CHAPTER I
INTRODUCTION OF THE PROBLEM

Prologue to the Problem

The term 'Medical Geography' was first used by those researchers of diseases who showed the distribution of the latter with the help of maps and atlases¹. To these researchers maps and atlases played an important role in establishing relationship between various aspects of ecology and occurrence of diseases in the spatial context, and this new approach, i.e. 'Medical Geography' started gaining ground.

The attention of the Physicians since time immemorial has been focussed on the symptoms of diseases. It is only recently, with the progress in biochemistry, biophysics, etc., that attention has been given to the biochemical disorders that are the result of disease².

For thousands of years people have wondered about the nature and cause of disease. To some, disease was a punishment meted out for misdeeds by an angered god. This kind of notion persists even today, even among people who 'know better'. It is realized today that human sickness and health are in fact


intimately related to human ecology. It is further realized that disease is a multifactorial phenomenon which occurs due to the interplay of various causative factors such as the physical, human and social environment that act over space through time. To understand these causative factors and to find out their relationship with the ecology are the central themes of Medical Geography. In recent years, however, the scope of the subject has widened to encompass the relationship between the various factors of human health and sickness and their respective geographical environment. Thus Medical Geography emphasises on the patterns of distribution and the areal aspects of environmental relationships between diseases and their causes.

A. Leslie Bank in his paper entitled 'Trends in the Geographical Pattern of Disease', stressed the need of the sub discipline of Medical Geography and mentions that man's association with disease and medicine offers a most promising field which can be the domain of Medical Geography.

Incidence and spread of human diseases display distinctive areal patterns. Medical Geography endeavours to unravel these intricate patterns on the basis of the study of man-environment relationship. Man is viewed here as a significant component of the ecosystem. His activities and

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3 Ibid.
well-being depend on the entire gamut of influences impinged on him by the physical, biological and socio-cultural environment.

Thus the diseases that attack and overtake him are part and parcel of the entire environment he lives in. Medical Geography tries to find out the causes of diseases inherent in various aspects of his environment. Further, maps illustrating areal distribution of various diseases or groups of diseases are prepared, which are not only useful tools in epidemiology*, but a convenient form of expressing the areal or spatial characteristics of the diseases.

The Problem

India is a country, where a large proportion of the ever-growing population, largely devoid of the modern technological base and healthy living, is working as a hindrance to modernization and socio-economic transformation.

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* Epidemiology: Up to very recent times, epidemiology meant the study of epidemics, limiting the field to the study of transmissible diseases. In the United States, however, the meaning of the term has been enlarged. It is now applied to the study of the factors of occurrence of any disease, transmissible or otherwise. At a meeting in Colorado Spring in 1952, North American epidemiologists agreed to define their field as "the study of all factors and their interrelationships which affect the occurrence and cause of health and disease in a population". This definition is all-embracing. It certainly takes into equal consideration both the inorganic factors of climate and soil, which play a role in shaping societies of living things, as also the organic factors, which govern the inter-relationship of one living thing with another and of one society of living things with that of another. It includes the study of the responses offered by the tissue. It also includes the study of the cultural and social factors that bring stress or avoid it.
The country is vast, population is teeming and the problems are monumental. Every organization, government or public, and every individual educated or otherwise, has a responsibility to work towards solving the problems, especially human suffering of the country. Geographers who are supposed to understand the man-environment relationship best, are obviously expected to work towards solving these problems almost as a binding duty. But unfortunately in our country, it is rarely that geographers have so far given serious thought to analyse the cause-effect relationship of under-nourishment, insufficient clothing and substandard shelter of the bulk of the Indian population.

The physical capability to work of an average Indian is low, essentially because of his poor health and comparatively short longevity. The work potential of the inhabitants of the country, therefore, is not in keeping with its vast number. The deplorable health condition borne out of under-nourishment and substandard living is rampant throughout the country. The conditions in Assam are definitely not better in any way.

Common tropical diseases and those caused due to under-nourishment and sub-standard living take a high toll of the Indian population. Similar condition augmented by an ecology developed over heavy and long continued rainfall and low lying relief prevail in Assam. It is found from the
hospital statistics that Peptic Ulcer, Tuberculosis, Malaria and Cancer of the throat region are the oft recorded serious and dreaded diseases in Assam. In view of their common incidence, it is felt that their distribution and ecological setting should be carefully probed for further scientific study and remedy.

**Relevant and Similar Works**

Studies on Medical Geography were never taken up seriously in the past, partly because geneses of the diseases were not widely known to common people, and partly because the scope of geography was not widened to include the cause and distribution of the disease. Moreover with the discovery of bacterial infection, it was erroneously believed that to understand the epidemiology of an infection, all that was needed was to know its causal germ. No importance in fact was ascribed to the study of environment.

Medical Geography, a new discipline, is now growing at a rapid pace. This is revealed in the increasing number of papers presented on this subject in the various International Congresses and seminars in recent years.

The earliest literature in Medical Geography goes back to the Hippocratic collection of the works of the Greek philosophers. The famous Greek treatise on 'Airs, Waters,' and Places contains a description of the effect of topography and climate on the health and character of man.
In 1911 Dr. S.R. Christophers studied and mapped the incidence of the epidemics in the Punjab. In 1926 Dr. S.R. Christophers and Dr. J.A. Sinton prepared a map which is still held to be the classic map of Malaria in India.

During the last two decades or so, a number of publications on Medical Geography have been brought out in the U.S.A. (May); Britain (Learmonth, Geddes, Howe, Waddy), Germany (Jusatz) and U.S.S.R. (a team of scientists headed by Ignat'yev). The work on Medical Geography has been taken up in right earnest in the U.S.S.R. where not only the spatial distribution of diseases has been taken into consideration, but stress has also been laid on geographical and geochemical causative factors of human diseases with reference to environmental conditions.

Dr. Jacques M. May, the then Director of the Medical Geography, Department of American Geographical Society, New York, released the studies in Medical Geography in three volumes (Published in 1958 and 1961).

Among other important studies of the recent past are Stamps' books on 'Some Aspects of Medical Geography'  

(b) Studies in Disease Ecology, 1961.  
(c) The Ecology of Malnutrition in the Far and Near East, 1961.  
(London 1964) and 'Medical Geography of Life and Death' (London 1964). In these publications Dr. Stamp emphasized the need of the study of health in general apart from the mortality of a population. G. Melvyn Howe (1972) in his book 'Man, Environment and Disease in Britain', made an historical survey of the intricate relationships of human disease and environment in Britain from an areal viewpoint.

J. M. May in a number of papers mapped the world distribution of diseases like Malaria, Cholera, Poliomyelitis etc. He also dealt with the methods and objectives of Medical Geography in some other papers.

Medical Geography is still in its infancy in India. From Christophers' work on the epidemics in the Punjab and the map of Malaria published in the earlier part of this century, there was a long gap until Learmouth took up in 1958 some fundamental works on the character and spatial pattern of a number of diseases in the country.

Learmouth's contributions in the reputed journals like 'The Indian Geographical Journal' and 'Geographical Review' deserve mention and have been considered as outstanding in the field of Medical Geography in India. Most of these

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pioneering works were devoted to the general distribution of diseases and correlating them with the Indian diet and other environmental factors. *The Medical Geography of India* of R.P. Misra is a recent work in this field. His book was published by National Book Trust, India in 1970. This work gives a broad survey of the distribution of diseases in India. It also discusses the geographic problems related to nutrition and health and the availability of medical services.

The latest addition to the study of Medical Geography has been made by Dr. Bireswar Banerjee and Dr. Jayanti Hazra (1974). Their study portrays the complex role of environment on incidence, proliferation and spatial distribution of diseases.

These works were followed by numerous empirical papers to the study of the causes and patterns of diseases within a specific area. Miss Ramala Basu in her paper entitled, 'Cholera in Calcutta - A case study in Medical Geography', made an attempt to study the incidence and distribution of Cholera in Calcutta. She examined the cause and effect relationship of the disease with the help of the scatter

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Indra Pal in his paper entitled, 'Aspects of Medical Geography', gave an introduction and definition to Medical Geography and the world distribution of certain diseases. Kailash Choubey in his paper entitled, 'Diseases of Sagar City in the Light of Environment and Nutrition Deficiency Factors', studied the diseases of Sagar City in relation to the environment and nutritional deficiency factors. A. Leslie Bank in 1959 discussed the trends in the world of the studies relating to diseases and their prevention within the framework of Geography. While advocating for Medical Geography he gave a broad background to the subject and the problems faced by those working in this field, and tried to point out the direction one should proceed in. Mrinal K. Dutta in his paper entitled, 'The Diffusion and Ecology of Cholera', studied the endemic and epidemic areas, their periodicity and stimuli in India. He took both the physical and cultural factors affecting Cholera

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and studied the control and prevention of the disease.

In Assam 'Medical Geography' is almost unknown. Two early treatises dealing with the socio-economic and religious aspects of the inhabitants of north east India, namely 'Yoginitantra' and 'Kalikapurana' deal with certain diseases prevalent among the inhabitants of the region and their remedies which included long inventories of medicines and medicinal plants. These are perhaps the only books in which medical geography of this region received certain place.

After the annexation of Assam by the British, a large number of books dealing with all aspects of the State were published by the British explorers and administrators. D.A. Macleod who came to Assam as a surgeon along with the early British Administrators, wrote a monograph entitled 'A sketch of the Medical topography of Bishnath and its immediate neighbourhood, with an Account of the Diseases generally prevailing in Assam 1837'. This perhaps is the first scientific work done on the Medical Geography of Assam. He gave the impression that any type of fever or any other disease prevalent in Assam then was due to the consequence of Miasma or Malaria, generated in the decomposed vegetable matter. According to him, this Miasma is generated in greater quantity in the autumn and spring than during other seasons of the year. Miasma seems to have affected more frequently those people who slept on the
the ground, rather than those who live in the upper stories. He had warned the Europeans to stay away from the jungles of Assam during the summer months.

F.N. Macnamara in his book on climate, medical topography and diseases written as early as in 1880\textsuperscript{13}, has given not only a detailed account of the topography, drainage, and climate of Assam, but also put forward a good account of the principal diseases prevailing in the State then. He has dealt with each district separately.

Works of similar nature have recently been undertaken by doctors, where emphasis is obviously given more on the medical side than to the geographical aspects of the diseases. Dr. S.N. Sarma, former Principal of Gauhati Medical College, worked on the 'Incidence of Cancer in Assam' and Dr. B.D. Baruah from Assam Medical College has written a number of articles on 'Cancer in Assam', (1964).

Besides these, no other work of any significance on Medical Geography has been done in Assam in spite of the crying necessity of such studies.

\textsuperscript{13} F.N. Macnamara, \textit{Climate and Medical Topography in their Relation to the Disease - Distribution of the Himalayan and Sub-Himalayan Districts of British India}, 1960, Chapter X.
Significance of the Topic

Diseases are not unchanging phenomena. Their appearance and character are subject to historical development and varying geographical and demographical conditions of population. Some diseases seem to disappear, and new ones appear. Infectious diseases which only one or two generations ago, used to account for very high morbidity and mortality, have been eradicated by the advance of medicine. Instead some other diseases such as cardiovascular diseases and tumours, have taken the first place, a development which is partly connected with a rising average expectation of life. The overall picture of diseases within one country or community, which one can call the 'disease-panorama', varies then from time to time, from country to country, and from society to society. 14

Hippocrates, in the fourth century B.C., was probably the first to describe the science of epidemiology which deals with the seasons for the causation of the prevalence of disease and the nature and causes of variations in it. In his treatise on 'Airs, Waters, and Places', he stated that whoever wishes to investigate medicine properly, should proceed thus: in the first place to consider the seasons of the year, and what effects each of them produces —— Then the winds, the hot and the cold, especially such as are

14 Folke Henschens, History of Diseases, Translated by J. Tate (New York, 1967).
common to all countries, and then such as are peculiar to each locality. We must also consider the qualities. In the same manner, when one comes into a city to which he is a stranger, he ought to consider its situation, how it lies as to the winds and the rising of the sun; for its influence is not the same whether it lies to the north or the south, to the rising or to the setting sun. These things one ought to consider most attentively, and concerning the waters which the inhabitants use, whether they be marshy and soft, or hard, and running from elevated and rocky situations, and then if saltiest and unfit for cooking; and the ground, whether it be naked and deficient in water, or wooded and well watered, and whether it lies in a hollow, confined situation, or is elevated and cold; and the mode in which the inhabitants live, and what are their pursuits, whether they are fond of drinking and eating to excess, and given to indolence, or are fond of exercise and labour, and not given to excess in eating and drinking. 15.

From the earliest times, therefore long before the discoveries of Pasteur and Koch, men have been striving to replace the simplified but erroneous explanation of disease as a divine vengeance for wrong doing or the result of an

evil curse. With the discoveries of bacteria towards the end of the last century, the whole field of epidemiological investigation has broadened, and medical science has moved from the early "Empirical Era", when the emphasis was on the diagnosis and treatment of the sign and symptom of disease to the present "Era of Ecology".

Today medical preoccupation is no longer with the entity of the disease as such, but rather with the study of the individual in his natural habitat. We are concerned with an understanding of man in relation to his total environment, social as well as physical, and emphasis is now directed towards the diagnosis and treatment of the communities' ills.

Medical Geography investigates the impact of environmental factors (both of the natural environment and of the man-modified environment) and of natural spatial complexes on human health in addition to studying the distribution of diseases.

The uneven distribution of diseases over space through time, tempts one to investigate if any one of them have a point of origin due to the interaction between the pathological and geographical factors.

Plotting the data of incidence and variability of various diseases on the same map, and depicting their distribution, we can identify the areas where these break out
in endemic and epidemic forms. Furthermore, the data may also be studied and analysed cartographically if these are recorded in different ways such as tables, questionnaires, etc. and accordingly can be drawn by different methods like dot, shade, pigraph, etc. on maps. The maps in this case, may more strictly be called as cartograms since they are simplified maps specially designed to show clearly or to highlight selected facts and to permit comparisons and correlations.

The significance of undertaking such a work lies in the fact that the society in general, and this part of the country, which lacks in specialized knowledge of the spatio-temporal pattern of the diseases in particular, will greatly benefit from its findings.

Objective of the Study

The last fifty years have seen the most remarkable changes in the effectiveness of our methods of controlling diseases. The time has now come where members of the medical profession can no longer work in isolation, for the problems of the future are rather those of communities than of individuals.

It is becoming apparent that there is an urgent need for co-ordination of the various disciplines concerned with man and his environment and activities, and in this connection
the association of diseases and medicines with geography offers a most promising field.

We are on common ground when we stress the importance of the environment on human health and well-being, and in this context we subdivide environment into physical, biological and social compartments. We are therefore leaving behind us the time when disease and disease control were the sole concern of the persons engaged in the medical profession. It is now universally realized that these are no longer only medical but also equally social.

The objective of Medical Geography is not merely the study of the geographical environment only. It is the study of the geographic environment in so far as it affects the health of man. It is not the study of the disease in itself but the area affected by disease and its distribution within that area.

Based on the aims and objectives of the study the hypothesis has been built to study the Disease - Environment relationship, in other words, correlation between the elements of environment and the incidence of diseases so as to find the spatial distribution of the diseases mentioned earlier. This research may point out the causative factor(s) of the diseases undertaken for study.
To test the above hypothesis the following techniques will be used.

(i) Correlation between the environmental factors and certain diseases both physical and social - will be tested by coefficient correlation, regression and other cartographic techniques.

(2) Population distribution and density will be tested with the methods of Dot, Circle, Shade, Pyramids, etc.

(3) Distribution and spatial pattern of diseases will be made by Poisson distribution with significant variation and the level of incidence will be made by the chi-square test.

Diseases Studied

According to the "International Classification of Diseases, Injuries, and Causes of death*, Assam has a

* International Classification of Diseases is widely accepted as the basis for classifying morbidity and mortality. This classification is revised by the World Health Organisation approximately every 10 years, the latest revision being that of 1967 (8th ed.). This classification (ICD) gives 1,000 groups of diseases and each group a code. Full instructions are provided for using the code. Since this classification is in far too great detail for most statistical purposes, for general use, the 1,000 categories are grouped into 50 categories signifying the causes of death. Almost all the nations, where causes of death statistics are collected, make use of this system.
high mortality and morbidity rate of a few particular disease, such as Tuberculosis, Peptic Ulcer, Malaria, Cancer of the throat region, Dysentery and various heart ailments.

The scope of this work is confined to the study of four diseases, namely, Peptic Ulcer, Tuberculosis, Malaria and Cancer of the throat. The rationale behind selecting the above mentioned diseases for the present study lies in their high incidence, and mortality rates caused by them, as revealed by the medical records maintained by the Government hospitals and Public Health Departments of the State.

It is found that there are about 7 - 8 million Tuberculosis patients in India, and mortality is estimated to be about 80 - 100 per 100,000 population per year. Assam's rate of mortality as a result of Tuberculosis attack is estimated at 50 - 70 per 10,000 population.

Of all the Cancer cases in Assam, 75.3 per cent is of the throat region. Nearly 4,000 patients come every year for treatment of this disease. Nearly 50 - 60 per cent of the total patients in Assam suffer from Peptic Ulcer and about the same percent suffer from Malaria.

16 P. K. Duraiswami, Director General of Health Services, 'National Tuberculosis Programme of India', 1968.

Spatial Concentration

*Malaria* is the most common disease in the tropics and causes millions of deaths every year either directly or indirectly. Malaria infection, however, seldom occurs in India at a height over 2000 metres above sea level, because of the low temperature at higher elevations. Over the Brahmaputra Valley significant prevalence of *Malaria* is found in the Goalpara, Lakhimpur and Darrang Districts.

*Tuberculosis* is a specific infective disease. Unlike other infections, many persons become infected by *tuberculosis* in their early life. Only a relatively small number develops clinically recognisable evidence of disease at the time of the first infection. It is stated as a number one killer disease in India. There is a high incidence of it in Goalpara, Lakhimpur, Sibsagar, Darrang, and Kamrup Districts of Assam as compared to the rest of the districts.

*Peptic Ulcer* appears to have had its beginning with Man's occupation of this planet. The cause of *Peptic Ulcer* remains a mystery inspite of much research and a multitude of books written on the subject.

Accurate knowledge of the geographical incidence of *Peptic Ulcer* is difficult to obtain unlike the diseases like *Malaria* and *Kala Azar* which are endemic to certain regions, where precision in diagnosis is achieved. The incidence of *Peptic Ulcer* is fast changing.
The records of the recent years reveal a very high incidence of the disease in Dibrugarh District followed by Kamrup, Darrang, Nowgong and Lakhimpur.

Cancer is attracting increasing attention because it is the most dreaded disease as also because increasing pathological success in diagnosing it in recent years as a result of the discovery of various tests and precision instruments. Moreover it has immense research interest because there is a distinct spatial variation in the prevalence of Cancer in different sites of the human body. There is an increasing evidence that environmental factors play a salient role in the aetiology of Cancer. Incidence of throat cancer is high in the districts of Kamrup, Dibrugarh and Darrang.

Physical and Organic Bases of the Diseases

Malaria is a specific fever caused by certain protozoal parasites of the class Sporozoa belonging to the suborder Haemosporidiidae and the family Plasmodiidae, whose definitive host is mosquito and intermediate host is man. These parasites infect the red blood corpuscles, produce anaemia, enlargement of spleen and liver, and give rise to periodic fever which is usually intermittent but may be remittent or continued.

Malaria is the most common disease in the tropics. It is most prevalent in the latter months of the rainy
season and during the months which intervene between the rains and the winter, because a high atmospheric temperature is necessary for the development of this parasite in the mosquito. Infections begin in June or July and reach its peak in October, or even in early part of November. Temperature above 10°C and relative humidity above 63 per cent are favourable conditions for the infection, as the Malaria parasites prosper in the mosquito under such environment. High rainfall accompanied with high temperature favours a high malarial incidence, although it is not universally true. In certain places such as Sri Lanka, heavy rainfall flushes out the breeding pools of the mosquitoes and causes definite decrease in the incidence of Malaria.

A high subsoil water-level means increased occurrence of malaria, presence of pits, pools, marshes, buildings, bridges, canals, embankments and railways, interfering with the natural surface drainage, causes an increase of malaria while well-drained uplands are generally free from it.

In endemic and highly malarial areas young children are seen to be more common victims than the adults. Both sexes are equally liable to this malady.

**Tuberculosis** is a specific communicable disease caused by Mycobacterium tuberculosis, a micro organism that was
discovered by Koch in 1882. It affects both the pulmonary and non-pulmonary tissues. The disease may be acute or chronic and general or local. It is an ubiquitous disease, found almost everywhere among human groups all over the earth.

The agent of tuberculosis is of three types: human, bovine and avian groups. The Mycobacterium tuberculosis that grow and propagate in these three forms of life do so in different media. The germs in the three different species also have some minor morphological differences among themselves, which are visible under the microscope. The ones attacking human is more frequently found in lung while these attacking the bovine and avian subjects are more commonly found in intestines, lymph nodes and bones.

The tubercule bacilli are more resistant to the action of chemicals and heat, as compared to most other bacteria. It takes about 24 hours for a 5 per cent phenol and 6 hours of direct sunlight to kill them. But they are easily killed by heat at 60°C in half an hour. In sheltered places, the bacilli may remain viable or under hibernation for several months.

Tuberculosis can occur at any age of a human being, but the majority of patients, who seek treatment in India, are found between the ages of 20 and 40. In India, tuberculosis is more prevalent in males than in females. This may
be due to the more frequent mobility of males, and consequently greater chance of infection of males than females who are generally confined to their home.

The prevalence of tuberculosis diminishes as social and economic conditions improve. Poor housing with associated over-crowding increases the risk of massive infection or re-infection tuberculosis, if one of the occupants suffer from it. The everyday hygiene and daily habits of the people such as spitting, throwing garbage, etc. also influence the spread of tuberculosis.

Therefore it is not surprising that tuberculosis has an uneven distribution throughout the world, since it is related to the degree of economic, technical and social development.

Peptic Ulcer is one of those diseases which may not be responsible for a high rate of mortality, but once it occurs and develops unchecked, the ulcer is likely to last a lifetime, disabling the normal life of a person and causing painful complications. 'Peptic Ulcer' is an ulcer found either in the lower end of the Oesophagus, the stomach, the duodenum, and the small intestine anastomosed to the stomach, or rarely, at the junction of a Meckel's diverticulum with the small intestine, and is caused by the acid-pepsin digestion of the mucosa.
Peptic Ulcer have become more common these days as the disease is psychosomatic having been closely associated with the mental tensions and physical stress and strain which are mounting in the context of the modern life, particularly in the urban areas. More men rather than women are prone to it, especially in the age group of 30 to 45 years, when they are exposed to maximum strain. Blood groups also bear a relationship to the incidence of Peptic Ulcer. It is found that the persons with the blood-group O, are more liable to Ulcer than those in groups A and B.\(^\text{18}\)

The great symptom of Peptic Ulcer is pain in the stomach, relieved by intake of food and alkalies. It is when the stomach is empty that the pain is most severe so that the patient may have to get up in the middle of the night to eat or drink something to cause remission of the pain.

Temperamentally the people suffering from Peptic Ulcer are usually restless, anxiety worn, ambitious and compulsive.

Cancer is a disease of the growth of malignant tissues inside the body. The division of cells does not end with

the birth of a baby. The daily wear and tear throughout life keeps the cell division a continuous process. The process within the physiological limits is a balanced one and never exceeds the requirement of normal wear and tear. But unfortunately, in some individuals, excessive cell division may occur disharmoniously, producing neoplasms or tumours. The dreaded cancer belongs to this category of disease.

The annual death from cancer in India is between 400,000 - 500,000, according to Jussoawala of Tata Memorial Cancer Research Institute, Bombay (1976). In various studies undertaken about the incidence of cancer, it is found that about 40 to 50 per cent of cancer cases is in the region of the head and neck.

In Assam, cancer of hypopharynx i.e., lower part of the throat, has high incidence.

In many forms of cancer, although the exact causal agent may not be known, there is reason to believe that it is related to environment or occupations. Some forms of occupation bear a striking relationship to cancer in particular sites. This is a subject of increasing importance in the industrial age, in which we now live. The truth is that throughout life we seem to swim in a sea of carcinogens, and

it is more by good fortune than good management, that some of us escape cancer to die due to other causes.

**Scope of the Study**

Opinions differ as to the exact scope and concept of this subject. Undoubtedly, this subject is a boundary discipline existing between geography and medical science. Disease by itself does not draw the attention of a geographer. But the role of environment on a particular disease, i.e. the causative factor and the spatial distribution of the diseases are of special interest to him. Sometimes man himself becomes a causative factor. Hence, an integrated approach may reflect a scientific perspective.

This study will be based on the relationships between the pathological factors or 'pathogens' and the geographical factors or 'geogens'. The factors proposed to be dealt under the two major heads mentioned above are

I. Pathological Factors or 'Pathogens':

1) **Causative agents** Those whose presence actually cause the disease such as Viruses, Bacteria, Fungi, Protozoa and Metazoa.

2) **Vectors** Those which carry the immature germs of the agent of disease for transmission to a healthy person, e.g. mosquito, fly, etc.

3) **Intermediate hosts** Those organisms which are
essential to the life cycle of the agent. For example, snails are the intermediate hosts of bilharzia and cyclops of guinea-worm.

iv) Reservoirs Those hosts which serve to carry the infection in nature, when man is not available or suitably protected, as also, as in addition to man.

v) Man He is also a pathogen.

II. Geographical Factors or 'Geogens':
(They have been broadly classified and amongst them the most potent factor is the climate).

1) Non-Biotic Factors
   i) Rainfall, humidity, temperature.
   ii) Relief,
   iii) Soil
   iv) Underground water table.

2) Human or Social Factors
   i) Population distribution and density.
   ii) Social customs and traditions.
   iii) Economic condition: Standard of living, housing, diet, clothing, sanitation, income.
   iv) Communications.
   v) Fairs and festivals
   vi) Drug and addictions.
   vii) Dominant Blood Group.
3) **Biological Factors**

1) Fauna and Flora.

ii) Parasitism – Human and Animal.

iii) Prevalent Diseases.

In the course of collecting and handling data for this work the researcher was faced with various difficulties mainly because of paucity of relevant information relating to causes and factors of the diseases.

Strictly medical information upon health, ill-health or death is not usually gathered in the neatly compartmentalised way in which we would like it to have. Dealing with morbidity, some difficulties with data are there, e.g. confidence may be breached by allowing access to patients particulars, and some conditions such as extra-marital pregnancy, psychiatric disturbance, etc., may be socially inadmissible. Diagnosis of the ailment of a patient may alter after first record. Sometimes again, the patient may suffer from several diseases but he or she may be recorded only under the most treatable one. Lack of unanimity in diagnostic standards between different practitioners, differences in patient’s recognition of sickness and degree of effort put in seeking treatment, cost of treatment and, in some cases, religious flavour with treatment make the study more difficult and complicated.
Medical statistics and the availability of adequate runs of comprehensive figures of vital statistics are still woefully lacking in this part of the country. Figures that are to be used are required to be standardised. Than again there is the question of locational specificity of the data. For instance, medical data are collected from hospital statistics which may not include for each patient a home address. Data may refer to administrative division to which the patient originally belongs whereas his present residence and place of work may lie elsewhere. Moreover a patient's residence and place of work may lie in two different divisions although his or her case history may record only one of the places. Indeed occupational risks to disease may arise from either previous or present employment, or from journey to work, or from residential surrounding or social contact, or as a result of cumulative effect of all these. In order to receive a comprehensive case-history all these need locating. Last of all lies the choice of the related or auxiliary data to be considered. As already explained, this is often an intensely subjective matter. Moreover vast stores of information are held by government agencies and such other sources, but these are not accessible or hardly assimilable. Where the related or auxiliary data seem to be non-existent, the medical geographer faces the usual problems of devising a questionnaire suited for his purpose.
Presentation of Data

The data, as discussed earlier will have to be accepted as they are inspite of the difficulties stated above. These masses of statistical data in figures, however clearly they might be arranged in systematic tables, present but a uniform appearance. The same data, when represented in a map, convey at once, the relative bearing and proportion of the phenomenon which they represent together with their position and extent. Thus, a map will make visible to the eye the development and nature of any phenomenon in regard to its geographical distribution. Therefore, it is certainly true that the map is still one of the main tools of geographical interpretation.

Methodology

Traditional approaches in geographical investigation can be divided into the deductive and the inductive methods. The modern approach in any investigation utilizes both the traditional methods and in addition empiricism.

Developed to a high art by the ancient Greeks, the Deductive Method covers reasoning from the general to the specific. That it, the process is a matter of reasoning from certain reliable preliminary statements, or premises, to conclusions that may be drawn from such premises. The premises must be sound and must be based on the direct
observations of nature. If the premises are untrue, any conclusion drawn from them is also untrue. In this lies the inherent danger of total reliance on the deductive method.

In the Inductive Method, facts are used as evidence to prove a conclusion. In other words, the inductive process begins with the gathering of specific facts that are then assembled in order to arrive at a general conclusion or generalization.

Modern researchers have discovered that it is impossible to rely exclusively on either the deductive or the inductive method. Based on the works of Aristotle, Bacon, Charles Darwin (1809-1882), and countless others, the Scientific Method is the approach that is most often employed by researchers today. The following may be used as a guide to understanding the scientific method.

1. Choosing a subject.
2. Forming a statement of the problem.
3. Forming a hypothesis or theory.
4. Collection and organizing the evidence.
5. Drawing conclusion and writing the paper.

The great advantages of this approach is that it is logically problem-solving, it permits replication and therefore cross-checking, and most important of all, it
instills into the geographer the lingua franca of the sciences. The best aspect is emphasized because no discipline, and particularly geography, can exist in isolation of others, and any common language, whether it is the result of the use of similar research procedures, techniques, or tools (such as computers) that breaks down disciplinary barriers is important of itself.

Medical Geography, an interdisciplinary study is based on the collection and analysis of data which exist in records and in the field at a particular point of time. The study depends mainly on inductive reasoning using empirical methods in which generalizations were made from observed features. Therefore the study is based on empirical evidence and applying the inductive method to support the deduced hypothesis.

Thus we see that we cannot depend solely on the inductive or deductive method.

Thus this study has been carried out by the scientific method. Both the inductive and deductive approaches have been employed and supplemented wherever necessary with empirical methods.

Collection, tabulation, classification and analysis of data will form the core of this research endeavour. Since the topic of the research cuts across the boundaries of a number
of different disciplines, the data and information will have to be collected from diversified agencies and sources besides personal field work.

What is desired to show in this work is the geographical approach to the analysis of data. The medical data, of course, have to be accepted as they are. It is admitted that the persons belonging to the medical profession will, prima facie, find the facts inadequate, and even misleading. But in a study of this nature, one is left with no other alternative but to accept whatever data are available.

Thus all disease data have been collected from the office of the Director, Health Services, Government of Assam and all other District Health Offices in the State, and from the two Medical Colleges at Gauhati and Dibrugarh. Questionnaires have been made for more intricate details like diet, income, housing, etc.

The relevant data on climate have been collected from the Regional Meteorological office, Alipore, Calcutta, besides the Meteorological office at Borjhar, Gauhati.

Physiographic information have been obtained from the geological memoirs, Survey of India Maps and relevant books and journals.

Data and information on social and human factors have been collected from census reports, Department of Anthropology,
Gauhati University, Anthropological Survey of India and other Published reports, Monographs, etc.

Now, since the data collected from the district health offices all over the valley and Directorate, Health Services Office, do not fit the normal frequency distribution, instead form a skew frequency distribution, the data has been transformed into their appropriate logarithm values. This transformation process is necessary before most statistical analyses or tests are employed. After transformation, when plotted, it has been seen that, apart from the extreme values, these do approximate to a straight line. This indicates that the transformation does lead to a closer fit to the normal frequency distribution. That thus the basically straight line is seen again indicates that a logarithmic transformation of this body of data is essential. Therefore, it is with values derived from these transformed data that any further analyses are concerned.

The simple correlation - coefficient technique has been used in this study to find possible relationships with two variables, for example distribution of swampy area and malaria incidence. When depicting these on a map, the number of cases for a particular disease has been expressed as one per ten thousand persons, and shown in a dot form.

Before going to the details of each disease, it
must be made clear, that since all data are standardised through log transformation, all $a$, $b$ and $r$ values are in a standardised form or in other words in log values.

**Organisation of the Study**

The study has been divided broadly into three parts - the first dealing with, (A) introduction, the second is (B) analysis of the problem, so as to bring out any possible correlation between the existing geosystem and the incidence of the diseases, and the third part is (C) synthesis, summary and conclusion.

The first chapter is the Introduction, the second chapter be the 'Physical Background of the Study Region,' which will include rainfall, humidity, temperature, relief, soil and drainage. The third chapter contains the 'Socio-Cultural Environment, and Health in which the population distribution and density, standard of living, religion, etc., are studied. Fourth chapter is devoted to the 'Ecology of Disease', which includes definition and causative agents, factors influencing hosts susceptibility and geographical distribution. Fifth chapter is intended to show the 'Spatial Distribution.' This would also include a discourse on the cause-effect relationship as revealed in the assessment.

The last, i.e. the sixth chapter will contain the conclusion.