IN ALIGARH DISTRICT

S. Najmul Islam Hashmi*

ABSTRACT. In India where landless agricultural laborers constitute a significant part of rural population, the generation of employment opportunities in agriculture is very essential. The extension of cultivated land is one of the most important basis for employment generation . It is estimated that in India 7 to 12 million hectares of land are affected by salt or alkali and the reclamation of these lands would be helpful in increasing the employment opportunities in rural areas.

In Aligarh district, where about 33,000 hectares of land are suffering from salinity and alkalinity problem, many projects are reclaiming these lands and they are also demonstrating the technique of reclamation to the farmers of the district. A number of farmers have reclaimed their lands as a result of this demonstration. Thus in the present paper, an attempt has been made to assess the generation of employment opportunities due to reclamation of alkali lands.

In India, where landless agricultural laborers constitute a major part of the rural population, the generation of employment opportunities is very essential. Providing employment to the rural poor is one of the basic problems India faces today. India is a land of villages where more than 70 percent of its population live in rural areas. If we want to see any development in India, it means we have to develop the rural areas and provide employment opportunities to the rural population. No doubt, the problem of unemployment is also alarming in urban areas but it is not as severe as in the rural areas. Therefore, the government of India started many programmes like the National Rural Employment Programme, Rural Landless Employment Guarantee Programme, Training of Rural Youth for Self-Employment, Jawahar Rozgar Yojana and so on. The aim of all these programmes is to provide employment to the rural poor. Besides these programmes, the extension in cultivated land has also been one of the important bases for the generation of employment. No doubt, a considerable increase in cultivated land has been recorded since independence, but there is still ample scope for bringing more area under cultivation by reclaiming large tracts of waste and barren land. It is estimated that in India about 7 to 12 million hectares of land are affected by salts or alkali (Jaggi, 1985).

Aligarh district, is one of the seriously affected districts of Uttar Pradesh, where about 33,000 hectares of land (about 7 percent of the total district area) are affected by salinity and alkalinity. There are many projects and schemes working in the district to bring these saline and alkali lands under cultivation for crops or for some other purposes

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like grass cultivation and tree plantation. These projects and schemes have demonstrated the reclamation technique for crop production, grass cultivation and tree plantation to the farmers of different villages. A large number of farmers have reclaimed their lands for crop production as a result of this demonstration effect.

For this study, data was collected primarily from field survey. Twenty farmers from Baroli, Gursikaran, Ibrahimabad and Chherat villages were selected. A detailed information about the use of human labor, bullock labor and tractor in the reclamation of alkali soils and crop production on these soils was gathered by interviewing these farmers. Rice and wheat are generally grown on these soils after reclamation. The employment opportunities generated due to reclamation of alkali soils, rice and wheat cultivation were estimated. Both human labour and bullock labour were estimated in days and a day consisted of 8 hours where as the tractor was expressed in terms of hours. Due to variation in employment opportunities in different sizes of holdings, the total holdings were classified into 5 groups, according to the size of the total operational holding of the farmers rather than the actual area reclaimed by the farmers.

Employment Through Alkali Land Reclamation

In the reclamation of alkali lands, employment of human labour, bullock labour and tractor is needed for land levelling, bunding, irrigation and application of gypsum. Table 1 shows the total employment opportunities of human labour, bullock labour and tractor in the reclamation of alkali soils. The average employment opportunities of human labour were recorded to be 38 days per hectare which consisted of 26 days of family labour and 12 days of hired labour. The table shows that there was greater use of human labour by the marginal and small farmers than big farmers. The employment of human labour was 45 days per hectare in the holdings below one hectare while the holdings between 4 to 10 and above 10 hectares it was 34 days. Small and marginal farmers used more of family labour than hired labour where as the big farmers generally used more of hired labour. The reason for this is that there was greater availability of family labour with the small and marginal farmers and they were more interested in the maximum output of their own labour than the medium and large farmers who have lesser availability of family labour. Moreover, small and marginal farmers made greater use of bullock labour which needs human labour for this purpose rather than medium and large farmers who used the tractor needless labour as well as less time for this purpose.

The average employment of bullock labour was 8 days per hectare but it was generally owned by the farmers. There was greater use of bullock labour by small, marginal and semi-medium farmers while on the holdings of bigger size between 4 to 10 hectares it was 4 days only and there was no use of bullock labour in holdings of 10 hectares and above. Thus it can be said that small and semi-medium farmers employed more bullock labour than big farmers. Because the big farmers made a total or near total use of tractor rather than the small and marginal farmers who are handicapped by their inability to afford a tractor for all the operations, they had to rely partially or fully on bullock labour.

Tractor was also used for land reclamation but greater use of tractor was by big farmers rather than small farmers. The farmers having 10 or more hectares of land holdings mainly used the tractors. This has not only supplemented the total bullock labour but also to some extent the human labour. Other farmers also used tractors but it was generally less and hired. The farmers having holdings between 2 to 4 and 4 to 10 hectares used the tractors both own and hired, where as the small and marginal farmers also used the tractor to some extent but it was totally hired.

Employment in Rice Cultivation

The total employment opportunities for human labour, bullock labour and tractor in rice cultivation were estimated. It includes all the operations starting from nursery-raising to harvesting, threshing and winnowing. From Table 2 it is observed that the average employment for human labour was 84 days, which consisted of 34 days of family and 50 days of hired labour. The number of family labour was much higher in case of marginal and small farmers than the medium and large farmers. The total number of human labour was decreasing from small farmer to large farmers. It was 95 man-days on holdings below one hectare and 73 man-days on holdings of 10 hectares and above.

As far as the use of bullock labour and tractor is concerned, they were employed only marginally as the entire work for the preparation of field to cultivate rice has been done in the course of land reclamation itself. The total average use of bullock labour was only 1 day per hectare which was used generally by small farmers. The use of tractor was taken only by large farmers having holdings of 4 hectares and above. The average employment of tractor was only 0.18 hours per hectare. The use of bullock labour and tractor in the rice cultivation was mainly for preparation of land for nursery-raising.

Employment in Wheat Cultivation

The total employment opportunities of human labour, bullock labour and tractor were also estimated for wheat cultivation which included preparatory tillage to harvesting, threshing and winnowing (Table 3). The total average human labour was estimated to be 40 days per hectare in wheat cultivation. The number of total human labour in wheat cultivation was also higher in case of marginal and small holdings than medium and big holdings. There was 45 human labour days in holdings below one hectare and this figure shows a decreasing trend as the size of holdings increases. However, there was major share of family labour in the holdings of small and marginal farmers while the farmers having holdings between 4 and 10 hectares and above it relied mainly on hired labour.

The average bullock labour was employed for 11 days per hectare. The use of bullock labour was 18 days in the holdings of less than one hectare and 15 days in the holdings between 1 to 4 hectares. The big farmers used the bullock labour only for 1 day while the farmers whose holdings vary from 4 to 10 hectares used the bullock labour for 8 days per hectare. The bullock labour was mainly used by small and marginal farmers but in the case of medium and big farmers it was substituted by tractor. Medium and big farmers used only their own bullock labour but marginal and small farmers used a considerable amount of hired bullock labour.

Tractor was used only by medium and big farmers. The average use of tractor was 3.4 hours per hectare but the big farmers, who generally did not use the bullock labour, used tractors for about 11 hours per hectare. The farmers having holdings 4 to 10 hectares also used tractor for about 6 hours per hectare. Tractor did not only replace the bullock labour but also human labour to some extent.

CONCLUSION

The foregoing study reveals that the reclamation of alkali lands has been helpful in generating employment opportunities in rural areas of Aligarh district and if such type of land reclamation work is conducted in any other part of the country, the employment opportunities will also be generated for the rural poor of that area. It will not only increase the employment opportunities in rural areas but will also help in increasing the food production.

A large number of workers in rural areas are landless labourers. They depend on seasonal work and they are among the poorest in the rural community. They do not have any permanent jobs. They move here and there in search of jobs. Generally, these workers move to city areas in search of jobs creating problems of employment and housing in city centres.

The per hectare average annual employment opportunities of human labour in reclamation and cultivation of wheat and rice on alkali soils were estimated to be 162 man-days per hectare and on the basis of this estimate if we reclaim the total 33,000 hectares saline and alkali lands of the district, there will be additional employment opportunities of

TABLE 1. EMPLOYMENT OF HUMAN LABOUR, BULLOCK LABOUR AND TRACTOR IN RECLAMATION OF ALKALI SOILS PER HECTARE-HOLDING SIZE-WISE.

Holding Size-Group (Hectares)	Human Labour Days			Bullock Labour Days			Tractor Hours		
	Family	Hired	Total	Family	Hired	Total	Owned	Hired	Total
Below 1	45	—	45	11	2	13	—	4	4
1- 2	26	11	37	10	1	11	—	5	5
2- 4	30	8	38	9	2	11	1	4	5
4-10	15	19	34	4	—	4	5	7	12
10 & above	13	21	34	—	—	—	14	—	14
All Farms	26	12	38	7	1	8	4	4	8

TABLE 2. EMPLOYMENT OF HUMAN LABOUR, BULLOCK LABOUR AND TRACTOR IN CULTIVATION OF RICE PER HECTARE ON ALKALI SOILS UNDER RECLAMATION-HOLDING SIZE-WISE.

Holding Size-Group (Hectares)	Human Labour Days			Bullock Labour Days			Tractor Hours		
	Family	Hired	Total	Family	Hired	Total	Owned	Hired	Total
Below 1	62	33	95	2	—	2	—	—	—
1- 2	66	21	87	2	—	2	—	—	—
2- 4	27	53	80	1	—	1	0.2	—	0.2
4-10	14	64	78	—	—	—	0.37	—	0.37
10 & above	3	70	73	—	—	—	0.32	—	0.32
All Farms	34	50	84	1	—	1	0.18	—	0.18

TABLE 3. EMPLOYMENT OF HUMAN LABOUR, BULLOCK LABOUR AND TRACTOR IN CULTIVATION OF WHEAT PER HECTARE ON ALKALI SOILS RECLAMATION-HOLDING SIZE-WISE.

Holding Size-Group (Hectares)	Human Labour Days			Bullock Labour Days			Tractor Hours		
	Family	Hired	Total	Family	Hired	Total	Owned	Hired	Total
Below 1	36	9	45	11	6	17	—	—	—
1- 2	31	12	43	9	6	15	—	—	—
2- 4	20	20	40	15	—	15	—	—	—
4-10	13	26	39	8	—	8	4	2	6
10 & above	06	32	38	1	—	1	11	—	11
All Farms	22	18	40	8	3	11	3	0.4	3.4

5,348,000 human labour days. But as the reclamation work is done only in the first year of reclamation, the generation of employment in the subsequent years will be only on account of rice and wheat cultivation. If we assume the same rate of employment in various operations of wheat and rice cultivation on alkali lands after reclamation, the generation of employment opportunities would be 124 man-days per hectare. These crops would generate permanent employment opportunities of about 4,000,000 man-days per annum on the entire 33,000 hectares of saline and alkali lands of the district. Thus, it can be said that land reclamation has been helpful in increasing the number and size of holdings, employment opportunities in rural areas, wage-rate and also the stability in the rural life.

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DISTRIBUTION OF HEALTH SERVICES AND PLANNING STRATEGY FOR RURAL HEALTH SERVICES IN INDIA: A CASE STUDY

Mrs. Shipra Banerjee*

ABSTRACT. Medical care is very important as it is a basic welfare need of the people. People's efficiency can be increased with the proper health care and for increasing efficiency of the labour force, there is urgent need of integrated health services. Although it is a basic need of the people, a large part of India is deprived of it, and very little attention has been given in this direction till the fifth five year plan. In the sixth plan (1980-85), an integrated health policy has been launched in India but not much progress has been made so far. The objectives of the present study are to bring out the present distribution pattern of health services and to suggest a diagnostic planning for reducing the gap in the distribution of facilities in the Aligarh district.

INTRODUCTION

Medical care is no less important in the area of development policy. Foremost, it meets the basic welfare needs, and it greatly contributes to the efficiency of the labor force (Klassan, 1968). Although health service is under the minimum need programme, a large part of India is deprived of it. From time to time different committees have recommended for the improvement of health services in the rural areas. The Bhore Committee recommended improvement and expansion in medical care in 1946 (Report of the Health Survey and Development Committee, 1946). In 1963 and 1973 two other committees revived the idea of integrated health and family planning services through multipurpose workers (Report of the committee on integration of Health Services, 1963 and Report of the committee on the multipurpose workers, 1973). Till 1980, not much headway was made in this direction. Since the sixth plan period, it became a component of the minimum need programme and a new health policy has been launched. Under the health policy set out in the Sixth Plan period (1980-85), the objective was to strengthen rural health service in such a way that the target of health for all is achieved by 2000 A.D. Under this policy the following health infrastructures have been developed: 1) Primary Health Subcentres; 2) Primary Health Centres; 3) Rural Hospitals.

The main objectives of the present study are as follows: (i) To elucidate the spatial distribution of medical facilities in the study area; (ii) To submit a comparative analysis between the distribution of medical

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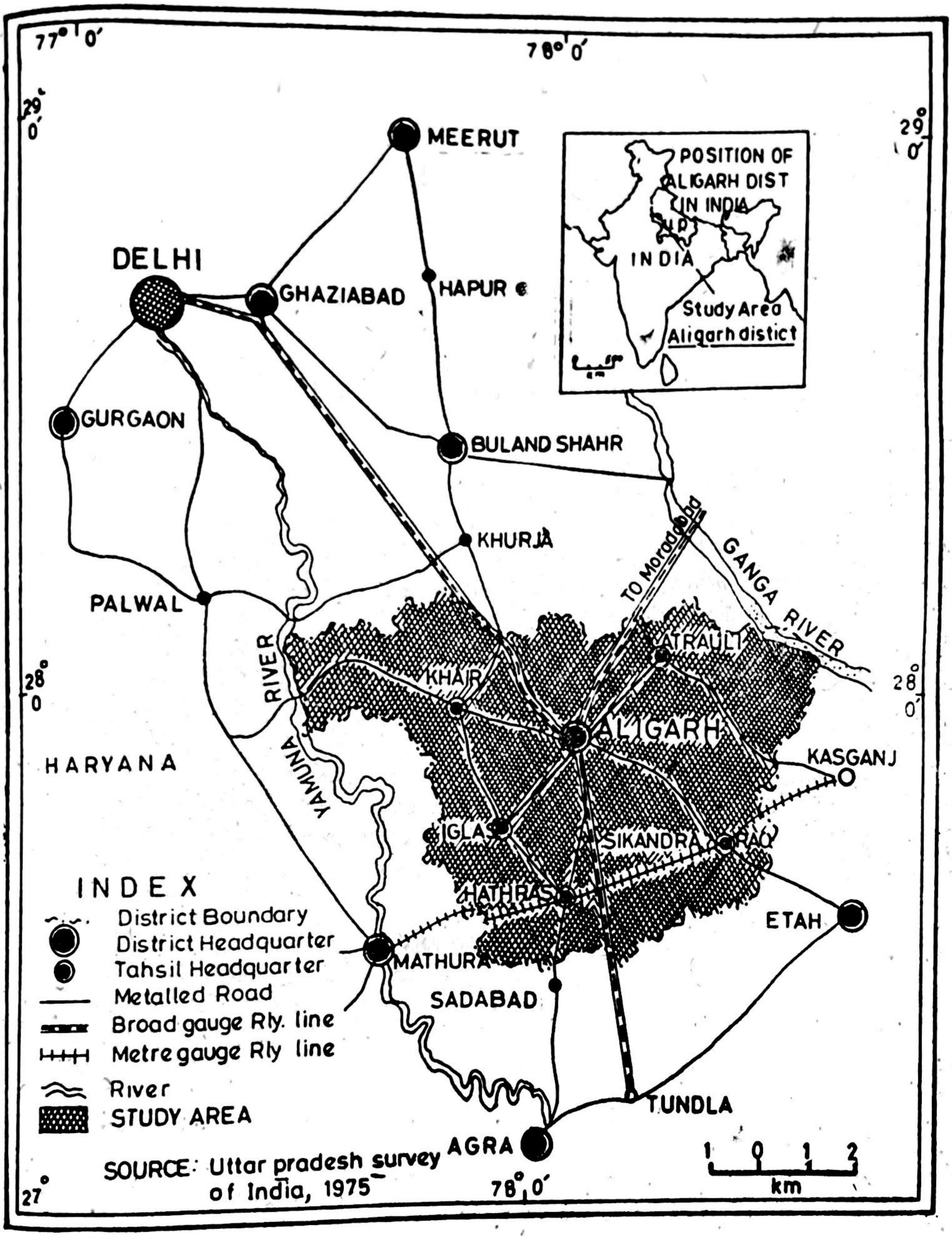

FIG. 1. ALIGARH DISTRICT LOCATION MAP

facilities and settlement based on the population size; (iii) To find out locational gaps of medical facilities and suggest an appropriate location for rural health services.

Area Profile

The Aligarh district is situated in the **doab** of Gange Yamuna. It is one of the agriculturally developed districts of Uttar Pradesh. It is bounded by Bulandshahr district in the north, Mathura district in the south and southwest and Etah district in the east and southeast. The extreme northwestern boundary is formed by the river Ganga which separates Budaun district from Aligarh, while the northwestern border is formed by the river Yamuna separating Aligarh from Gurgaon district of Haryana State (Fig. 1). The district has 2,574,925 population (1981) out of which 1,982,781 is rural. It consists of 1,724 settlements including 20 towns and covers 5,014 sq. kilometres of the district.

Data Base and Methodology

The data has been taken from Census records of 1981 and from the District Health Office of Aligarh for the year 1987.

Methodologies which have been adopted here are as follows: a) For showing distribution and gap in health facilities at locational level, table and cumulative frequency graphs are used; b) Mean spacing of facilities has been estimated on the basis of Mather's Model given as follows:

$$\bar{S} = 1.0746 \frac{\sqrt{\bar{A}}}{\sqrt{\bar{N}}}$$

Where S = Mean spacing in unit length
A = Area of the given region
N = Total number of settlements in the given region and
1.0746 = spacing constant

c) For suggesting new locations for the health sub-centres, threshold population has been estimated. To determine the population threshold of various rural health services, the modified 'Reed Muench Method" has been applied (Haggett and Gunawardena, 1964). According to this method, the threshold of any function is the middle point of its entry zone which is specified by a lower population level at which no settlement has that particular function and by an upper population level at which all settlements of that size have that function. Here, mathematically the medium population threshold has been estimated and are given in Table 1.

TABLE 1. Median Population Threshold (MPT)

Service	M P T
Primary Health Sub-Centre	2,560
Primary Health Centre	6,769
Rural Hospital	11,321
Specialized Hospital	55,000

d) For micro level network of services some more locations are to be identified. Villages which are not having threshold population, also need some provision of health services. For providing facilities to those locations some new locations are to be identified. For identification of such locations the foremost task was to understand the range of movement of people for availing services of health sub-centres. For this purpose 10 central villages having health sub-centres were selected as a sample. Selected villages are Somna, Amrauli, Andla, Barla, Lodha, Bijauli, Tochhigarh, Gopi, Pora and Madrak (Fig. 2). While sampling, care has been taken regarding space coverage. They were selected from all parts of the district, along the road side and away from the road side. Information was collected on people's movement from adjoining villages to central villages. In order to collect primary data, 20 households from each village were interviewed. In addition to that, village Sarpanch (village headman), incharge of village health sub-centres and some key informants were interviewed. The effort was made to find out the range distance from where people move to avail health facilities in central villages. The average, travel distance of people in availing facilities is estimated at three kilometres. It is assumed that such organization of villages with health sub-centres will serve villages within three kilometre distance.

Spatial Distribution of Health Facilities

Four main categories of health services are recognized. These are primary health sub-centres, primary health centres, rural hospitals and specialized hospitals.

Primary Health Sub-centres. This is the lowest level of rural health service where basic health facilities like general medicine, family planning services and services for child health care are provided. An auxiliary nurse/midwife takes care of providing these services. These sub-centres function under the supervision of primary health centres located at the block headquarters. The nurses who look after the needs of the rural population undergo one and half years of medical training. The general approach of the government is to provide a sub-centre for every 5,000 population.

The spatial distribution of sub-health centres shows a large degree of variation. Blocks namely, Tappal, Iglas, Gonda, Mursan, Hasayan,

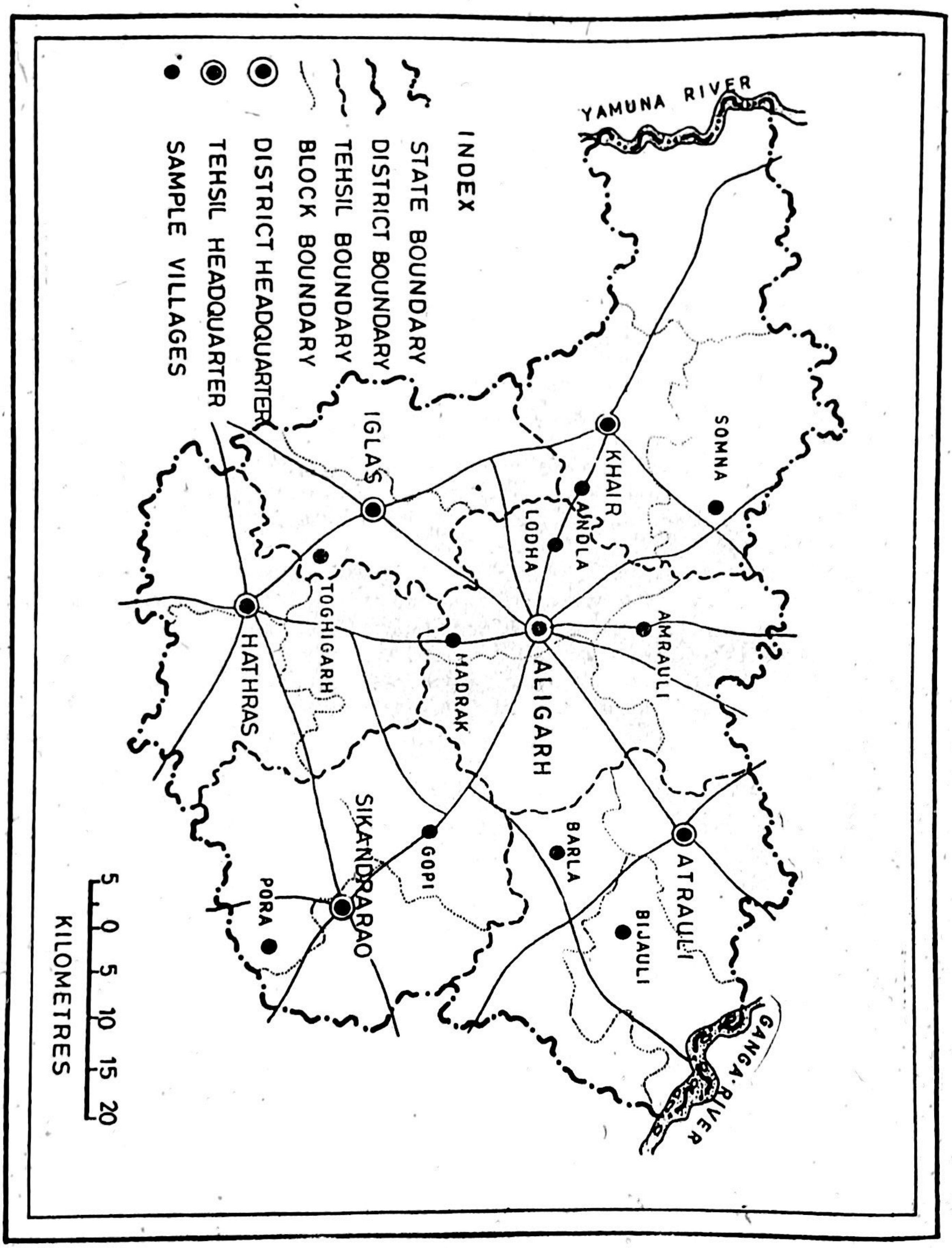

FIG. 2. ALIGARH DISTRICT SAMPLE VILLAGES

Atrauli and Bijauli have a lesser number of sub-centres than Gangiri, Sikandra-Rao, Khair, Chandau, etc., so with the adjoining parts of Aligarh town. The distribution is also mostly confined to villages with 1,000 and those with more than 2,000 population (Fig. 3). The mean spacing of settlements with health sub-centres is 4.06 km, and the population served per health sub-centre is 7,315.

A perusal of table 2 shows that out of the 1,724 total settlements, 352 settlements (20.42 percent) have primary health sub-centres. It is also observed that the maximum concentration of settlements having health sub-centres is in 1,000-1,999 (33.28 percent) followed by 2,000-2,999 (33.72 percent). Below 1,000 population share of settlements having facilities is low though the total share of settlements is quite high. Above 5,000 population, settlement is only 2.14 percent but settlements having facilities is more than 8.0 percent. Fig. 4 showing cumulative frequency curve of settlements and settlements having facilities indicate that, there are considerable gaps in all lower level of population size groups. The gaps are specially noted in 500-999 and 1,000-1,999 population size.

Primary Health Centres. Primary health centres provide higher level medical aid to village people. Each health centre has three doctors, one lady doctor, one compounder, one ward boy, two auxiliary nurse mid-wife, one health visitor, one health assistant on family planning, one dai, one lab technician, one village health worker and a health inspector. They look after the needs of the sub-centres which are also under the particular primary health centre. Each primary health centre has four beds two for maternity and two for emergency. These centres are responsible for distributing all kinds of medical aids and facilities to sub-centres and each primary health centre controls some sub-centres also.

TABLE 2. DISTRIBUTION OF SETTLEMENTS HAVING HEALTH FACILITIES IN ALIGARH DISTRICT (1987)

Population Size Groups	TOTAL SETTLEMENTS No.	Percent	PERCENT OF SETTLEMENTS Primary Health sub-centres	Primary Health centres	Rural Hospital
Below 200	72	4.18	0.85		
200-499	318	18.42	4.86	2.64	
500-999	584	33.90	15.50	2.64	
1,000-1,999	482	27.90	33.70	7.89	
2,000-4,999	232	13.46	36.28	34.24	10.00
5,000-9,999	29	1.70	6.82	34.24	30.00
10,000-19,999	3	0.20	0.85	7.89	20.00
20,000-49,999	2	0.12	0.56	5.23	20.00
50,000 & above	2	0.12	0.56	5.23	20.00
Total Number	1,724	—	352	38	10
Total percent		100.00	20.42	2.20	0.52

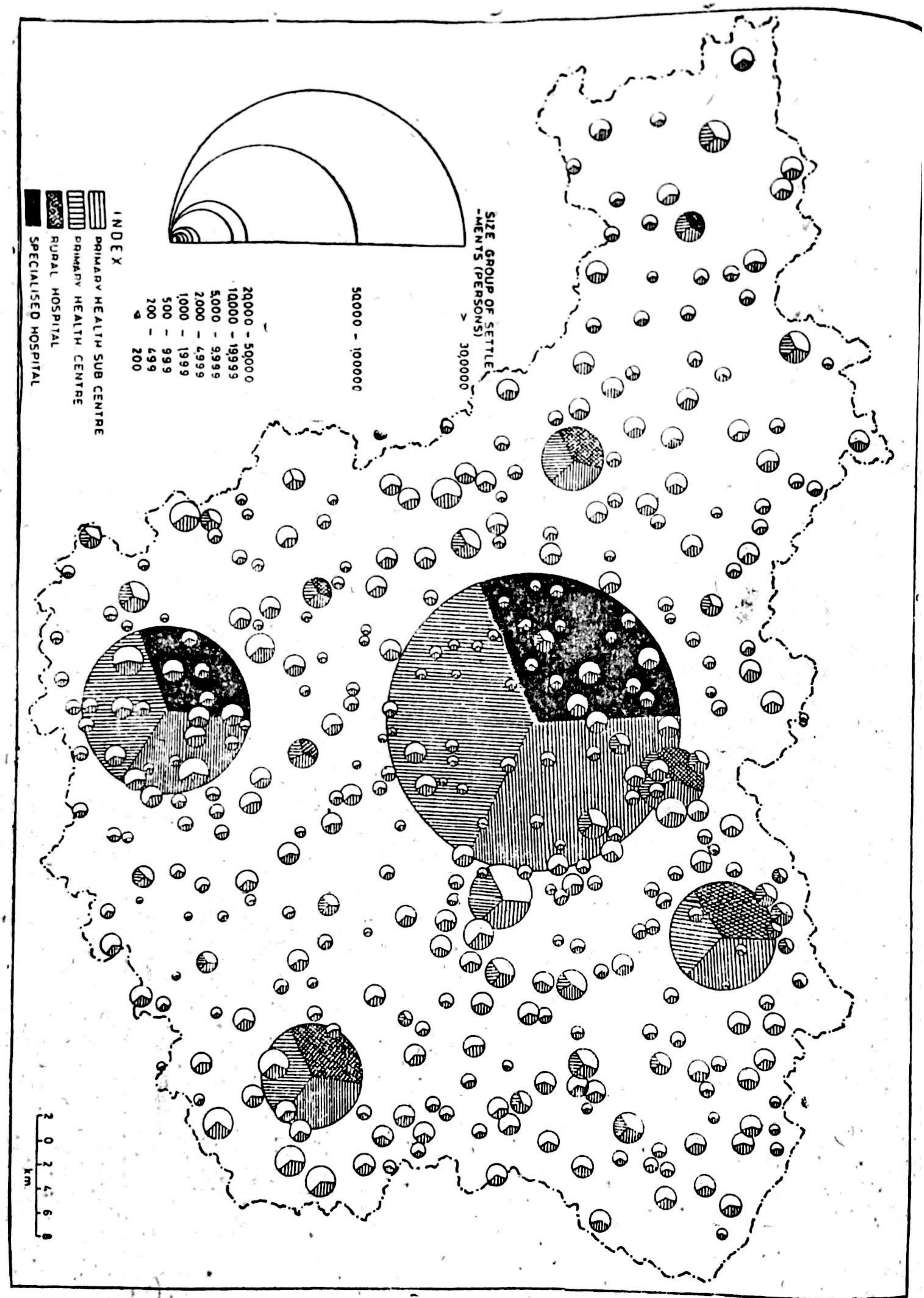

FIG. 3. ALIGARH DISTRICT SPATIAL DISTRIBUTION OF HEALTH FACILITIES 1987

Scanned with CamScanner

Primary health centres are mainly located in the block headquarters. In addition to block headquarters, primary health centres are also located in small towns like Beswan, Jalali, Kauriaganj and Vijay-garh. Some large villages which have these facilities are Chandapa, Chherat Sudak, Barla, Gabhana, Maho, Gorai, etc. (Fig. 3). The mean spacing of primary health centres is 13.35 km. and the population served by each primary health centre is 67,761. These figures highlight the inadequacy of medical facilities in the rural areas.

From Table 2 it is observed that out of the total number of settlements of the district 38 settlements (2.20 percent) have primary health centres. Settlements with primary health centres are greater in 2,000-4,999 (34.24 percent) and 5,000-9,000 (34.24 percent) population range. Below 2,000 population, settlements having health centres is low. Fig. 4 shows that there is a considerable gap between cumulative graph of settlements and settlements with facilities. Maximum gap is observed in the population group 1,000-1,999. Even at higher population range all settlements do not have health facilities hence there is no correspondence between curves.

Rural Hospitals. Hospitals are centres of higher order health facilities. It has family planning centres, child health care centres and facilities for the treatment of outdoor and indoor patients. These hospitals have four-five doctors including one lady doctor. The number of beds in these hospitals is 30-35. These hospitals are mostly located in small towns like Khair, Atrauli, Sikandra, Rao, Jatari, Sasni, Kasimpur, Iglas (Fig. 3). Mean spacing indicates that hospitals are located at a mean distance of 24.10 km. and the population served by each hospital is 214,577. This indicates the inadequacy of hospital facilities in the district.

Table 2 shows that out of the total settlements of the district about 10 settlements (0.52 percent) have rural hospitals. Settlements having population of less than 2,000 do not have any rural hospitals. Settlements having rural hospital facilities are observed in 5,000-9,000 (30.0 percent) population size group. The rest of the higher population size groups have 20 percent settlements with these facilities though their share in the total settlement is very insignificant. Fig. 4 indicates that there is a wide gap between the distribution of settlements and settlements having these facilities. This indicates that the facilities of hospitals are low at all levels of population.

The district has some specialized hospitals with modern medical facilities. These hospitals are mostly confined to the district headquarters in Aligarh. Aligarh town alone has six hospitals for public services. It has an eye hospital, Jawaharlal Nehru Hospital (A.M.U.) and District Civil Hospital with modern facilities and specialist doctors. These hospitals undertake various kinds of programme like immunization and family planning for its surrounding areas. Hathras is another town of the district which has hospitals, polyclinic and nursing homes for higher order medical services.

Planning for Health Services

The discussion made so far indicates that the rural areas of the district are deprived of proper health facilities and there is need for suggestions of new locations, so that medical aids are within the reach of all village people. For the balanced development of health services, two types of proposals are made, one deals with a short term plan, e.g., the plan for immediate action. The second deals with the plan for the year 2001.

Short Term Plan-Phase I. In the short-term plan, correction for faulty locations are to be made with immediate action. An implementation needs some time hence the duration is suggested up to 1995. In this plan two types of proposals are made: a) Identification of locational gaps on the basis of population threshold; b) Planning through central villages.

A locational gap for primary health sub-centres is identified with the help of a population threshold. Population threshold is defined as the minimum number of consumers required to support a given service. If a population threshold is 1,000 then it means that normally all settlements having that population should have that function also. On the basis of population threshold, all planners are in a position to identify all settlements having higher population but not having functions and accordingly they can suggest the location of that function. We have calculated the population threshold of health services given in Table 1 and with the help of that we can identify the gap and make future proposals.

On the basis of threshold population of 1987*, 60 settlements could have primary health sub-centres hence they are suggested for that. But with the deployment of these sub-centres, the need of primary health sub-centres are not fulfilled because nearly 84.40 percent (Table 2) of the village has a population below 2,000 and they need medical services. In providing services to these small villages, some villages are to be selected. In such cases a required threshold population will be fulfilled for the cluster of villages around it. In selecting villages, locational aspects should be given due consideration.

For better network of health services at grassroots level, some rural health services are suggested through central villages, central places forming a nuclei of services to serve its immediate area. These are lower order focal points in the entire settlement system. Central village planning is an approach which works for area development through spatial and functional integration. In these central villages various other services

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* Population is projected from 1981.

are also suggested for integrated infrastructural development, but that is not under the scope of the present study. Through central villages two main rural health services, e.g., primary health sub-centres and primary health centres are suggested:

a) For the primary health sub-centres locations of 53 central villages are suggested. With the deployment of these sub-centres, the district will have health facilities at the grassroots level;

b) 16 central villages are suggested for the higher order health services, e.g., primary health centres. All health centres are suggested for promotion from the primary health sub-centre to primary health centres. The government norm of providing one health centre for every 30,000 population has remained the main criterion for such suggestions. They are suggested in such locations where they can command four five primary health sub-centres and provide services of higher order to 30,000 to 40,000 people in that area. Primary health centres are suggested at Andla, Siwala, Malab and Umri of Khair **tehsil**, Tochhigarh and Hastapur-chandiri of Iglas **tehsil**, Boroli-khas, Ukhlana and Madrak of Koil **tehsil**, Salempur and Kaumri of Hathras **tehsil**, Kanau, Kachora and Agsouli of Sikandra-Rao **tehsil** and Sankura of Atrauli **tehsil** (Fig. 5).

Long Term Plan-Phase II. So far, we have discussed a plan for filling in the present functional gap with the help of the threshold population of 1987 and the central village planning. These plans are of corrective measures and should be implemented immediately for the equitable distribution of services in the district. A long-term plan is suggested for the district up to the year 2001. It is expected that by 2001, population will increase hence the need for these health facilities will rise by that time. In the long-term plan two types of proposals are made: a) for the individual settlements which will achieve new threshold population; b) for the central villages.

By projecting the population up to 2001, some new settlements will achieve the threshold population for having primary health sub-centres. Twenty-eight settlements will achieve population threshold for primary health sub-centres and for them, primary health sub-centres are suggested.

By 2001 the command area of the central villages will have increased and will enhance the need for health facilities. For meeting those needs, the capacity can be increased instead of deploying more facilities. All primary health centres whose capacity are to be increased are Tappal, Pisawa, Gabhana and Chandaus, Andla, Siwala, Malab and Umri of Khir **tehsil**, Jawan Sikandarpur, Cherrat Sudak, Nahal and Boroli-Khas of Koil **tehsil**, Kazimalad, Bijauli, Barla, Dadon, Gangiri and Sankura of Atrauli **tehsil**, Gonda, Gorai, Sathni Tochhigarh and Hastapur Chandferi of Iglas

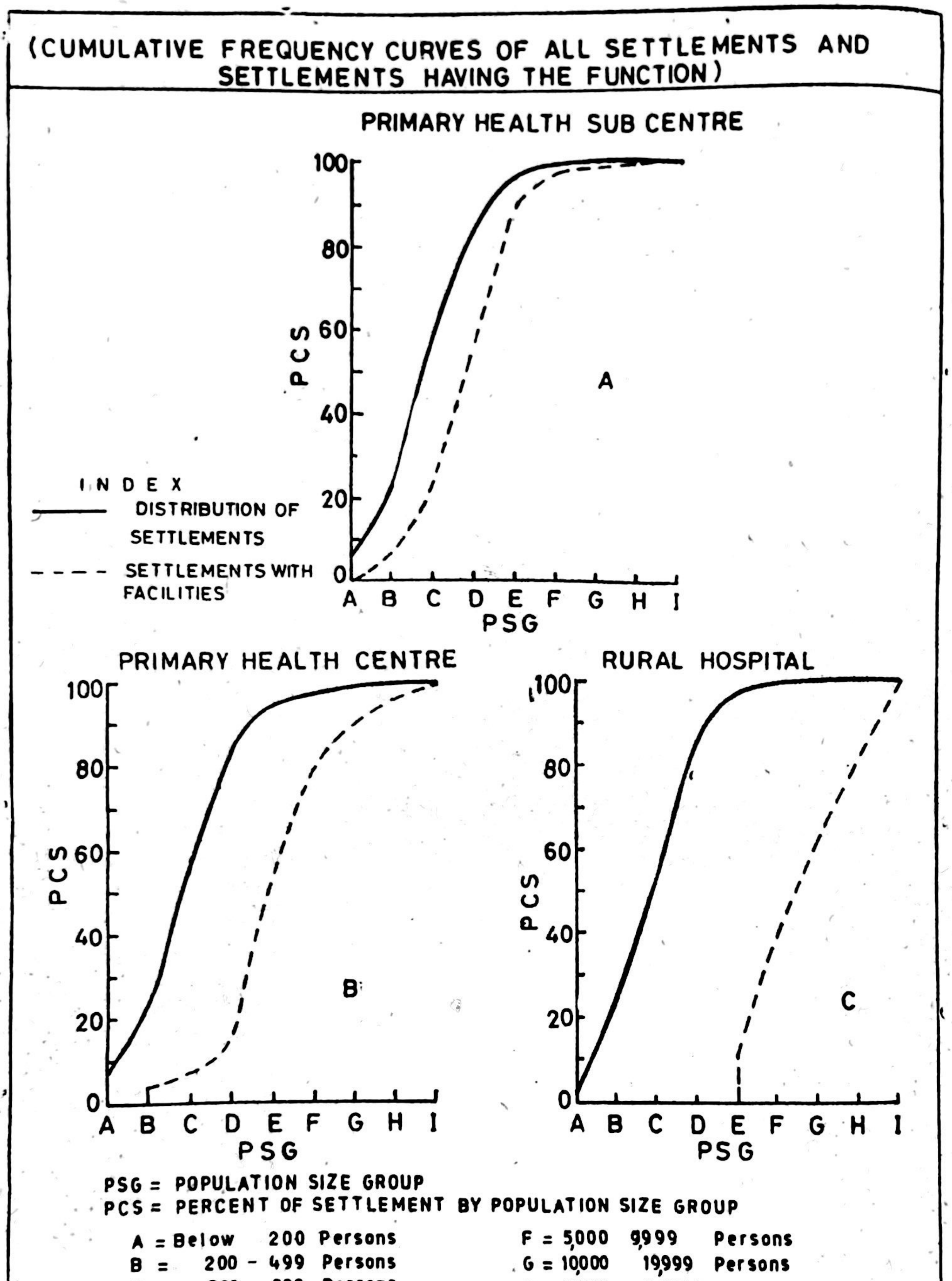

FIG. 4. ALIGARH DISTRICT HEALTH FACILITIES (1987)

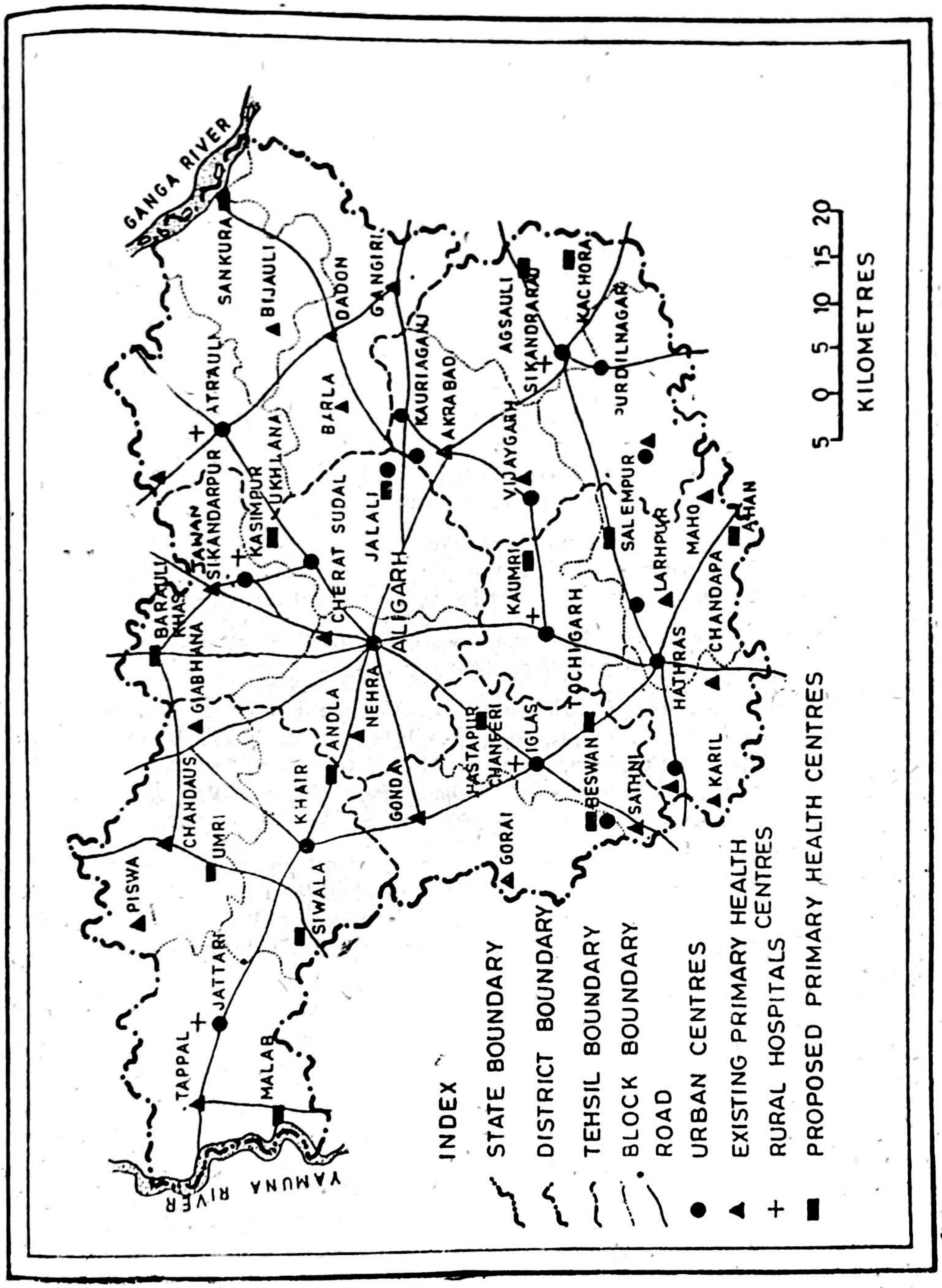

FIG. 5. ALIGARH DISTRICT SPATIAL ORGANIZATION OF PRIMARY HEALTH CENTRES (1995)

tehsil, Akrabad, Kanau, Kachora and Agsouli of Sikandra Rao **tehsil**, Kril, Chandapa, Larpur, Maho, Ahen, Salempur and Kaumri of Hathras **tehsil** (Fig. 5).

The provision of the above-mentioned health infrastructures will go a long way in reducing the gaps and fulfilling the needs of health services in the rural areas.

CONCLUSION

From the foregoing analysis, the following conclusions can be drawn:

(a) Medical facilities are inadequate in the district and they are highly concentrated to towns and large villages.

(b) The lowest level medical aids can be availed by only 20.04 percent of settlements. The higher level rural health services like primary health centres and rural hospitals are acquired by few settlements having more population.

(c) There is a great gap between the distribution of settlements and the settlements having health facilities. That is specially noticeable in the case of primary health centres and rural hospitals.

(d) Population served and mean spacing of facilities also highlight the locational gap of facilities.

(e) High degree of variation is noticed in the distribution pattern of facilities. Tappal block, Iglas block, Mursan block, Hasayan block and adjoining parts of Aligarh town have less number of villages with sub-centres than Gangiri, Sikandra-Rao, Akrabad, Khair and Chandaus blocks.

(f) For reducing the functional gaps, locational planning has been framed out in two phases. They are short-term plan and long-term plan. In both phases, facilities are provided in two ways: I) through the population threshold; and II) through some central villages.

Such deployment of health facilities will cause an integrated health services to the area and will work for 'health for all' by 2001.

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