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RESEARCH ARTICLE

DISEASE ECOLOGY AND JAPANESE ENCEPHALITIES (JE) IN ARIYALUR TOWN USING OPTICAL REMOTE SENSING DATA

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ABSTRACT

Ariyalur is one of the most polluted towns in Tamil Nadu and many calcite mines surround by the town due to major industrial activity of cement industries. The leftout mining areas forms lakes around this region and many of them are abandon, filled with stagnant and wastewater. The town has the highest stray pig population for meat and the field investigation in this region clearly depicts that it has no proper drainage system in almost all the 18 wards. The town has always been an endemic zone of many infectious diseases due to its man-made unfavourable environmental conditions. The most important disease very often affects this town is the `***Japanese Encephalitis'***, otherwise known as `***Brain Fever'*** that affects the children within the age group of < 6. During and aftermath of the seasonal rainfall this town is worst affected to many infectious diseases. It is evident from the above that this zone is an epidemic zone for Japanese Encephalitis for the past four decades.

INTRODUCTION

Transformation of the living environment is a major factor modifying the relationships of all the possible stimuli with which man has to contend in order to survive. Any discussion of disease as an alteration of living cells or tissues, which jeopardizes their survival in the environment, must be based upon the global system of what is termed as environmental stimuli and man's adjustment to these stimuli.

The data concerning the relationships between the malaria parasite, its two hosts, man and mosquito, and the environment in which these hosts live together illustrate clearly the three aspects of environmental stimuli physical, biological, and cultural which modify the dominance of this parasite and any other of the vast number of stimuli with which man has to contend. There are many gaps in our knowledge about the nature of these three factors and their intricate interrelationships with changing disease dominance. In the diseases of man, the cultural factor is crucial, since cultural traits either bring stimulus or host together or erect barriers to keep them apart (Kitron. U, 1998).

Man-made Environmental Factors

However, man-made changes in certain cities in the tropical belt have definitely resulted in the transformation of the average and extremes of temperature in the same areas. The phenomenon is easily observable in a metropolis like Bangkok, where the maximum level of temperature has risen by several degrees in the last decade because of tall buildings that impede the cooling breezes from the sea and because of heat reflected from extended asphalt surfaces.

Concurrently, however, the filling of the marshes and klongs has reduced the chances for mosquito breeding, making it difficult to assess the respective importance of these coincidental factors in modifying *Plasmodium* dominance? Environmental factors influence the parasites through the physiology of the mosquito vector and its survival rather than through influence on the parasite itself. For instance, the relative humidity of the environment influences the survival of the mosquito to a great extent but seems to have no effect on the parasite inside the mosquito host (Su.M.D 1994).

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Mapping Vector Zones by Remote Sensing Technology

Satellites acquire information through a variety of modes, helping to identify potential breeding sites. Vegetation with unique reflection spectra and human settlements that emit weak electromagnetic radiation signals are keys to making the correlation between potential breeding sites adjacent to human habitation, and the potential spread of malaria. Remote sensing technologies have allowed medical ecologists to view vast areas of malaria transmission, and have provided a new and important tool for mapping the breeding habitats of infected mosquitoes, predicting densities of vector species, and even developing risk maps for malaria transmission (Wood.B.L *et al*, 1992).

Japanese Encephalitis

Japanese encephalitis (JE) is a viral disease that infects animals and humans. It is transmitted by mosquitoes and humans causes inflammation of the membranes around the brain. Intensification and expansion of irrigated rice production systems in South and South-East Asia over the past 20 years have had an important impact on the disease burden caused by Japanese encephalitis. Where irrigation expands into semi-arid areas, the flooding of the fields at the start of each cropping cycle leads to an explosive build-up of the mosquito population.

This may cause the circulation of the virus to spill over from their usual hosts (birds and pigs) into the human population. Japanese encephalitis (JE) is a disease caused by a flavivirus that affects the membranes around the brain. Most JE virus infections are mild (fever and headache) or without apparent symptoms, but approximately 1 in 200 infections results in severe disease characterized by rapid onset of high fever, headache, neck stiffness, disorientation, coma, seizures, spastic paralysis and death. The case fatality rate can be as high as 60 per cent among those with disease symptoms; 30 per cent of those who survive suffer from lasting damage to the central nervous system. In areas where the JE virus is common, encephalitis occurs mainly in young children because older children and adults have already been infected and are immune (Danel.M., *et al* 1998)

Mosquitoes belonging to the Culex tritaeniorhynchus and Culex vishnui groups, which breed particularly in flooded rice fields, transmit the virus causing Japanese encephalitis. The virus circulates in ardeid birds (herons and egrets). Pigs are amplifying hosts, in that the virus reproduces in pigs and infects mosquitoes that take blood meals, but does not cause disease. The virus tends to spill over into human populations when infected mosquito populations build up explosively and the human biting rate increases (these culicines are normally zoophilic, i.e. they prefer to take blood meals from animals). Japanese encephalitis is a leading cause of viral encephalitis in Asia with 30,000-50,000 clinical cases reported annually. It occurs from the islands of the Western Pacific in the east to the Pakistani border in the west, and from Korea in the north to Papua New Guinea in the south. Because of the critical role of pigs, its presence in Muslim countries is negligible. JE distribution is very significantly linked to irrigation of rice production combined with pig rearing (Gatrell, A.C., *et al*., 1996).

Objectives

The objective of present study is to find the existing spatial and environmental conditions and also investigate how far this town has been deteriorated that lead to several infectious diseases reported with particular reference to the `Japanese Encephalitis' or Brain Fever that affects the child population in the town. Precisely it is to identify the disease ecological zone of Japanese Encephalitis, particularly the location and character of pig sheds with huge pig population and their disastrous environmental condititions which would create a conductive atmosphere for the vector growth, using the optical remote sensing technology.

METHODOLOGY

To analyze the above problem, data relating to both primary and secondary have been gathered from various sources. The secondary data relating to the demographic factors particularly the population density, literacy rate, child population, morbidity and mortality rate, crime rate physical and climatic data, To identify the major environmental hazardous zones and also the disease ecological zones in Ariyalur and surrounding, the Indian Remote Sensing Digital Data IRS P6 LISS III data has been acquired from NRSA. The data were subjected to various digital image analysis techniques using ENVI 4.0 to map the recent builtup areas, huts, water bodies, stagnant water areas, improper drainage, Pig shed, vegetation cover, Agricultural areas and barren surface.

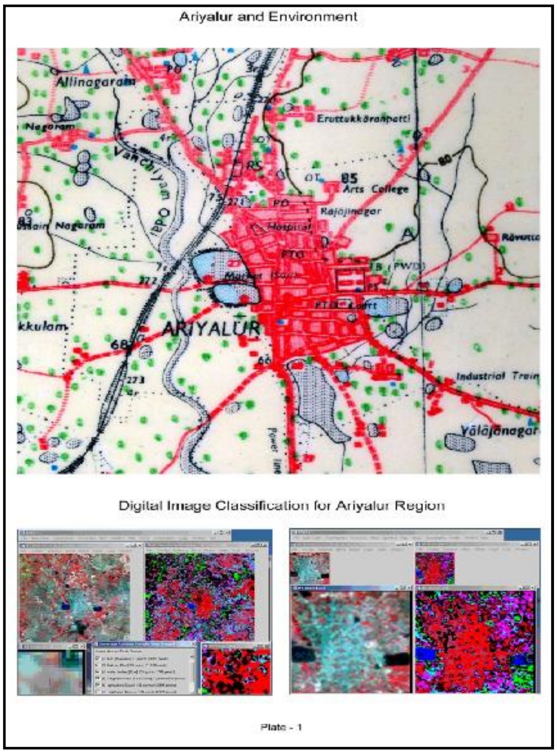
Application of remote sensing data in disease vector surveillance

The use of aerial photography and manual interpretation techniques to identify and map disease vector habitats dates from 1949 when study on the distribution of scrub typhus in portions of Southeast Asia. He determined that hyperendemic disease foci were associated with a vegetation type known as *parang*. Conventional black-and-white aerial photography was used to identify the distribution of *parang* vegetation, and therefore map the distribution of scrub typhus foci. The darker tone and rough texture of *parang* vegetation on this photography made it possible to distinguish it from surrounding types using visual interpretation techniques (Epstein, P.R., D.J. Rogers, and R. Slooff. 1993).

Similar visual interpretation techniques that exploit tone and texture have been used to identify and map landscape units associated with tick-borne encephalitis and tularemia in parts of the (former) Soviet Union (Personal communication from Korenberg, E., Gamaleya Institute for Epidemiology and Microbiology, Academy of Medical Sciences, Moscow, Russia). These studies were based on the concepts of landscape epidemiology and natural nidality of disease developed by Pavlovsky. In 1973, NASA scientists used visual interpretation of color and color-infrared photography to map vegetation types associated with *Aedes sollicitans* breeding habitat near New Orleans, Louisiana. Wagner *et al*. also used high-altitude color-infrared photography, in 1979 to produce a detailed map of *Aedes* breeding sites in a newly formed mosquito abatement district in Michigan. These habitat maps were subsequently used to direct control measures. More recently, Welch *et al*. have used color-infrared aerial photography as a surveillance tool for *Psorophora columbiae* oviposition habitats in Texas rice fields. Their work was based on the visual interpretation of photography acquired during the summer and winter to map general land-use patterns and identify potential within-field breeding sites (Su, M.D., and N.T. Chang. 1994).

Tracking Enviornmental Viable Zones

Ariyalur and its environs are most vulnerable zones for the outbreak of Japanese encephalitis disease. It is evident that there has been an occurrence of JE due to dreadful environmental conditions in and around Ariyalur like, the stagnant water in the calcite mines, improper drainage inside the town, mixed residential areas with huts and buitups, pig sheds and pig population in the high densely populated areas, and so on. To locate the environmentally viable zones, particularly the pig sheds (root cause for JE disease) and other Environmental parameters like the stagnant water areas, huts and water bodies the Indian Remote Sensing Digital data (IRS P6) has been used for digital image analysis using Envi 4.0. The results as well as the classified details are given in plates 1-3. For the classification method, Global Positioning System (GPS) has been used to take field samples of the above environmentally hazardous areas, both in and around Ariyalur. The supervised classification method was implied to derive various results of the images, after several rectification procedures. Plate-1 shows the first phase of the digital classification method.



Pig Shed Locations: Integration with GPS Data

Plate-2 displayed the processed image, demarcating the environmentally hazardous zones, in and around Ariyalur using IRS P6 LISS III digital data. From the processed image the clear demarcations of pigsheds (in red colour). Similarly the huts, stagnenat water areas with drainage can also be seen after digital classification method.

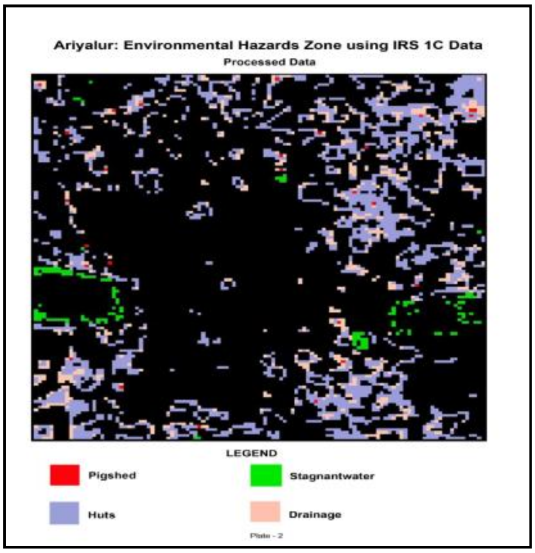


Table 1 displays the GPS locations generated from the spectral reflectance values of the pigsheds in Ariyalur and its surrounding regions. These values were verified through field investigation methods to justify whether the pig sheds are originally present in these locations, which have been aggravating the situations from the past to the present by outbreaking the JE disease.

Tracking Ecological Problems using Remote Sensing Digital Data

Plate-3 shows all the detailed features, including the builtup areas, huts, stagnant water areas, drainage, pig shed locations, agriculture and water bodies. The results of the calculated pixel values and transformed into the areas in sq. meter as well as sq. km has been given.

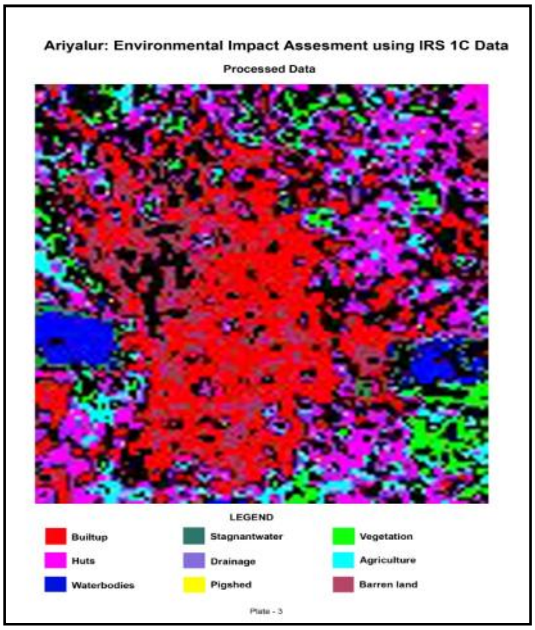


Table 1 GPS Locations (in latitudes and longituded) generated from the IRS 1C Digital Data which reflects the pixel values of Pigsheds

Sample No.	Latitude	Longitude	Sample No.	Latitude	Longitude
1.	11.09.39.89	79.04.02.22	39.	11.08.26.49	79.06.45.00
2.	11.09.30.70	79.04.27.00	40.	11.08.14.64	79.06.36.01
3.	11.09.30.90	79.04.57.89	41.	11.07.49.58	79.07.01.30
4.	11.09.32.15	79.05.03.24	42.	11.07.48.75	79.06.59.66
5.	11.09.27.77	79.04.15.07	43.	11.07.40.72	79.07.15.36
6.	11.09.18.59	79.03.38.88	44.	11.07.37.33	79.06.53.97
7.	11.09.17.38	79.03.40.54	45.	11.07.30.79	79.06.48.65
8.	11.09.08.33	79.03.25.36	46.	11.07.25.92	79.06.50.33
9.	11.09.11.19	79.04.29.60	47.	11.07.13.31	79.06.50.82
10.	11.08.44.31	79.03.21.40	48.	11.07.10.11	79.06.59.08
11.	11.08.34.75	79.03.52.77	49.	11.07.09.01	79.07.18.86
12.	11.08.15.81	79.05.23.92	50.	11.06.51.72	79.06.45.20
13.	11.08.15.13	79.05.44.52	51.	11.06.11.90	79.06.52.87
14.	11.08.01.66	79.04.34.59	52.	11.06.08.55	79.06.38.06
15.	11.07.34.71	79.03.14.86	53.	11.06.03.56	79.06.20.38
16.	11.07.33.90	79.03.14.87	54.	11.05.52.69	79.06.38.99
17.	11.07.29.98	79.04.41.39	55.	11.05.48.91	79.06.20.07
18.	11.07.31.22	79.05.48.51	56.	11.05.35.17	79.06.32.92
19.	11.07.24.60	79.05.31.26	57.	11.05.41.00	79.04.46.63
20.	11.07.22.17	79.05.32.10	58.	11.05.16.97	79.05.45.68
21.	11.07.16.45	79.05.28.02	59.	11.05.13.83	79.04.59.57
22.	11.07.16.45	79.05.28.43	60.	11.07.06.70	79.04.27.12
23.	11.07.10.77	79.04.26.27	61.	11.06.59.92	79.03.43.51
24.	11.07.07.09	79.03.20.40	62.	11.06.59.51	79.03.43.51
25.	11.07.05.47	79.03.21.64	63.	11.06.42.29	79.03.23.03
26.	11.07.06.70	79.04.27.12	64.	11.06.40.24	79.03.19.75
27.	11.07.08.69	79.05.23.12	65.	11.06.22.85	79.03.35.11
28.	11.08.15.81	79.05.23.92	66.	11.06.28.00	79.04.17.49
29.	11.07.16.45	79.05.28.02	67.	11.06.30.89	79.04.24.89
30.	11.07.16.45	79.05.28.43	68.	11.06.07.68	79.04.20.51
31.	11.07.22.17	79.05.32.10	69.	11.06.04.70	79.03.59.11
32.	11.07.24.60	79.05.31.26	70.	11.05.59.75	79.03.49.67
33.	11.07.31.22	79.05.48.51	71.	11.05.58.58	79.03.57.09
34.	11.08.15.13	79.05.44.52	72.	11.05.49.03	79.04.29.28
35.	11.08.20.54	79.06.03.85	73.	11.05.51.60	79.03.47.25
36.	11.07.52.47	79.06.03.20	74.	11.05.41.65	79.03.16.84
37.	11.08.25.49	79.06.15.76	75.	11.05.27.88	79.03.26.00
38.	11.05.30.80	79.03.38.33	76.	11.05.20.46	79.04.15.46

Source: GPS data about the Pigsheds generated from IRS 1C Digital Data

Table 2 shows the tabulated values calculated using the Envi 4.0 image analysis method and the derived areas in sq. meter as well as sq. km for the selected region of interest themes in Ariyalur and environs. From the table it is evident that the huts occupy 1.53 sq. km area and the builtup areas occupy 1.74 sq. km. Agriculture and barren land inhabit 2.03 and 3.43 sq. km area in Ariyalur. Though the drainage and stagnant water areas including the water bodies occupied only small proportion this along with the location of pigsheds makes this region for conducive atmosphere for the vector growth. This futher deteriorates the environmental conditions poorly in this region.

Table –2 Ariyalur and Environment: From Optical Remote Sensing Data

S.No	ROI Theme	Ariyalur and its surroundings		Ariyalur Town	
		Area in Sq.m.	Area in Sq.km.	Area in Sq.m.	Area in Sq.km.
1.	Builtup	1747812.50	1.74	525625.00	0.525
2.	Huts	1534218.75	1.53	345156.25	0.34
3.	Water bodies	123125.00	0.12	66093.75	0.06
4.	Stagnant water	140625.00	0.145	22656.25	0.02
5.	Drainage	253437.50	0.25	104843.75	0.105
6.	Pig shed	5000.00	0.005	4218.75	0.004
7.	Vegetation	809062.50	0.80	85312.50	0.08
8.	Agriculture	2030468.75	2.03	138437.50	0.13
9.	Barren land	3435781.25	3.43	220000.00	0.22

Source: Generated from IRS P6 Remote Sening data

CONCLUSION

Field observation reveal that in Ariyalur town majority of the septic tank is let open to drain in the open drainage and due to large scale pig population they make the environment uglier and creates an environment to grow bacterial organisms. Solid wastes are disposed on the roads with out any proper care by the administration and some time they are disposed on the open drainage and that is the reason majority of the open drainage is blocked and the water flows on the road side as well in front of the residential areas. The majority of the residential areas in the centre of the town is having cattle sheds either at the backyard or adjacent to the residential house. The housing pattern in the town is mixed, that is some residences are with concrete roof, some are with thatched sheds and some are very poor conditions with adverse environmental quality. In the center of the town more than 90 per cent of the town us dirty/ dusty and this has been proved in the analysis.

During rainy season particularly the abandoned mining centers that are present in the low lying areas are filled with water and due to seepage most of the places are with wet soil. Because of this reason the low-lying areas are becomes the stagnant wastewater areas that allows the mosquitoes to breed and search for 'blood meal'. This environment is further deteriorated with the growth of pig and cattle's, which supplements the conducive environment for the vectors in this region.

Perceptual experiences about the various mosquito related problems in the town are particularly in the marshy environment (bushes nearby houses) low lying areas during rainy season, unclaimed solid wastes for a long time that was disturbed by the stray pigs. Majority of the respondents are not aware of the protection from the mosquito bite and its aftermath problems and majority of them are not bothered to protect the mosquitoes by way of self-contained methods (by using nets, mosquito coils and so on). The perception about the Japanese Encephalitis (Brain fever) that affects the children under the age of 6 years are very common in this region and it is interesting to know from the respondents that they are unaware about the genesis of the disease environment.

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