

Ecological Aspects of Some Communicable and Non-communicable Diseases in Sri Lanka.

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Abstract

The geochemical, physical, and climatic features of Sri Lanka have had their effect on the occurrence, distribution, and periodicity of important disease conditions, both communicable and non-communicable. Consequently population groups inhabiting the affected provinces or districts have been vulnerable to these diseases. Some vector-borne diseases and zoonotic diseases which occur in certain ecological environments seem to be reappearing. Following appropriate interventions the incidence and distribution of malaria, a major public health problem in the past, have taken a very favourable turn and is currently confined to a few districts. Ecological changes associated with development projects were associated with increased prevalence of malaria as well as the emergence of secondary vectors of malaria. Population movements too contributed to increased transmission and dissemination of malaria, while increased animal husbandry practices were related to outbreaks of Japanese encephalitis. Atmospheric pollution, both indoor and outdoor, is responsible for many adverse health effects. Both the excess and deficiency of certain substances which the human body normally obtains from drinking water and food can cause important health effects.

Key words: Ecology Geochemistry Climate Human habits Diseases

Introduction

While the discipline of epidemiology concerns the study of the factors which determine and influence the frequency and distribution of disease, injury, and other health-related events and their causes in a defined human population, ecological aspects of diseases concern the study of the underlying principles that influence the spatio-temporal patterns of diseases. Over the past decades Sri Lanka has been experiencing several diseases, both communicable and non-communicable, which have exhibited a clear spatio-temporal distribution related to ecological factors. These ecological factors include physical, geo-physical, climatic, and socio-economic factors, among others.

Communicable diseases

i) Vector-borne diseases

a) Malaria

Malaria has been a major public health problem in the country until a few years ago(1) resulting in epidemics of varying magnitude especially before the DDT era(2) which were found to be associated with deficient monsoonal rains resulting from El Nino Southern Oscillation(3). The major factor which determined the distribution of malaria in Sri Lanka has been the extent to which conditions were favourable for the production of the principal vector

of malaria, *Anopheles culicifacies*. This essentially a dry zone* species has been found to be present in the jungle covered plains and villages, with its prevalence decreasing with increasing altitude, and hardly found at altitude above 2500 feet. In the intermediate zone and unusually in the wet zone its densities can increase during dry weather if the rivers and streams undergo pooling creating preferred breeding for this species(2). This was well illustrated during the great malaria epidemic of 1934/35 when unusually dry weather prevailed in the intermediate and wet zones and the river basins became hot beds of malaria in addition to neighbouring areas(4). Even subsequently there have been many outbreaks of malaria in the intermediate and wet zones when the monsoonal rains failed(5). On the contrary excessive rainfall in the dry zone can which result in the production of surface ground pools of water can cause increased transmission of malaria by creating vector breeding sites(6).

Man-made breeding sites too have contributed towards an increased malaria incidence in some areas. Water-filled gem pits have been an important source of vector breeding(7). During the 1967/69 malaria epidemic the gemming sites in Elahera had played a major role in the genesis of the epidemic(8). Investigations have revealed breeding of *An.culicifacies* in wells, irrigation channels, abandoned quarry pits, and burrow pits(1). A

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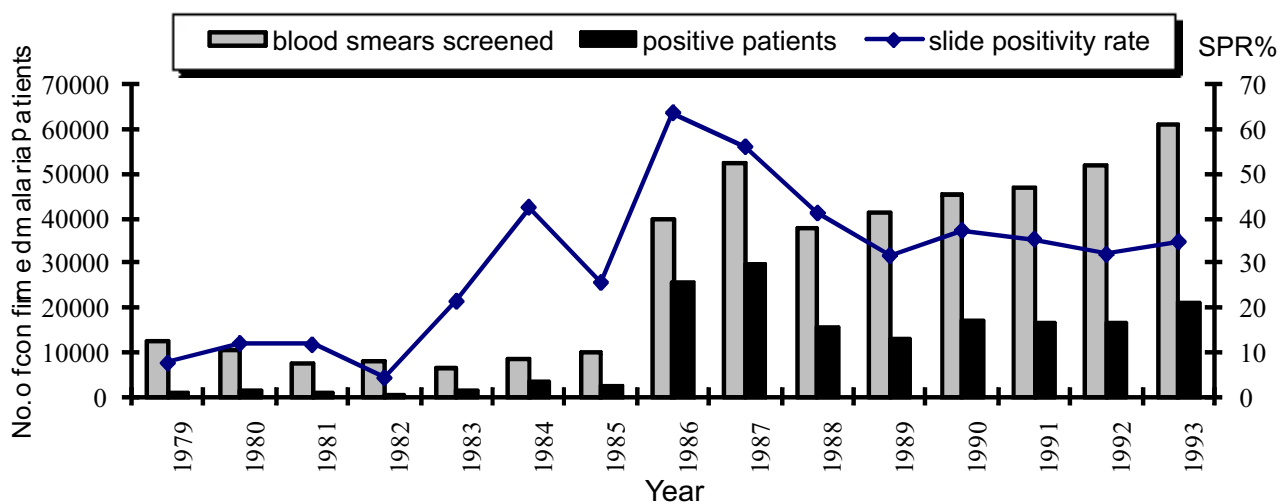
secondary malaria vector *An. annularis* which could play a significant role in malaria transmission under certain circumstances(9) has been found to breed in tank and reservoir margins(1). Studies done during the stage of development of irrigation in an area under the Mahaweli development Project have established that all the three Anopheline species incriminated in malaria transmission in Sri Lanka, viz., *An. culicifacies*, *A. subpictus*, *An. annularis*, increased in abundance(10). Construction of the Polgolla dam across Mahaweli river was found to be associated with the creation of new foci of malaria around Kandy town caused by reduced flow of the river beyond the dam(11).

Large population movements from non-malarious areas to areas in which the malaria vector density is high can result in an increased malaria prevalence in

the receiving area. The incoming population who would not have acquired resistance against malaria could easily fall prey to the disease and the results would be reflected in the malaria figures at the serving medical institutions(12). (fig 1)

Mass population movements which involved people from all parts of the island visiting popular pilgrim centres in malarious areas and returning back were considered to be a factor which led to dissemination of infection during the 1967/69 malaria epidemic(8). Under the present scenario of very low malaria prevalence in Sri Lanka many of the locally infected cases in 2010 and 2011 had been among members of the security forces engaged in construction and restoration work in the Northern province(1,13) probably due to their exposure to localities with high vector densities.

Figure 1 - Malaria morbidity recorded by 4 main government medical institutions in the Mahaweli System H (1979 - 1993) (Thambuttegama, Talawa, Nochchiyagama and Galnewa)



b) Dengue & Dengue Haemorrhagic Fever (DHF)

The prevalence of these two diseases have a direct relationship to the state of the environment and the climatic factors. Both the local vectors of dengue, *Aedes aegypti* and *Aedes albopictus* breed mainly in water-filled discarded receptacles as observed in many of the districts, while water storage tanks and barrels collecting water have to be found to be a major breeding sites in certain other districts(14,15). The rapid and unplanned urbanization witnessed during the last few decades has contributed to the increased incidence of dengue and dengue haemorrhagic fever in no uncertain manner. Polythene bags and small plastic cups containing snacks which are often disposed in an indiscriminate manner after use have been observed to be important

contributory factors for the creation of vector breeding sites. Storing water in barrels is a common practice in households which receive an interrupted supply of pipe-borne water. With the increasing use of motor vehicles it is common to see discarded tyres stored in the open which have collected rain water, providing another important vector breeding site. Within the household flower vases and ant-traps, if kept with water unchanged for more than a week, favour vector breeding. Prevalence of dengue fever/dengue haemorrhagic fever increases following the monsoonal rains, due to collection of rain water in various types of receptacles strewn around, especially in urban areas. Studies have shown the correlation between rainfall and the increase of *Aedes aegypti* populations(14).

c) Japanese encephalitis

This disease endemic in the country, occurs in many parts of the island below an elevation of 914 metres, the major vector encountered locally being *Culex tritaeniorhyncus* which breeds mostly in paddy fields(16). In the dry zone the disease is mainly found in rice growing areas and in the wet zone when it occurs, it is frequently in areas where pig breeding or coir industry is evident. The role of the pig as an amplifier host has been confirmed(17). The long and high viraemia in the pig, the human habit of keeping the animal in peri-domestic areas, and the large number of offspring it produces, are considered reasons for this animal being considered the most important amplifier host(18). The prevalence increases following north-east monsoonal rains, due to flooding of ricefields and formation of ground pools of rain water. Changing ecological factors have been incriminated as the cause in the genesis of the epidemics of JE in Anuradhapura district in 1985/86 and 1987 respectively. Increased paddy cultivation, high rains immediately prior to and during the period, and a 10-fold increase in the domestic pig population in the Mahaweli Accelerated Development areas have led to an increased vector population and an increased transmission of the virus(19). Migration of people from non-endemic areas, who would not have had any immunity against the disease, to new land under the Accelerated Mahaweli Development Scheme, too was considered to be a contributory factor(20). The distribution of Japanese encephalitis is significantly related to irrigated rice production combined with pig farming(21).

ii Emerging vector-borne diseases

a) Cutaneous Leishmaniasis

Since the reporting of the first case of cutaneous leishmaniasis of indigenous origin from Anuradhapura district in 1992, outbreaks of cutaneous leishmaniasis have been reported mainly from the districts of Anuradhapura, Hambantota, and Matara(22). The disease is now considered to be endemic in the country. In addition to the cases of mostly detected cutaneous leishmaniasis, cases of muco-cutaneous and the visceral type also have been detected(23). The causative agent of cutaneous leishmaniasis in Sri Lanka has been established as *Leishmania donovani* MON-37(24). Studies have established that the possible vector in Sri Lanka is *Phlebotomus argentipus*(25,26). The disease transmission is known to be mostly between man and the vector, but evidence has been found in Sri

Lanka that the domestic dog may be a possible animal reservoir(24). Studies have demonstrated that the possible vector is widely distributed in the country(26), and it is *zoophilic*** and *anthropophilic****(23). *P. argentipus* generally inhabits semi-arid areas but may be found in peri-domestic environments too. Persons in dry zone areas engaged in outdoor activities, especially working inside or on the fringe of the jungles or forests, and in jungle clearings have increased susceptibility to leishmaniasis. In a study conducted by the Dept. of Parasitology, University of Colombo, 82% out of 65 patients reporting from several provinces who were confirmed as having cutaneous leishmaniasis (smear positive), had given a history of living and working in close proximity to the jungle(27).

iii) Zoonotic Diseases

a) Scrub Typhus

This is a zoonotic disease found in nature and exists between certain species of trombiculid mites and their small mammal hosts(28). Patients with scrub typhus, a member of the typhus group of rickettsial diseases, have been recorded in Sri Lanka in the thirties and forties. An outbreak had occurred in Embilipitiya during the second world war when a large number of foreign troops were stationed there. In addition to scrub typhus, murine typhus and spotted fever group (SFG) varieties have been reported in Sri Lanka(29). Scrub typhus is caused by *Orientia tsutsugamushi*, and is transmitted by the larval mite of *Leptotrombidium sp.* The adult mite along with larval stages, free living in the soil, are abundantly found in an environment of scrub jungles and forests, from which the disease has derived its name. Man is infected by the bite of an infected larval mite which has acquired the infection from the reservoir host or alternatively at birth, from the infected adult mite through transovarial infection.

The region in the world in which scrub typhus is prevalent (i.e., "the tsutsugamushi triangle") closely follows the distribution of *Rattus rattus*(30). Thus scrub typhus is essentially a disease contracted by persons working in an environment of scrub jungle or forest, or in an environment surrounded by tall vegetation. In the study carried out by Premaratna et al.,(31) all the patients diagnosed as having rickettsial infections had claimed that there were rats in the vicinity and that they engaged in some outdoor activity in the peri-domestic garden.

b)Leptospirosis (Weil's Disease)

This is an endemic disease in Sri Lanka, reported throughout the year. The prevalence is more during periods of high humidity and heavy rains, and two peaks have been observed corresponding to the two monsoonal rains. The minor peak is experienced during March–May, and the major peak between October – December(32). The causative organism *Leptospira sp.* is present in the kidneys of infected animals such as rodents, cattle and canines, and is excreted in the urine. Humans get infected by the entry of the organism by ingestion of contaminated food or water, accidental entry through the abraded or damaged skin, or through mucosa of mouth or nose or the conjunctiva of the eyes. In Sri Lanka rat may be considered to be the important reservoir of infection. Many environmental factors are conducive to the transmission of leptospirosis. Main victims are paddy field workers who are exposed to an environment which is wet or moist and in which rats are abundant encouraged by the practice of storage of paddy in the paddy fields. During floods the rats get displaced from their burrows and from drains and there is a strong possibility of flood waters getting contaminated with infected urine, especially in environments in which rats have been abundant. Periods of flooding are usually followed by an increased prevalence of the disease. Poor housing and improper waste disposal too predispose the occupants to leptospirosis as the rat population around such houses is bound to increase.

c) A sporadic case of atypical trypanosomiasis.

In 1999 the malaria microscopist at Base Hospital, Kalmunai, while examining a blood smear of a patient for malaria parasites detected unusual bodies in the blood film which was sent to the M.R.I for diagnosis. The Parasitologist at the M.R.I confirmed the presence of trypanosomes in the blood smear. The patient, a 65 year old male, was later transferred to Teaching Hospital Batticaloa and subsequently to the National Hospital, Colombo, where he was treated with the appropriate antiparasitic drugs, and recovered. Blood samples sent by the Parasitologist, M.R.I, to the London School of Tropical Medicine & Hygiene revealed the presence of *Trypanosoma evansi*(33). *Trypanosoma* is a protozoan parasite with a number of different species. In humans *T. brucei gambiense* and *T. brucei rhodesiense* cause African trypanosomiasis (sleeping sickness) while American trypanosomiasis (Chaga's disease) is caused by a different species. There are also different species

infecting wild animals and domestic animals like cattle(34). The vector of trypanosomiasis varies with the *Trypanosoma* species it transmits. In India human infections with some of animal species have been detected(35,36). In one case the patient has been a cattle farmer, and in the other, the patient has been living in a rat infested area. In the case reported in Sri Lanka the patient has been handling a herd of buffaloes. Blood samples were collected from some animals in the area around the residence of the local case of trypanosomiasis and samples from two buffaloes were revealed to be positive for *T.evansi*(33). This patient had not given a history of travel abroad or receiving any blood transfusion. It is probable that the patient got infected through close contact with infected buffaloes through the bite of an infected insect vector. Although it is generally considered that human plasma has a protective factor against animal trypanosomes, studies have suggested that some animal species might have developed resistance to human plasma(37).

Non-Communicable Disease

i) Diseases caused by environmental pollution

a) Atmospheric pollution

Atmospheric pollution refers to an undesirable state of the atmosphere due to the contamination with smoke and harmful gases (mainly oxides of carbon, sulphur, and nitrogen) as a result of human activities. Emissions from motor vehicles with their numbers rapidly increasing during the last few decades, and the rapidly expanding industries with their resultant emissions have been identified as the main contributors. The major air pollutants in urban areas have been identified as follows(38).

Major Air Pollutants in urban areas

- Oxides of carbon
- Oxides of nitrogen
- Oxides of sulphur
- Particulates
- Inorganic compounds (e.g., lead)
- Photochemical smog (e.g., ozone)
- Hydrocarbons

source: Ileperuma; 2000 (38)

Ambient air pollution

Emissions from motor vehicles, a major source of environmental contaminations(39) contains all the above contaminants (tab. 2), and contributes to formation of ozone too. It has been revealed that high levels of sulphur dioxide and particulate matter in

urban areas are associated with increased respiratory diseases and increased mortality(40). Persons such as traffic policemen on duty and school children attending schools by the roadside are especially vulnerable to adverse health effects of exposure to vehicular emissions. In Sri Lanka the number of motor vehicles plying on the roads, especially in urban areas, has increased tremendously during the last few decades, and together with the expanded industrialization, is considered an important cause resulting in a host of adverse health effects.

Lead poisoning among workers exposed to lead fumes, such as foundry workers and workers in paint manufacturing plants, is well known and is considered an occupational disease, but unfortunately cases have also been reported in Sri Lanka indicating that children living in close proximity to work places which emanate lead containing fumes, have developed effects of lead poisoning(41,42).

Indoor air pollution

Smoke emanating from solid fuel such as wood fires and space heating is considered a contributory factor towards considerable morbidity. In Sri Lanka too indoor air pollution has caused considerable mortality. Second hand smoke from tobacco is another important cause of indoor air pollution, particularly affecting children causing lower respiratory tract disease(40). Fortunately smoking in public places and public transport has been banned in Sri Lanka, but exposure to secondhand smoke at home and in work places may be quite injurious to respiratory health. Lead poisoning in children due to contamination of indoor air has been reported In Sri Lanka(43).

ii) Diseases of geochemical origin

In Sri Lanka rural populations live in geochemical provinces each of which has characteristic chemical composition in soil, water stream sediments and rocks. The chemical composition is an important factor which can influence the health of a population in a geochemical province as water and food is often obtained from the ground(44).

Dental Fluorosis

For several decades it has been known that dental fluorosis is endemic in certain provinces in the dry zone. Surveys carried out in the North-Central province(45,46) and the Walawe river basin in the

Southern province(47) have revealed that the prevalence of dental fluorosis among children is very high as opposed to the strikingly low prevalence in non-endemic areas including the central hill area. Investigations have shown that water from surface wells and deep wells from parts of the dry zone, particularly in the north central province, has a fluoride content higher than the level recommended (48). High-grade metamorphic rocks in the dry zone of Sri Lanka are said to be the sources of fluoride(49). Occurrence of a low fluoride zone in the central part of Sri Lanka is probably due to the fact that high rainfall in the area results in leaching of fluoride ions from the soils(50).

Epidemiological studies have revealed that long-term use of drinking water with high fluoride levels primarily produce effects on bone and teeth, whereas low concentrations provide protection against dental caries both in children and in adults.

Mild dental fluorosis may be developed at drinking-water concentrations between 0.9 and 1.2 mg/l, depending on drinking-water intake and exposure to fluoride from other sources. When drinking-water contains 3-6 mg of fluoride per litre, skeletal fluorosis may develop, particularly with high water consumption(51). Clinical dental fluorosis is characterized by staining and pitting of the teeth, and in advanced stages all the enamel may be lost. Drinking water is the most important source of fluoride intake although small amounts may be present in other dietary sources such as fish and tea, and in flouridated tooth paste. W.H.O recommended level for fluoride in drinking water is 1.5mg/ litre(51).

Endemic goitre

Prevalence of endemic goitre in Sri Lanka has been known for several decades. The earlier studies revealed that it had a clear geographical distribution pattern constituting an endemic belt in the wet zone of the country extending throughout the South-Western region of the island, including the entire Western, Sabaragamuwa, Central, and Southern provinces and a part of Uva province. In a survey done in the eighties covering a large number of children in 17 districts an overall prevalence rate of 18.8 % had been established (23.2% for girls and 14.0% for boys) whereas the rate varied from 30.2% in Kalutara to 6.5% in Matale. The rate was more in rural than urban areas, and more in inland compared to coastal areas(52). A more recent study carried out by the Medical Research Institute in collaboration with the UNICEF on a large sample of children aged

8-10 years has concluded that the North-Central province and Eastern province too had a high rate of goiter(53). Iodine deficiency besides causing endemic goitre, can also result in irreversible brain damage in the foetus and infant, and retarded psychomotor development in the child. It is also the most common preventable cause of mental retardation, and affects reproductive function, and children's ability to learn(54)

Studies have shown that climate has a marked influence on the geochemical distribution of iodine in the environment. Iodine in ground water is taken to deeper levels by the high rains in the wet zone while in the dry zone evaporation brings up the iodine to surface soil layers(55). The sea is a major source of iodine and a relationship has been established between iodine deficiency diseases and the distance at which a particular community lives away from the sea(49). However the high rate of goitre which was recorded in Kalutara district in close proximity to the sea suggests that there are factors other than the availability of iodine in the environment which may influence the prevalence of goitre. Goitrogens which can interfere with utilization of iodine by the thyroid glands have been suggested(55). In soils rich in humus, in spite of a high iodine content, the bioavailability is very low due to the pH conditions(49).

Discussion

It is quite convincing that environmental factors play a key role in the aetiology, distribution, and prevalence of many locally encountered diseases, both communicable and non-communicable. Some environmental factors such as heavy rains and the consequent flooding are unavoidable. However, unfavourable health effects of even these factors may be avoided compounded by appropriate measures. The importance of environmental management in the prevention of some vector-borne diseases cannot be overemphasized. Certain zoonotic diseases could be minimized by controlling the domestic and peri-domestic rat population. Creating awareness about the risk of disease faced by occupational groups and persons engaged in outdoor activities in jungle and jungle-fringe environments for recreational purposes, would help the susceptible persons to seek preventive measures, and early diagnosis and treatment if likely symptoms are encountered. Prevention of exposure to air pollution, both outdoor and indoor, is of paramount importance in protection of both children and adults from a host of diseases.

* Climatic zones are based on the total amount of rainfall received during the south-west monsoons (dry zone <500 mm, intermediate zone 500-1000 mm, wet zone >1000 mm)

** *Zoophilic* - obtains blood meals from animals

*** *Anthropophilic* obtains blood meals from humans

Abbreviations

DDT dichloro diphenyl trichloroethane

MRI Medical Research Institute

WHO World Health Organization

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