Chapter Seven

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Maintenance and improvement of health and lifestyle of resident population has always been a priority aspect in the development planning of any country. Usually a two pronged approach is made. On the one side, efforts are taken to keep the dreaded contagious diseases at bay so that mortality is reduced. In the second dimension, an effective health care delivery system is formulated so as to sustain the general health of the population. Hence Disease surveillance and health care delivery have become focal themes of research not only in the field of medicine but also in various social sciences. This is particularly applicable to community diseases which are contagious and spread easily. Among the different diseases, malaria is one such most infectious communicable disease which widely prevalent in the tropical and semiarid regions of the World.

In addition to the environmental factors, the socio-economic parameters of the society also play a vital role in the vulnerability of the population towards the attack of malaria. After independence, various measures were undertaken in India aiming to eradicate this dreadful disease. However, still it remains as a major disease in many parts of the country. One of the important observations indicates that new areas are becoming endemic to malaria and mortality rates are increasing. Thus it becomes essential to have detailed research study on malaria in various endemic regions of the country so that effective control measures could be adopted. In Tamilnadu, Ramanathapuram district is the most endemic region accounting for more than 50% of rural malaria cases in the State. Hence it is chosen as the study area for the present investigation on malaria.

Ramanathapuram district is one of the coastal districts located in the southeast corner of Tamilnadu and has an area of 4089 sq. km. The district as a whole has 11 blocks. Among the 11 blocks of Ramanathapuram district, the six coastal blocks of Tiruvadanai, R.S.Mangalam, Ramanathapuram, Mandapam, Tirupullani and Kadaladi reported more than 90% of total malaria cases in the district. Hence the coastal blocks are taken as the study area. It covers a total area of 2401 sq. km and had a population of 746240 persons in 2001.
The general elevation varies from 2m in Rameswaram Island to 35m above the mean sea level in Tiruvadanai block. The slope of the land decreases from west to east towards the coast. The coastal region of Mandapam and Kadaladi blocks consist of sand dunes looking like small hillocks. The coastal areas are flanked by beach ridge, complex-sand dunes, swales, swamps and backwater. The streams and rivers in general exhibit dendritic and intermittent pattern of drainage all over the coastal blocks. All the streams and rivers are seasonal in nature. River Vaigai of Ramanathapuram block, Kottakudi of Thiruppullani block, Palar, Gundar and Vembar of Kadaladi block empty into Gulf of Mannar and they have some tidal water source at the river mouth. All the streams are dry in nature and end with tanks then and there. The major tanks like Sakkarakottai tank, Ramanathapuram tank and R.S.Mangalam tanks act as main source of water for drinking and irrigation purpose. No river or stream is found in Rameswaram island.

Ramanathapuram coastal blocks are characterized by semi-arid type of climate. Average maximum temperature recorded in the region varies from minimum of 30.9°C in January to a maximum of 36°C in April. May temperature is also almost the same as that of April. Temperature decreases from May to August which may be due to rainfall and wind from Southwest monsoon. After a slight increase in September, temperature decreases gradually to the minimum in January. Average annual rainfall for the region is about 880mm. Of this, about 69% occurs during the Northeast monsoon period. November is the wettest month followed by October. During Southwest monsoon period, 11% of the total rain falls. Winter is the driest among the seasons. The study area has a comparatively higher relative humidity which varies from a minimum of 67% in March to a maximum of 78% in September and December. Most of the months have more than 70% relative humidity making the area to be more sultry and humid.

Black soil as a whole constitutes about 46 percent of the total soil. River alluvium includes alternate layers of sand and clay for a huge thickness. It occurs in areas bordering the Vaigai river. Coastal alluvium occurs in Kadaladi, R.S.Mangalam, Mandapam, Ramanathapuram, Thirupullani and Tiruvadanai blocks. There are vast stretches of saline and alkaline soils found in the coastal blocks. Rameswaram island contains mainly sandy soil. Keelakarai region accounts for significant deposits of gypsum.
During recent decades, all over the State, the growth rate fell appreciably during 1991-2001 and this is also noticed in the study area. However decadal growth regained its momentum in 2001-2011. Out of the total population of 1.18 million (2001) of the District, the study area has a share of 63% with 746240 persons. They are distributed over an area of 2401 sq. km which accounts for 57% of the total area of the District.

In the study area Females outnumber males. As per 2001 census, the highest population concentration is found in Ramanathapuram and minimum population in Rameswaram island. The study area has an overall positive sex ratio of 1043. However, among the blocks, Tiruvadanai and Tirupullani have a still higher sex ratio while Rameswaram is the only block with a negative sex ratio of 939. Nearly 15% of the total population belongs to the SC/ST population category. R.S.Mangalam and Tirupullani have a greater concentration of SC/ST population. At the other extreme, Rameswaram and Mandapam have the least concentration of this group.

Nearly two-thirds of the total population of the study area are literates. In general male literacy rate is higher than the female literacy rate. Ramanathapuram block has highest literacy rate while Kadaladi registered the lowest rate of 57%. The same ranking is applicable for both male and female literacy rates. On the whole, only about one-third of the total population constitutes the main workers. Even here, the work participation rate is very low in Mandapam block, Rameswaram and Ramanathapuram. On the other hand, nearly 42% of the total population in R.S.Mangalam are engaged in various occupations. Other workers category has the highest share of 51.4% followed by Cultivators and Agricultural labourers. R.S.Mangalam, Kadaladi and Tiruvadanai blocks have more than two-thirds of their workers under Cultivators and Agricultural labourers category. Similarly Tirupullani and Mandapam have sizable concentration of Household industry workers. Rameswaram has almost all its main workers under the ‘Other workers’ category. Ramanathapuram and Mandapam blocks also have more than 70% of the total main workers under this group.

The present study focuses on the incidence and management of diseases. Hence the role of Primary Health Centres (PHC) becomes more significant. Each PHC has a service area. There are altogether 34 PHCs in the study area. Of the total number of 34 PHCs, 50%
have a population ranging between 10000 and 20000 while another 30% have a population between 20000 and 30000. Pamban and Thangachimadam PHCs serve a population of about 32000 each. The density of the population in the study area is 311 persons per sq. km. in 2001. Ramanathapuram PHC has the highest density of population. Thondi and Pamban rank next. On the other hand Melakidaram, Uchinatham and T. Utrakosamangai have the lowest density. 53% of the total PHCs have a density which is less than the average for the study area. The central axis of study area has a higher density than the rest of the area. The overall sex ratio for the study area is positive with a value of 1043. Thangachimadam, Pamban, Mandapam, Appanur, Ramanathapuram and Ervadi have a negative sex ratio of less than 1000 females. Nearly one-third of the PHCs have a sex ratio between 1000 and 1050 while another 25% have a sex ratio between 1050 and 1100. A very high positive sex ratio of more than 1100 females is noticed in Puduvalasai, Vellayapuram, Mangalakudi, S.P.Pattinam, Pudumadam, Tirupullani and Regunathapuram. Coming to the PHC service areas, children age group has the highest share of 15.2% to the total population of Thondi PHC. At the other end, Mangalakudi has the lowest share. Moderate share of children age group is noticed in the central part of the study area.

15% of the total population in the study area belongs to SC/ST group, its distribution is very uneven. Pamban, Periyapattinam and Regunathapuram have the lowest share of SC/ST group to their total population. On the other hand, T. Utrakosamangai has more than half of its population under this category. In general, most of the coastal PHC service area, particularly in the east and south, has lower concentration of SC/ST population. Total literacy rate for the study area varies from a minimum of about 53% in Melasirupothu and Melakidaram to a maximum of 78% for Ramanathapuram. Pudumadam, Pandukudi, Chittarkottai, Puduvalasai, Vellayapuram, Thangachimadam and Mandapam PHCs have a better literacy rate. Ramanathapuram has the highest male literacy rate because it is the District Headquarters while Melakidaram and Valinokkam have the lowest rate. Ramanathapuram has the higher female literacy while Melasirupothu and Appanur have to lowest rate. About 46% of the total population of Tiruvetriyur PHC are engaged as main workers while this work participation rate is the lowest in Puduvalasai. Melasirupothu, Tiruppalaikudi, T. Utrakosamangai and Appanur PHCs also
have a higher work participation rate while Pudumadam, Valanur, Chittarkottai and Sikkal have a lower work participation rate. Thangachimadam and Ramanathapuram PHCs have almost no workers in the Cultivators and Agricultural Labourers category. This is because of the urban characteristics of these PHCs. On the other hand nearly 90% of the total workers in Melasirupothu, Mangalakudi and Anandur belongs to Cultivators and Agricultural Labourers category. In general Household industrial workers have only a very low share of 3.4%. Regunathapuram nearly one-fourth of the total main workers are engaged in the Household industrial activities. In other PHC service areas, it is very low. It is almost nil in Appanur, Melasirupothu and Vellayapuram PHCs. In the case of Other workers category, Thangachimadam PHC is unique because almost all the total workers belongs to this category. In Ramanathapuram, Pamban and Mandapam PHCs also, more than 90% of the workers are grouped as ‘Other workers’.

Agricultural land use is the most important type of land use and accounts a share of about 31.9 % of the study area. The maximum agriculture areas are found in the Gundar basin of Kadaladi block, River Vaigai basin of Ramanathapuram block, River Peyar basin of R.S.Mangalam block and River Kottakarai of Tiruvadanai block. Dense scrub ranks second. It is indicating a comparatively semi-arid climate for the region. Tanks are found scattered and Ramanathapuram District is known as a Tank District. Hence water bodies cover about 11.6 % of area. Plantation land use type covers nearly 180 sq. km. Open scrub and Barren land account for a share of 6% each. Being a coastal region with dry climate in the southern parts, salt extraction is a major activity. Nearly 2% of the total area comes under salt pan, salt intrusion and sea water. Nearly 4.5% of the total area comes under built-up land with major settlements. Fishing has a significant role to play in the economy of the district. There are about 50 villages in which a large population of fishermen lives. The important fishing centers in the district are Thondi, Pamban, Devipatnam, Rameswaram, Keelakarai and Alangulam.

The study area has a fairly good network of roads. Two National Highway passes through this study area. NH 49 connects Rameswaram with Kochi via Madurai. NH 210 connects Tiruchirapalli with Ramanathapuram via Tiruvadanai and R.S. Mangalam blocks. The State Highway of East Coast Road (ECR) passes through this study area in the north
south direction and it connects all the coastal blocks of Ramanathapuram district. The road availability and accessibility is comparatively poor in Tiruvadanai, R.S.Mangalam and Kadaladi blocks. All the villages are connected with roads though maintenance in the coastal areas and in the block soil areas is very poor. The region is also connected to the national network of Railways through a Broad gauge railway line. This ends at Rameswaram. About 66 km. of railway line occur in the study area.

Malaria is the only major disease that is endemic from 16th century till date. It occurs due to a parasite carried by a vector to the host. There are five species of parasites of the genus Plasmodium that affect human. They are: Plasmodium Falciparum, Plasmodium Vivax, Plasmodium Ovale, Plasmodium Malariae and Plasmodium Knowlesi. Among these species, P. falciparum is the most deadly. It is more predominant in Africa. On the other hand, P.vivax is less dangerous but it is more widespread. The other three species are found less frequently. These species of parasite are carried by a vector which the vector is the female mosquito of more than 30 anopheline species. Host in this case is human body. Transmission of the disease and the intensity of malaria vary from season to season and from year to year. Differences in the malaria parasite and the mosquito vector and human populations as well as in climate and physical environment create a variety of malaria situations. In Southeast Asia, coastal and marshland malaria is related to the presence of mosquitoes that breed specifically in brackish water and can cause serious problems in peri-urban as well as in rural areas. Malaria is the world’s widespread vector-borne disease caused by female anopheline species. Globally, an estimated 3.3 billion people were at risk of malaria in 2011. According to the latest WHO estimates, there were about 219 million cases of malaria in 2010 and an estimated 660 000 deaths in the world.

The African region with 45 countries has an estimated share of more than 80% of malaria cases and more than 90% of total death due to malaria in the World in 2012. Among the WHO regions, Europe has the lowest share in both incidence and death. In fact there is no death due to malaria in the European region in 2010 and 2011. Southeastern Asia ranked 2nd followed by Eastern Mediterranean in the case of number of deaths. The Southeast Asian region is also notable for malaria cases and India leads to other countries in this region except Pakistan and Indonesia in 2001. In 2001 and 2005 India ranked 13th in
the world as far as confirmed cases of malaria is concerned. However, control measures undertaken by Government and other agencies led to a gradual decline in the number of cases. Consequently, India slipped down from 13 to 18th rank in 2010 and 2011.

About 95% population in India resides in malaria endemic areas and 80% of malaria reported in the country is confined to areas consisting 20% of population residing in tribal, hilly, difficult and inaccessible areas. Among the five species of malaria, two are more dominant in India. Spatially the distribution of Malaria cases in concentrated in a few States. Odisha leads all these states in almost all time points. In 2001 Chhattisgarh and Karnataka ranked next to Odisha in the percentage share of malaria cases. However, after 2005 Jharkhand became a major State for the incidence of malaria and it replaced Chattisgarh at the second rank. Maharashtra has become another newly added major state for malaria in 2010 and 2011. In fact, in 2011, the four States of Odisha, Jharkhand, Chhattisgarh and Maharashtra accounted for 53% of the total malaria cases in to country.

Tamilnadu ranked 15th among the States in the incidence of malaria in 2011. However between 2001 and 2011 the position of Tamilnadu has been fluctuating. In fact, Tamilnadu ranked 14th in 2001. But, the increase in the number of cases in 2005 led to an increase in the rank and Tamilnadu had 12th rank in that year. Subsequently, the decline in the cases made Tamilnadu to have 17th rank in 2010. In spite of the higher ranking, the disease is well controlled by the health care system so that there is no death due to malaria in 2001, 2005 and 2011. However, in 2010 there has been a report of death of three persons due to malaria.

The National Rural Health Mission (NRHM) has identified that malaria is localized and concentrated in certain regions. Based on location, it identifies three types of malarial incidence. Costal malaria is found in the southeastern coastal areas of Tamilnadu such as Ramanathapuram, Thoothukudi and Kanniyakumari Districts. The actual number of malaria cases is the highest in Ramanathapuram district. 11.5% of the State population is under risk due to the urban malaria which is mainly concentrated in Chennai. In Tamilnadu, Chennai Metropolitan area and Ramanathapuram district have top ranks in malaria incidence. Ramanathapuram district accounts for more than 50% of rural malaria cases 2003-2011 only in 2001 and 2002, there was a comparatively lesser incidence. Still it
has the largest share among the districts. Incidence of malaria cases has shown a fluctuating trend falling in line with the State malaria cases. In 2011 the total rural malaria cases in Tamilnadu was 6602. Out of this 605 of the cases occurred in Ramanathapuram District alone. Thus it is validated that Ramanathapuram District is the most endemic district in Tamilnadu as far as malaria is concerned. A perusal of registered malaria cases indicates that coastal blocks have more than 90% of the cases in the District.

The effective mechanism to control the disease could be channelized only through the Primary Health Centre. Hence for the present investigation, the six coastal blocks together from the macro unit while the service areas of Primary Health Centres from the micro unit. There are 30 PHCs in 2001 and 34 PHCs in the coastal blocks of Ramanathapuram District in 2011.

Disease surveillance and control use different parameters for different types of diseases. As far malaria is concerned, the National Vector Borne Disease Control Programme (NVBDCP) uses different parameters.

Two parameters are taken for the present study, namely Annual Parasite Index (API) and Slide Positivity Rate (SPR).

In 2001, a total of 809 cases have been tested positive for malaria in the coastal blocks of Ramanathapuram District. 90% of the malaria cases occur only in 7 PHC areas. At that time there were only 30 PHCs in the study area. Of them no malaria case was reported in Pandukudi, Vellyapuram in Tiruvadanai block, Thiruppalaikudi in R.S.Mangalam block, Kavanur in Ramanathapuram block and Puduvalasai in Mandapam block. At the other extreme, the highest number of cases is concentrated in Pamban, Thangachimadam, Mandapam and Pudumadam PHC areas which account for more than 78% of malaria cases. All these four PHCs are located in Mandapam block making it a more endemic area than the other blocks.

It is commonly observed that a value of more than two API is considered as ‘risky’ by WHO and the type of control measures is decided as per API score. For the study area as whole, the API score in 2001 was 1.05. Among them Pamban has the extreme value of 12.4. Pudumadam, Thangachimadam, Mandapam and Valanur also are ‘risky’ areas with
API score varying between 3 and 4. All these PHCs except Valanur occur within Mandapam block. For the study area as whole, the Slide Positivity rate is 0.5%. Among the 25 malaria incident PHCs, Pamban, Pudumadam, Valanur, Mandapam and Thangachimadam have a SPR which is more than the average for the study area SPR score. All these PHCs except Valanur are located in Mandapam Block.

In 2001, maximum number 60% of malaria cases occurred in the Monsoon season and another 22% in Post-monsoon season. Winter had the minimum incidence of malaria. During the Winter season of 2001, only one-fourth of the total PHCs had incidence of malaria. The maximum of 21 cases is found in Pamban PHC. Thangachimadam, Pamban, Pudumadam and Mandapam PHCs have more incidence of malaria in the pre-monsoon season. Extreme concentration of malaria during monsoon season was reported in Pamban and Thangachimadam. More than two-third of malaria cases during monsoon season are reported in Pamban and Thangachimadam. For the study area, Post-monsoon is a period of maximum rainfall. Since number of rainy days is more and winds are stronger, stagnant water for breeding of mosquitoes is disturbed more. This may be a reason for comparatively lower incidence of malaria in this season. The extreme level of 68 cases was reported in Pamban PHC. Thangachimadam, Mandapam and Pudumadam PHCs also reported significant number of malaria cases in 2001.

Available data for 2001 indicates that malaria is more prevalent among men than among women. Out of 809 reported malaria cases, 71% are males. Uchinatham PHC has no male patient. All the three reported cases are only female. On the other hand all the reported malaria cases are only male in Thondi, Sikkal, Chittarkottai, Mangalakudi, T.Uthrakosamanagai, R.S.Mangalam and Anandur PHCs.

In 2001, out of 809 malaria cases, number of children under 5 years of age is almost nil in most of the PHCs. Out of the total malaria cases only 3% belongs to this group. All of them are reported only Pamban, Pudumadam, Thangachimadam and Mandapam PHCs falling under Mandapam block only. Nearly one-fourth of the total malaria cases belong to the Adolescent age group of 5 to 14 years. Among the 25 PHCs where malaria is reported in 2001, this age group is not represented in Sayalkudi, Melakidaram, Thamaraikulam, T. Uthrakosamangai, Mangalakudi, R.S.Mangalam and
Anandur PHCs. It may be observed that the share of this age group to the total malaria cases is comparatively higher in Thangachimadam, Mandapam and Pudumadam PHCs than the study area as a whole. Adult population is more prone to malarial attack as per the data available in 2001. 70% of the total malaria cases come under the age group of more than 14 years. Here also the ranking of PHCs does not show any deviation from the ranking for total malaria cases. Pamban is the top ranking PHC here also and all the top four PHCs belong to Mandapam Block. However the number of cases is more in the Gulf of Mannar coast area than the other parts.

Malaria cases in the study area between 2001 and 2010 indicate a fluctuating trend. Between 2002 and 2005 there has been a notable increase in the incidence of malaria. During the last 10 years, the highest number of malaria cases was reported in 2005. Subsequently there has been only a fluctuating trend with a sizable decline in 2009. Hence 2010 has been chosen as the second time point.

Compared to 2001, a higher number of malaria cases were reported in 2010. For the study area as whole, there were 3237 malaria patients in 2010. The numbers of PHCs are increased to 34 in 2010. In Mangalakudi, Thondi, R.S.Mangalam and Anandur PHCs malaria cases were reported in 2001 but they do not have malaria cases in 2010. Similarly the newly created Tiruvetriyur PHC also reported no malaria case. Only in 26 PHCs incidence of malaria is registered. Of these, Pamban, Thangachimadam, Uchipuli, Mandapam, Tirupullani and Valinockam PHCs had more than 100 cases. Among these six PHCs Pamban and Thangachimadam PHCs registered extreme values and together they account for nearly 58% of total malaria cases in the study area.

The API for the study area as a whole was 4.1 in 2010 compared to 1 in 2001. The trend line of API is almost similar to the total number of malaria cases between 2001 and 2010. The highest Annual Parasite Index score found in Pamban PHC in 2010. Thangachimadam and Uchipuli PHCs have more than 10 API score. Mandapam, Valinockam and Valanur PHCs have moderate API score. Tirupullani, Narippaiyur, Erwadi, Periyapattinam and Devipattinam PHCs also have ‘risky’ level of API score in 2010.
The highest SPR score was registered in 2005 and the lowest score about 0.5% in 2001 and 2002. The SPR increased between 2002 and 2005. Later, it declined to 1.5 in 2009. The increased incidence of malaria resulted in the increase of SPR in 2010. The average score of SPR in 2010 is 2.4 for the study area as a whole. Pamaban, Thangachimadam, Mandapam, Uchipuli and Valinockam PHCs have high score of SPR which is more than the average of the study area. Mostly all PHCs that are endemic are found along the Gulf of Mannar coast. On the other hand Tiruvadanai and R.S. Mangalam blocks have almost nil score of SPR except S. P. Pattinam PHC.

The seasonal pattern of malaria in 2010 also shows that the higher incidence of malaria occurs during the Monsoon season and lower incidence during Winter. The incident share of monsoon season declined from 2001 to 2010. In 2003, Pre-monsoon recorded higher incidence. In 2004 Post-monsoon or northeast monsoon recorded a higher incidence. In 2010 nearly one-third of the malaria cases were reported during the Northeast monsoon period.

Only 13 PHCs have incidence of malaria in Winter season in 2010. Thangachimadam and Pamban PHCs share about nearly 80% of the incidence in this season. Other 11 PHCs have less than 10 malaria cases during this season. During the Pre-Monsoon period in 2010, 17% of the malaria cases occurred. Only 15 PHCs had malaria cases. Of these 15 PHCs, those in the Rameswaram island alone share 80% of the incidence. Other one-fourth of the PHCs have less than 10 malaria cases each. During the Monsoon period 65% of the PHCs have malaria incidence in 2010. Pamban, Thangachimadam, Uchipuli and Mandapam PHCs also have a higher incidence. Appanur, Melasirupothu, Sayalkudi and Uchinatham PHCs did not have any malaria case in this season of maximum incidence. These four PHCs had malaria only during the other seasons. Post-monsoon period is the period of maximum rainfall for the study area. Out of 34 PHCs, malaria cases reported only in 21 PHCs in 2010. Thangachimadam and Pamban account for about 54% of the total malaria cases. Tirupullani, Uchipuli and Mandapam PHCs also have a higher incidence.

Gender pattern of malaria incidence shows that male are more prone to malaria disease than female throughout the time period. The share of females has been on the
increasing trend between 2001 and 2010. In 2010, malaria incidence in gender shows that the male had higher share than the female. In all 26 PHCs male malaria cases are present but only 19 PHCs registered female malaria cases. R. Kavanur, T.Uthrakosamangai, S.P.Pattinam, Chittarkottai, Uchinatham, Appanur and Melasirupothu PHC have only minimum number of malaria cases which are totally male. Out of 19 PHCs where both male and female cases were reported, Periyapattinam, Devipattinam, Sikkal and Regunathapuram PHCs have reported almost equal number of male and female cases within the respective PHC areas in 2010. Percentage of share of male cases were comparatively higher than the study area average in Ramanathapuram, Thangachimadam, Tirupullani, Valanur and Narippaiyur PHCs. Thamaraikulam, Pamban, Uchipuli, Erwadi, Mandapam, Pudumadam and Valinockam PHCs have more female cases than the study area as a whole indicating that female population in these areas are more prone to this disease compared to other PHCs in 2010.

During all the years share of Adults is the highest while the share of Children is the least. However, the actual share varies from year to year. Between 2003 and 2009 Children and Adolescent had a comparatively higher share than the chosen time points of 2001 and 2010. In 2010, an extremely high share of Adult is noticed among the total malaria cases. Children are almost immune to the disease. Only 5 PHCs reported Child malaria case in 2010. Among them Narippaiyur, Valinockam and Erwadi reported more cases than Pamban and Mandapam shows higher incidence among the Children in 2010. Out of 34 PHCs only 16 PHCs have malaria cases in the Adolescent age group. More than 60% of cases among the Adolescent are found only in Pamban and Thangachimadam PHCs. More than 90% of the total malaria cases in 2010 belong to Adult age group. Pamban, Thangachimadam, Uchipuli and Mandapam PHCs alone share about 75% of malarial incidence among the Adult in 2010. Valinockam PHC has a higher incidence in the Kadaladi block among the adult cases.
Summary of Major Inferences from the Spatio Temporal Analysis

- There has been a fourfold increase in the total number of malaria cases between 2001 and 2010.
- Pandukudi, Vellayapuram and Thiruppalaikudi had no malaria in the entire study period while R.S.Mangalam and Anandur PHCs had no malaria cases after 2007.
- Uchipuli PHC had more malaria cases and higher API and SPR scores in 2010 to become the third ranking PHC. R. Kavenur, Puduvalasai PHCs did not report malaria cases in 2001 but had malaria cases in 2010.
- Pamban and Thangachimadam are the most endemic PHCs in the study area with higher API score and SPR rates during both time points of study. Valanur, Ervadi and Tirupullani come under ‘risky’ category as far as API score is concerned.
- Compared to 2002, Valinockam and Narippaiyur became endemic PHCs in 2010 while Pudumadam came out of ‘risky’ level in 2010. Other PHCs are less significant with regard to incidence of malaria.
- Seasonally Monsoon period have a higher number of malaria cases followed by Post-Monsoon period, Pre-monsoon period and winter season. Almost all the coastal PHCs which are located along the Gulf of Mannar coast have malaria incidence during all seasons. During the Monsoon and Post-monsoon periods incidence of malaria extends to the interior PHCs.
- Uchipuli and Tirupullani exhibited more than 10 fold increase in the number of male malaria cases between 2001 and 2010 and Uchipuli also showed an abnormal increase in the number of female malaria cases.
- There seem to be a positive correlation between plantation type of land use and incidence of malaria particularly along the Gulf of Mannar coast.
- In 2001 child malaria cases were reported only in Pamban, Pudumadam, Mandapam and Thangachimadam PHCs. However in 2010 incidence of child malaria cases shifted
from these PHCs to Narippaiyur, Valinockam and Ervadi PHCs. Valinockam and Narippaiyur also reported more malaria cases in the Adolescent age group in 2010.

Based on the spatio-temporal analysis, the 34 PHC service areas are categorized into six subgroups.

1) Pamban, Thangachimadam, Mandapam and Pudumadam PHCs are *Very High endemic PHCs in both time points.*

2) Uchipuli is the only PHC where there is an abnormal increase in the incidence of malaria between 2001 and 2010.

3) Valinockam, Valanur, Tirupullani, Narippaiyur, Erwadi, Periyapattinam, Devipattinam, Puduvalasai and Ramanathapuram PHCs are comes under the group of PHCs where incidence was low in 2001 and high in 2010.

4) Chittarkottai, T. Uthrakosamangai, S. P Patinam, R. Kavanur, Regunathapuram, Tiruvertiyur, Sikkal, Melakidaram, Uchinatham, Appanur, Melasirupothu, Thamaraikulam and Sayalkudi PHCs had minimal incidence in both time points.

5) In Anandur, Mangalakudi, Thondi and R.S.Mangalam PHCs *malaria was present in 2001 but eradicated in 2010.*

6) Thirupalaikudi, Pandukudi and Vellayapuram PHCs *did not report malaria cases in both time points.*

In order to understand purpose of resident population with regard to malaria nine sample PHCs have been chosen covering all the subgroups. They are Vellayapuram, Anandur, Chittarkottai, Pamban, Thangachimadam, Uchipuli, Puduvalasai, Valanur and Valinockam.

- Among the sample PHCs Valinockam and Thangachimadam had more female respondents. Nearly 50% of respondents belonged to small family category. Only Valinockam had more respondents under big family group. In general BC is dominant in the study area while SC/ST concentration is higher in Valanur. Literacy rate in the sample PHC is about 71% but Puduvalasai and Chittarkottai had lower level of
literacy. Most of the respondents had only up to middle level education. While Valanur and Valinockam had mostly Primary education respondents of Uchipuli and Vellayapuram had more number of graduates.

- 37% of the respondents are Cultivators and Agricultural labourers while another 25% are traders. Permanent employees with monthly income fishermen and casual labourers have a share of 10 to 15% each. Valanur, Anandur, Vellayapuram and Chittarkottai have more Cultivators and Agriculturel Labourers while Valinockam has a higher concentration of Casual labourers. More concentration of Traders is observed in Puduvalasai, Pamban and Thangachimadam. Both Pamban and Thangachimadam have the highest share of Permanent employees among the sample PHCs. 43% of respondents in Uchipuli are Fishermen. In general, the respondents have poor income. 48% of the respondents come under Low income group while another 23% have very low income.

- 71% of the households have protected water supply and another 20% get water from open wells. Uchipuli and Valanur PHCs have 100% protected water supply. In other sample PHCs also protected water supply is available to more than 60% of the households. Open well is the main source of Drinking water in Puduvalasai. It is also a major source of Drinking water for one-fourth of the households in Valinockam, Thangachimadam, Chittarkottai and Vellayapuram. Nearly one-third of the households in Anandur get Drinking water from Other source such as ponds. All the households in Uchipuli and Valanur get daily water supply. In Anandur and Vellayapuram water supply is available twice a week. Among the sample PHCs, a sizable number of households in Valinockam get water once in 10 days or more. On the whole only 50% respondents store water. However, among the sample PHCs, Anandur, Vellayapuram and Puduvalasai have more than 70% respondents who store water. 23% of the sample respondents do not undertake any treatment to the drinking water while nearly two-thirds boil the water before the drinking. Only 13% use water filters. Valinockam, Vellayapuram and Chittarkottai have a higher share of respondents who are using treated water by boiling. In contrast 60% of respondents in Anandur use only non-
treated water. Valinockam, Uchipuli and Puduvalasai also have notable share of respondents who use non-treated water.

- In the study area nearly 70% of the houses are pucca houses. Uchipuli is the only PHC which has more number of kacha houses. Valanur has the highest number of semi pucca houses. Puduvalasai and Valinockam have one-third of their households with Semi-Pucca houses. Only 21% of the total sample respondents identified malaria as a common disease in the study area.

- Among the sample PHCs awareness with regard to malaria is comparatively better in Uchipuli, Pamban, Thangachimadam and Valinockam. It is very low in Vellayapuram and Anandur. It is strange to note that only 9% respondents in Valanur PHC indicated malaria as a common disease even though it is an endemic area. On the whole 42% of the total sample respondents knew about malaria through Government field workers while another one-third of them knew from their relatives. Media is the other source for information in malaria. There is not much variation in the source among the sample PHCs.

- In the sample PHCs 71% use repellants as preventive measures. Only one-sixth of the respondents use net. Share of respondents using net is comparatively higher in Thangachimadam, Valinockam and Pamban. On the whole, only 50% of the respondents confirmed that house spry was undertaken in their home. 90% of respondents confirmed that spraying is effective and controlled mosquito. 80% of the respondents have indicated that spraying had some side effects on the health of the population though at limited level that too for a short period of time after spray.

- On the whole, 63% of preferred Government hospital. The percentage of those who go to Government hospital varies from a maximum of 81% in Valanur to a minimum of 43% in Pamban. Valinockam and Anandur also have a comparatively higher percentage of respondents who prefer Government hospitals. On the whole, slightly more than one-third of the respondents prefer to go to Private hospital. They are reluctant to go to the Government hospital either because of absence of doctors or due to longer waiting time or lack of proper attention or inadequate facility.
More than half of these respondents gave absence of doctors as the main reason for not preferring Government hospitals while another one-third cited long-waiting time for getting treatment as the main reason. Even here, more respondents in Valinockam gave absence of doctors as the main reason. Similarly in Thangachimadam nearly 50% of these respondents avoided Government hospital due to long waiting time. Only in Valanur majority of these respondents did not prefer Government hospital due to lack of proper attention given to the patients.

60% of the respondents had to travel less than 2 km to reach the PHC. Only 7% have to travel a distance of more than 6 km. Pamban and Thangachimadam PHCs have a comparatively higher percentage of respondents who travel for more than 6 km to go to a PHC. Most of the total respondents go by walk and 40% of the respondents prefer bus to go to PHC. 18% use van, auto to reach PHC. Uchipuli has the higher share of respondents who go by walk to PHC. It should also be noted that the distance to travel is also high for more than 50% of these respondents. The main reason is the lack of bus facility which is to be taken care of. About 50% of the respondents in Puduvalasai and Vellayapuram also go to PHC by walk. Frequency of bus trip is comparatively poor in the study area since 56% indicated that bus trips are made once in one hour or more. Pamban and Thangachimadam are better placed with frequency bus trips. 70% of the total sample respondents take less than 30 minutes to reach the concerned PHC. Only 12% of them take more than an hour to reach the concerned PHC. Pamban, Puduvalasai, Anandur and Thangachimadam have more than 50% of the respondents who can reach the PHC within 15 minutes. In Chittarkottai, Valinockam, Anandur and Puduvalasai more than 40% of the people are taking 15 – 30 minutes to reach the hospital. Valanur has highest share of people who take 30 – 60 minutes to the hospital. 72% of the respondents in Uchipuli take more than one hour to go the hospital, mainly because of lack of transport and because most of them go by walk. In the study area only 6% respondents could see the doctor within 15 minutes. However 46% had to wait for 30 minutes to 1 hour to see the doctor. 38% of the respondents indicated that the waiting time is more than one hour. Thangachimadam, Pamban and Valinockam had more respondents who could see the doctor quickly whereas in Anandur and
Puduvalasai more respondents had to wait 30 minutes to 1 hour to see the doctor. Only Valinockam and Vellayapuram have respondents who reported more waiting time.

- Three major components account for .76 variance among the data set. Awareness factor seem to be the most important component account for about 40% variance.

- An overlay of these major components provide a ranking of the sample PHCs. Valinockam has the high positive score while Pamban, Uchipuli and Valanur have positive score. Other sample PHCs have negative score.

**Recommendations**

The present investigation and the above given inferences led to certain lacunae in the efficiency of health care delivery system with regard to malaria in the study area. Hence, based on the above inferences, the following recommendations are given.

1) The categorization of PHCs indicates that a common programme for control of malaria for the entire study area is not preferable. Instead, area-specific control measures may be more effective and hence they are suggested here.

2) Pamban, Thangachimadam and Mandapam remains as the most endemic PHCs in spite of serious efforts undertaken for more a decade. Awareness level of population with regard to malaria is also high in these areas. A number of pits are dug to get water for irrigating coconut and cashew trees. Since these are open water source of fresh water, they are potential areas of breeding sites. Hence identification and control of such breeding sites should be given more priority here. House spraying is already done in these areas. Hence these PHCs may be considered for provision of ITN in collaboration with WHO.

3) There has been a spreading of endemic status from Mandapam block to Kadaladi block with Valinockam, Valanur, Narippaiyur and Erwadi becoming more endemic. Awareness with regard to malaria is poor, especially in Valanur. Further, these are the areas which had almost all the child and adolescent malaria cases in 2010. Therefore, creating awareness must be given top priority
for these PHCs. In addition spraying may also be extended. Accessibility is also an issue to be given consideration in these PHCs.

4) Uchipuli had an abnormal and steep increase of malaria cases, especially affecting females. Most of the cases are concentrated in the fishermen hamlets located along the coast. Accessibility is the major concern along with low awareness. Hence priority in this PHC should be on improving awareness and provision of bus facility so that this PHC can come out of ‘endemic’ status.

5) Tirupullani and Periyapattinam PHCs have become new ‘risk’ areas in 2010. Concentrated effort to create more awareness and control measures for breeding sites may make these areas safe.

6) In general, incidence of malaria is low in other PHCs. However, sporadic occurrence has been registered in some PHCs. Hence surveillance of other PHC areas should also be continued. Periodic undertaking of pre control measures in these PHCs may help them to remain as comparatively safe areas for malaria.

Scope for the Further Research

For the shortage of time and finance only 9 PHCs are selected as sample. Other risky PHCs can also be studied in detail. Endemic PHCs like Pamban and Thangachimadam may be taken as specific micro level areas and a detailed study on physical and demographic parameters can be done along with spatial occurrence of the disease using GIS and Remote sensing.

It is hoped that these recommendations may help to reduce the intensity of malaria disease for the study area so as to make the population to lead a healthy life.