

**Ministry of Education  
Department of Higher Education (Upper Myanmar)  
University of Mandalay**

**Mandalay University  
Research Journal**

Vol.3

June, 2012.



# **A Geographical Study on Seasonal Diseases in Mandalay City**

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## **Abstract**

Mandalay City, an old capital lying in Central Myanmar, has favourable geographic conditions for the development of seasonal diseases. With a total population of 796,091 and a density of 19,253 persons per square mile, 0.65% to 0.77% of the population is recorded to have suffered, among the seasonal diseases, mainly from diarrhoea, Dengue Hemorrhagic Fever (DHF) and Acute Respiratory Infection (ARI) during the recent years. In this research, the researcher identifies the epidemic seasons from the geographical point of view: diarrhoea occurs mostly in the rainy season, DHF in the late rainy season, and ARI in the late rainy season to the early winter. As epidemic areas, diarrhoea prevails yearly or periodically in water-logged settlement areas and in wards of poor sanitation and human environment, DHF in those areas as well as in the slum areas, and ARI in places polluted by air indoor or in surrounding areas. Moreover, it is found that the occurrence of diarrhoea increases when temperature, rainfall, and humidity become higher. DHF cases also increase directly with the three climatic elements but the correlation is high with relative humidity and low with the other two. ARI cases increase reversely with temperature and rainfall, and directly with relative humidity. Finally, a conceived model showing the factors influencing upon seasonal diseases in Mandalay City is produced.

Key Words: Seasonal Diseases    DHF    ARI    Epidemic Season

## **Introduction**

Epidemiologically disease distribution depends on time, place, and person (Alderson, 1983). Regarding time distribution, some diseases are in common source epidemics and some in point source epidemic either as short term fluctuations or periodic fluctuations or long-term fluctuations. Seasonal diseases are included in periodic fluctuations. The seasonal variations of disease occurrence may be related to environmental conditions (e.g. temperature, humidity, rainfall, overcrowding, lifestyle of vectors etc.) which directly or indirectly favour disease transmission (Than Htun Kyaw, 2006,2007). However, in many infectious diseases (e.g. polio), the basic for seasonal variation is unknown. Non-infectious diseases and conditions may sometimes exhibit seasonal variation, e.g., sunstroke, hay fever, snakebite etc.

In this research the researcher assumes that seasonal diseases are those which occur due to seasonal changes and due to seasons. In order to study the seasonal diseases from a geographical point of view, Mandalay City is chosen as the study area. Seasonal diseases only those that usually occur at the risk of public health in Mandalay City are studied here from the epidemiological point of view, based on geographical environment and neglecting local seasonal diseases that usually prevail in small scale. Here the researcher emphasizes the three of seasonal diseases which are common in Mandalay City.



## General Description

### Study Area

Mandalay city is located on the eastern bank of the Ayeyarwady River, in the Dry Zone of Central Myanmar. It lies between North latitudes  $21^{\circ} 51' 47''$  and  $22^{\circ} 01' 27''$  and between East longitudes  $96^{\circ} 03' 17''$  and  $96^{\circ} 03' 47''$  (Map-1). With an area of 41.388 square miles the city is constituted with five townships, consisting of 86 wards.

### Topography and Drainage

Mandalay City lies on the Mandalay plain, especially one-fourth area on the Ayeyarwady river terraces in the west and the other three-fourth on the plain in the east. Generally Mandalay plain is higher in northeast and east, and slightly slopes towards west and southwest. The city is at 215'-250' above sea level and lies on the flat alluvial plain except the Mandalay Hill (776'). On the plain, some places are water-logged areas. The terraces gradually lower towards the Ayeyarwady River and settlements are densely built on them from north to south. According to natural relief, the drainage could be assumed to be good but various man-made features cause poor drainage in the city.

The prominent drainage of the city is the Ayeyarwady River. It floods in July or August annually and some western wards of Pyigyitagun township are inundated. It indirectly affects the occurrence of a few seasonal diseases in Mandalay city. Another natural drainage is Thingaza creek. It drains into the Mandalay Kandawgyi Lake in the south, passing through wards of West Thirimarlar, West Dewun, Seinban, and East Thanlyetmaw. Nearby wards are usually flooded with stagnant water in rainy season and exist as incubated areas of larva of some diseases.

The other natural drainage is Payandaw creek flowing through the Pyigyitagun Township. Today it is polluted with chemical waste water dumped from the factories. Wards lying in lowland on its both sides are frequently inundated during the heavy rainy days of the rainy season.

The other man-made canals and ditches such as Shwetachaung Canal, Ngwetachaung Canal, Mahanadi Canal, Colombo Canal, Yenim-yaung Canal, Myaunggyi canal, and Myoma canal exist as sewage canals and flood over nearby wards, mostly in low-lying areas during the storm time.



Map 1 Location of Mandalay city

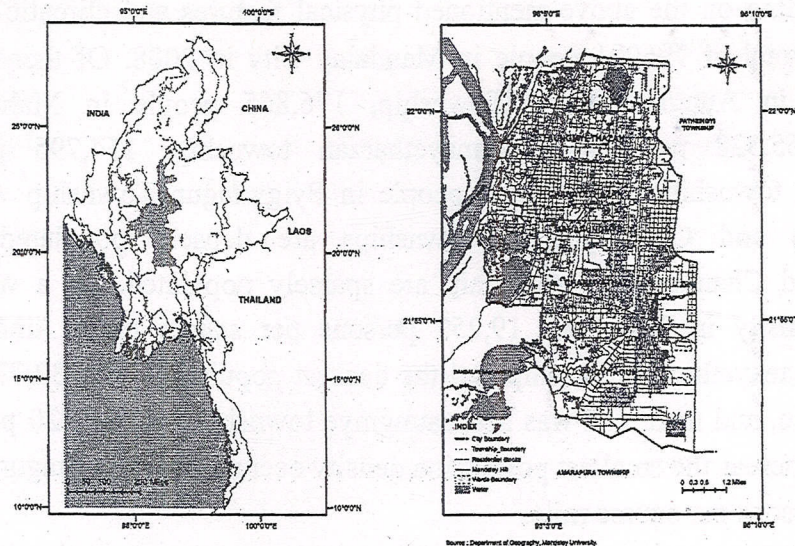
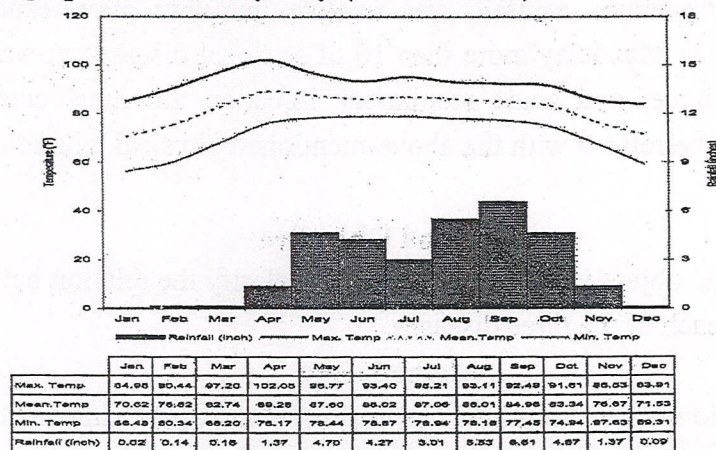


Figure 1 Climograph of Mandalay City (1977 to 2008)



Source: Meteorology and Hydrology Department, Mandalay.

### Climate

Mandalay lies in the hot Dry Zone of Central Myanmar. With a mean temperature of 81.76°F and annual rainfall of 32.09 inches, it suffers a Tropical Steppe Climate (BSh). However, in some years with annual rainfall more than 40 inches, the city suffers Aw climate. Temperature usually rises, starting from Mid-March and reaches in maximum in April and early May (Figure-1). During the rainy season (Mid-May to October), prevailing south and southwest monsoon winds provide much rain and reduce intense heat. The temperature decreases to its maximum in January with a mean monthly temperature of 70.77°F. Starting from the end of February, the temperature rises implicitly and it becomes hotter distinctively. Winter and summer seasons (November to Mid-May) are dry months. Relative humidity of the city occurs the lowest in March with 50.17% and 41.10%, and the highest in October with 77.47% and 77.7% in mornings and in evenings respectively. Actually relative humidity is low in hot and dry months and is high in hot and wet months.



## Population

Depending on the above-mentioned physical features and climatic elements, there lived a total of 796091 people in Mandalay City in 2008. Of these, 181,329 people were in Aungmyethazan Township, 176,865 people in Mahaaungmye Township, 165,528 people in Chanayethazan township, 154,795 people in Chanmyathazi township, and 117,574 people in Pyigyitagun Township. Generally, Mahaaungmye and Chanayethazan townships are densely populated whereas Pyigyitagun and Chanmyathazi township are sparsely populated. As a whole city, population density in 2008 was 19,253 persons per square mile. Among the 5 townships, Chanayethazan township had the densest population with 32,778 persons per square mile, and next to it was Mahaaungmye township with 30,920 persons per square mile whereas the smallest population density occurred in Pyigyitagun township with 5,986 persons per square mile.

The above-mentioned water-logged condition, population density, human environments, temperature, rainfall, and relative humidity may result in various seasonal diseases. In Mandalay more than 10 of seasonal diseases prevail every year but diarrhoea, dengue, and acute respiratory infection are most common. These diseases appear to be related with the above-mentioned physical, climatic, and human conditions.

## Aim and Objective

The aim and objective of this research is to clarify the relation between each of those factors and each of the three diseases.

## Methodology

The relations are examined by using Geographic Information System, graphical methods, regression method, field observation, deductive approach, and inductive approach. Before examining, first task the data concerned is collected from publications, articles, departmental records, and library. Simultaneously field observation is also made by delivery of questionnaires, and personal interviewing. Detailed records on seasonal diseases are obtained from Division Health Department, Mandalay. The second task is 'processing' of collected data into useful forms with the help of GIS (in investigation of water-logged and swampy area), computer, and manual work. The third task is to examine and analyze the processed data by means of statistical methods, graphical methods, and GIS investigation (in examining land-use pattern). As the fourth task, based on the result or the out-comings from the analysis, the hypothesis expected is examined whether it agrees with the results or does not. The collected and processed data are described and analyzed below.

## Description

### *Temporal Distribution*

**Diarrhoea** is an infectious disease that is spread via contaminated water or food (Park, 2001). The disease may occur after flood or during drought period in Myanmar (War Win Htike, 2007). Regarding the disease, data of patient population in



Mandalay City is obtained from health departments of townships, district, and division and described in figure (2). Spatial occurrences based on field observation are shown in Map (2).

The figure shows that temporal diarrhoea cases by townships appear to have been increasing slightly in four townships except Pyigyitagun Township where distinct increase year after year is found.

**Dengue Haemorrhagic Fever (DHF)**, the most common one of all the arthropod-borne viral diseases, is caused by infection with more than one dengue virus, *Aedes* mosquitoes. Dengue fever can occur epidemically or endemically. Epidemics may be explosive and often start during the rainy season.

DHF data in Mandalay City are collected in the same way as in diarrhea cases are described in Figure (3). Spatial occurrences by field observation are shown in Map (3).

Figure (3) indicate that DHF cases in Mandalay City are seen with tripeaks in two-year interval, and as the increasing trend. The map shows most of DHF cases occur in densely populated area.

**Acute Respiratory Infectious Disease ARI** : As to the field data and the health departmental data, ARI cases occur annually in all townships of Mandalay City. As a whole city, more than 1,450 people have suffered it every year during the 2001-2009 period. Temporal distribution of ARI is described in figure (4), and spatially in Map (4). As to the Figure (4), the disease ARI occurred in every month and slightly more cases are found in winter months of November to January.

#### Analysis on Climatic Elements

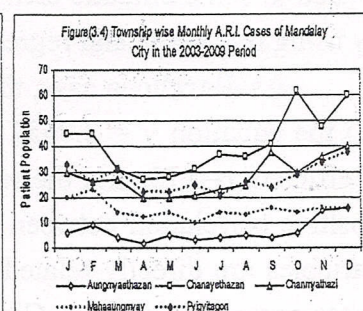
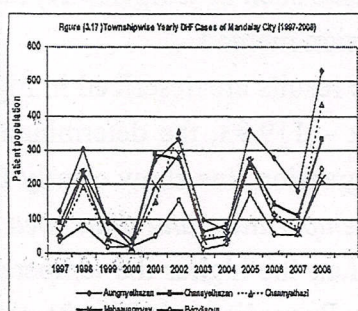
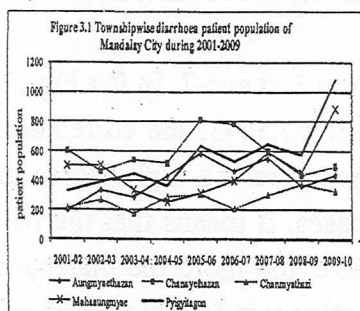
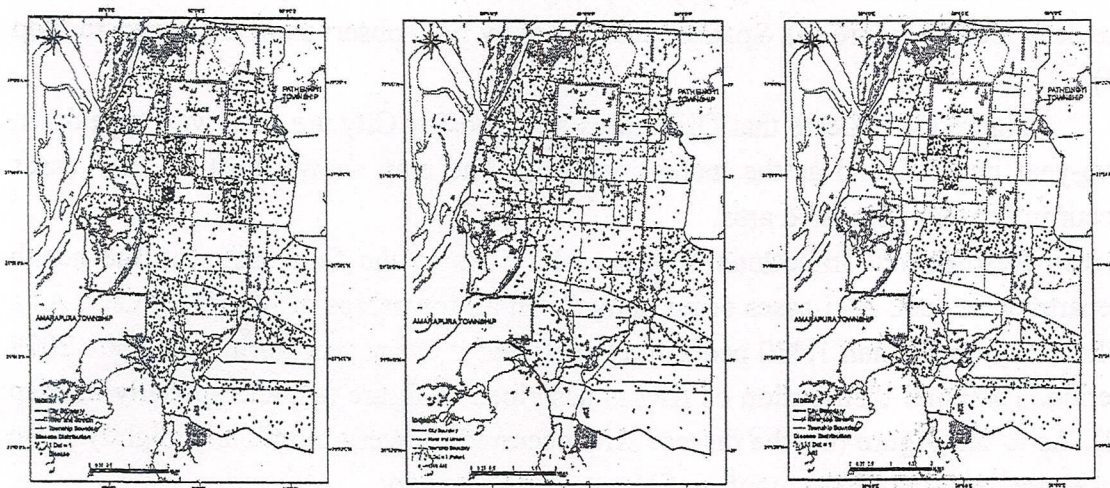
In this portion, it is examined whether diarrhoea, DHF, and ARI cases are related to some climatic elements such as temperature, rainfall, and relative humidity, by using line graph and regression method.

As **diarrhoea** case, the results are described in Figure 5, 6 and 7. In the Figure (5) the equation  $y = 3.7652x - 119.93$ , the determinant  $R^2=0.5643$ , the correlation coefficient  $r=0.75$ , and the regression line show clearly that there is a high degree of positive correlation between *temperature and diarrhoea* cases. It means that the two variables are directly related i.e., the higher the temperature, the more the diarrhoea cases occur in Mandalay City. Regarding rainfall, the equation  $y = 8.1972x + 164.19$ , the determinant  $R^2=0.6903$ , the correlation coefficient  $r = 0.83$ , and the regression line clearly show that there is a high degree of positive correlation between *diarrhoea cases and rainfall* in Mandalay City. In the Figure (7) the regression equation  $y = 1.2941x + 101.34$ , the determinant  $R^2 = 0.1588$ , the correlation coefficient  $r = 0.4$  and the regression line implicitly depict that there is a moderate degree of positive correlation between *relative humidity and diarrhoea* cases. In other words, the occurrence of disease cases is related moderately to the increase of relative humidity in Mandalay City for the years 2003-2008.

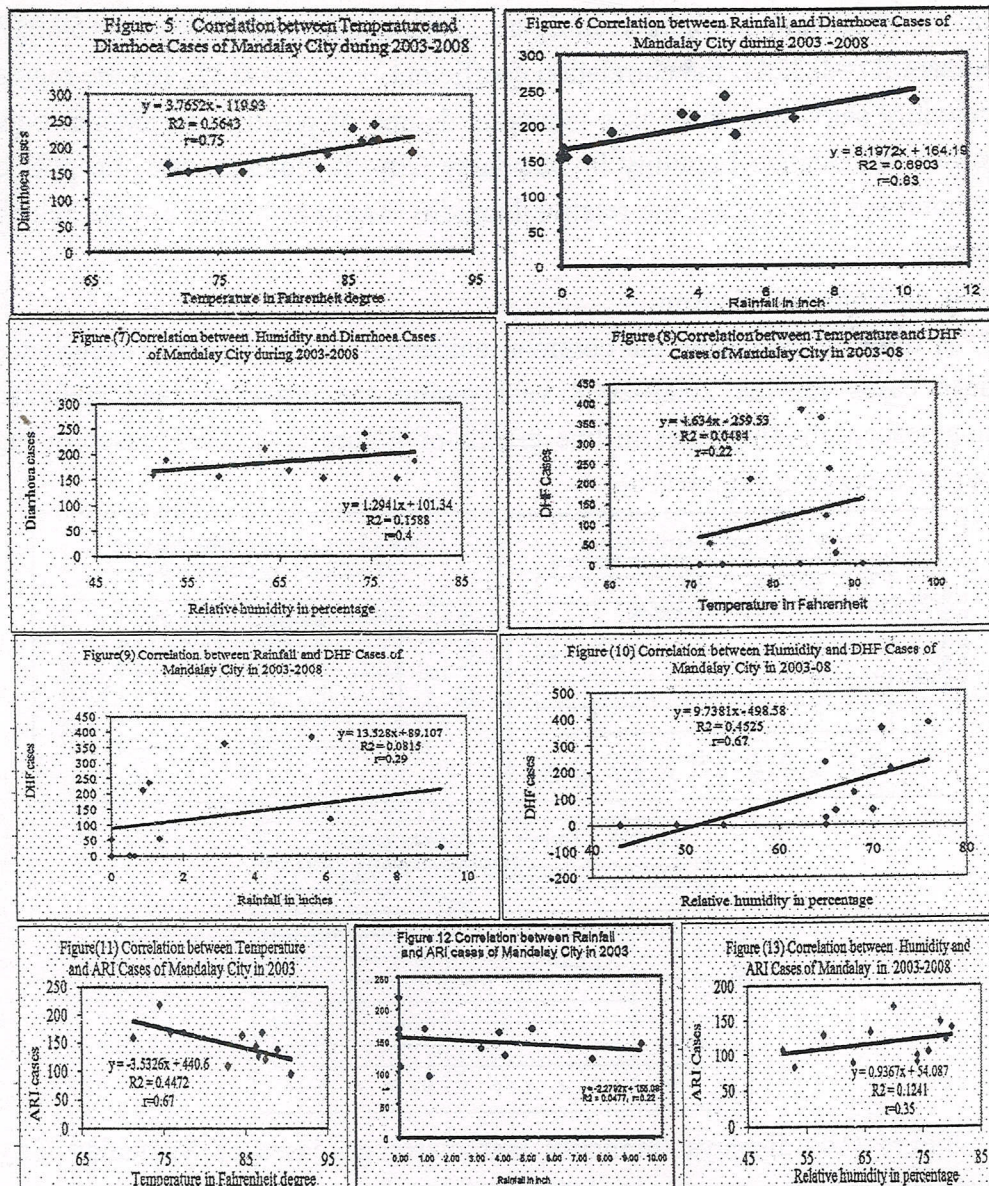
Regarding **DHF** case, the analysis and the results are mentioned in Figure 8, 9, and 10. In the Figure (8), the regression line, the equation  $y = 4.634x - 259.53$ , the



determinant  $R^2=0.0484$ , and the correlation coefficient  $r=0.22$  distinctly reveal that there is a low degree of positive correlation between *temperature and DHF* cases. It refers to weak relation between them although occurrence of DHF cases depends on temperature. Figure (9) implicitly describes that there is a low degree of positive correlation between *rainfall and DHF* cases. It is indicated by the regression line, the regression equation  $y = 13.528x + 89.107$ , the determinant  $R^2=0.0815$ , and the correlation coefficient  $r=0.29$ . It is found that the relation is weak although DHF occurrence is directly related with rainfall. It means that the occurrence of DHF cases is not related even moderately with rainfall in Mandalay City. Between *DHF cases and relative humidity*, significant







relation is indicated by the regression equation  $y = 9.7381x - 498.58$ , the determinant  $R^2 = 0.4525$ , the correlation coefficient  $r = 0.67$ , and the regression line, which show that there is a high degree of positive correlation between those two variables. In other words occurrence of DHF cases are directly related with relative humidity in Mandalay City. It means the higher the relative humidity, the more the occurrence of DHF increases.

In ARI case, it is analyzed in figure 11, 12, and 13. In Figure (11), the regression equation  $y = -3.5326x + 440.6$ , the determinant  $R^2 = 0.4472$ , the correlation coefficient  $r = 0.67$ , and the regression line show clearly that there is a high degree of negative correlation between *temperature* and *ARI* cases. It means that the two variables are inversely related i.e., the higher the temperature, the less the occurrence of ARI cases in Mandalay City. In figure 12, the regression equation  $y = -2.2792x + 165.08$ , the determinant  $R^2 = 0.0477$ , the correlation coefficient  $r = 0.22$ , and the regression line show clearly that there is a low degree of negative correlation between rainfall and ARI cases. It means that the occurrence of ARI cases decreases when the



amount of rainfall becomes larger. In figure 13 the equation  $y = 0.9367x + 54.087$ , the determinant  $R^2 = 0.1241$ , the correlation coefficient  $r = 0.35$ , and the regression line certainly show that there is a moderate degree of positive correlation between ARI cases and relative humidity in Mandalay City. It indicates that the ARI cases occur more and more when the relative humidity becomes higher but the relation is not strong.

### Analysis on Epidemic Season

In order to determine the common epidemic season, monthly occurrences of diarrhoea cases for the 2003~2008 year period are organized and analyzed by inserting season-dividing lines in line graphs of Figure (14), DHF cases in Figure (15), and ARI cases in Figure (16).

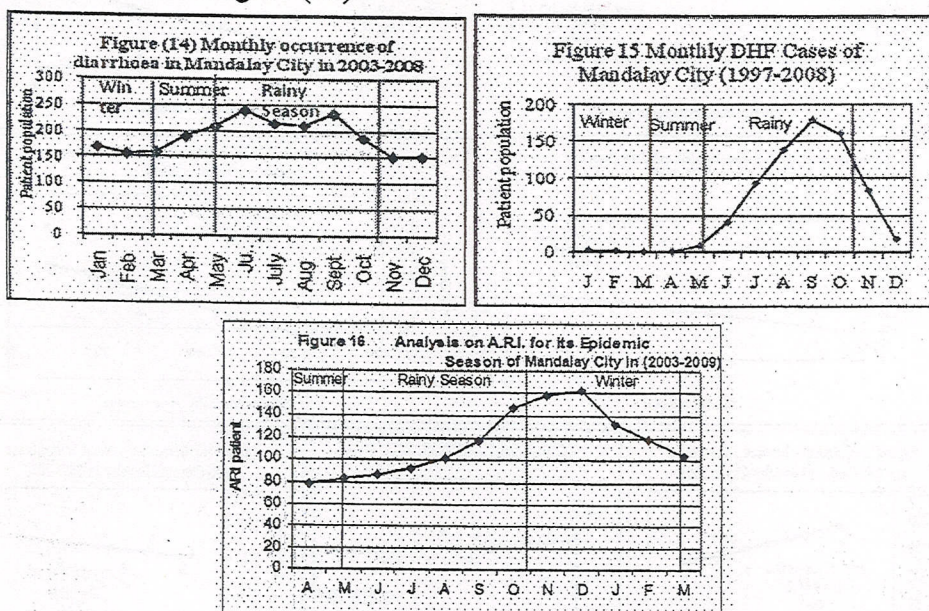


Figure (14) displays implicitly that diarrhoea cases of Mandalay City are found mostly in rainy season, especially maximum occurrences in June or September. Figure (15) shows that *epidemic season of DHF in Mandalay is in rainy months, particularly August, September and October, and it reaches its maximum in September*. Therefore, it can be identified that DHF prevails mostly in rainy season with a few occurrence in the transition period of winter to summer and summer to rainy season. Figure (16) indicates clearly that the highest ARI cases usually occur in December and the *epidemic season* of ARI in Mandalay City prevails in the late rainy season to the first half of the winter. If the research is summarized, the following results and findings are presented.

### Finding and Result

- (1) Regarding epidemic seasons, diarrhoea cases occur mostly in the rainy season with two peaks in June and September; DHF cases are dominant in late rainy season with peak in September; and ARI cases are mostly found in the period from the late rainy season to the early winter season with a maximum in December.
- (2) Regarding the relation between each seasonal disease and each of some climatic elements, in the case of diarrhoea it is found that the disease occurs more and



more when temperature, rainfall, and relative humidity increase, and it is correlated highly with rainfall ( $r=0.83$ ) and temperature ( $r=0.75$ ), but moderately with relative humidity ( $r=0.4$ ).

In the case of DHF, it is found that the occurrence of the disease increases with the three climatic elements but the correlation is low in temperature ( $r=0.22$ ) and rainfall ( $r=0.29$ ) and high in relation with relative humidity ( $r=0.67$ ) for the year 2003-2008 year).

In the case of ARI, it is found that the occurrence of the disease becomes lower when temperature and rainfall amount become higher, i.e. they are reversely related, and that the disease increases directly with relative humidity, but the correlation is high in temperature ( $r=0.67$ ), low in rainfall ( $r=0.22$ ), and moderate in relative humidity ( $r=0.39$  for the year 2003 and  $r=0.35$  for the 2003-2008 year).

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# **Headward Erosion of Fingertip Streams in the Mondaing Creek Basin in Meikhtila Area**

Win Win Nyunt

## **Abstract**

The title of research paper is "Headward erosion rate of fingertip streams in Mondaing Creek in Meikhtila Area". The study area lies in the western part of Meikhtila Township in the Dry Zone of Central Myanmar and has BSh types of climate with an average annual rainfall of 32.07 inches. Surface soils of this area are primitive crushed stone soil and yellow brown savanna soil with subsurface stratum of sandstone layer. In this area, headward erosion of 21 of Mondaing Creek was investigated during the 2004-2006 period. According to the study, it is found that average headward erosion rate is 11.47 metres per month in those of Mondaing Creek. As a final result, it is found that the gentler the slope, the greater the headward erosion rate of fingertip stream in this study area.

Key words: headward erosion, fingertip stream, Mondaing creek

## **Introduction**

This research has studied on the headward erosion of some fingertip streams in Mondaing Basin Creek in Meikhtila Area. The study area lies in the western part of Meikhtila Township. The initial heads of fingertip streams in Mondaing creek vary with the effects of environment such as climate, soil, slope and vegetation and time.

In the study area, 21 fingertip streams of Mondaing creek have been studied. Of these, 9 sites are on the left side and 12 sites are on the right side of Mondaing Creek. To describe initial heads, slope form parameters (angle, length and direction) have been measured by using G.P.S and abney level at a side.

Field work has been carried out in Meikhtila area starting from 2004 February to 2006 July. Regarding initial heads of fingertip streams and finding of headward erosion rates are analyzed by deductive method, inductive method and regression method.

## **Aim and Objective**

Aim of this research is to find general relationship between headward erosion and one of physical and human impacts such as lithology, gradient, vegetation cover, cultivated land and aspects.

Objective of this research is to measure and record the gradients and erosion rates of fingertip streams in Mondaing Creek in the western part of Meikhtila area.

## **Methodology**

Firstly, collections of 1:25000 scale topo-maps printed in 1953 and 1:40,000 scale aerial photographs were made. Based on these maps, sample fingertip streams heads were tentatively chosen and marked on the base maps.

Secondly, sample stream head sites were observed and all of necessary parameters were measured in detail at each site, by using GPS, abney level, clinometers, magnetic compass, measuring tapes, spirit level and camera. This type of



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