Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2018, 5(3):166-180**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Impact of Climate Variability on Human Health- A Case Study at Kanchanpur Union, Basail, Tangail District, Bangladesh

Rahman ML[1], Hossain ATMS[1], Terao T[2], Khan SI[3]

[1]Engineering Geology, Geotechnics&Geohazards (EGG) Research Group, Department of Geological Sciences, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh.
[2]Kagawa University, Japan
[3]GRAM BANGLA, Kanchanpur, Basail, Tangail, Bangladesh

Abstract The research paper discusses the changing pattern of climatic conditions (Particularly temperature and rainfall) with health hazards and finally discusses the impact of climatic variability on human health. The study was conducted on the basis of rainfall, temperature and health related disease data. The study revealed that in Tangail district, maximum and minimum temperature had increased and average rainfall had decreased gradually during last 28 years (1987-2014). The study shows that an average annual maximum and minimum temperature increase of 0.460° C and 0.005°C respectively. The long-term changes in annual average rainfall in Tangail is marked by a declining trend in which the slope of regression line is -1.061. It is clearly established that the highest temperature (both maximum and minimum) is found in monsoon season and the second highest is in pre-monsoon season from 1987-2014. By analyzing the health data, it is established that the highest number of patients suffering water borne diseases are in monsoon season for each of the year from 2010 to 2014 and pre-monsoon is the second contributor for increasing the number of patients. So it is observed that increasing the rainfall pattern especially in monsoon season affects to increase the number of patients in the area. Because of the high temperature in pre-monsoon season and the relatively heavy rainfall at the end of pre-monsoon and beginning of monsoon, the waterborne diseases spread rapidly all over the area.

Keywords Climate change, health hazards, diseases, rainfall, temperature variation

Introduction

Bangladesh is a low lying country and located at the interface with Bay of Bengal to the south and Himalayas to the north. Bangladesh is experiencing severe climatic impact on health and livelihood like other countries (viz. Nepal, South Africa) in the world [1].

Figure 1: Scenario of the investigated area during monsoon period

The investigated area is fully inundated by surface water more than six months and peoples are affected by number of water borne diseases during monsoon and post monsoon periods. No detail work has yet been done to see the impacts of climate change on human health of the peoples of Kanchanpur Union, Basail Upazila, Tangail District.

Mohit and Mustafa [2], Ahmed and Rahman [3] & Mboera et al., [4] discussed the Impact of climate change on human health and health systems in Tanzania. They discussed that a number of climate associated infectious disease epidemics have been reported in various areas of the country; mostly being associated with increase in precipitation and temperature. They also noted that change in temperature and rainfall patterns may affect the prevalence of diseases such as water-borne diseases like diarrhea, cholera, kalazar, dysentery etc. and create health hazards [5]. In this research, an attempt has been made to see the impact of rainfall and temperature on human health of the study area. Kanchanpur area is a union of Basailupazila in Tangail district (Figure 2). It is located between 90˚30' to 90˚35' N latitude and 24˚10' to 24˚15' E longitude. A location map of the study area is shown in Figure 2.

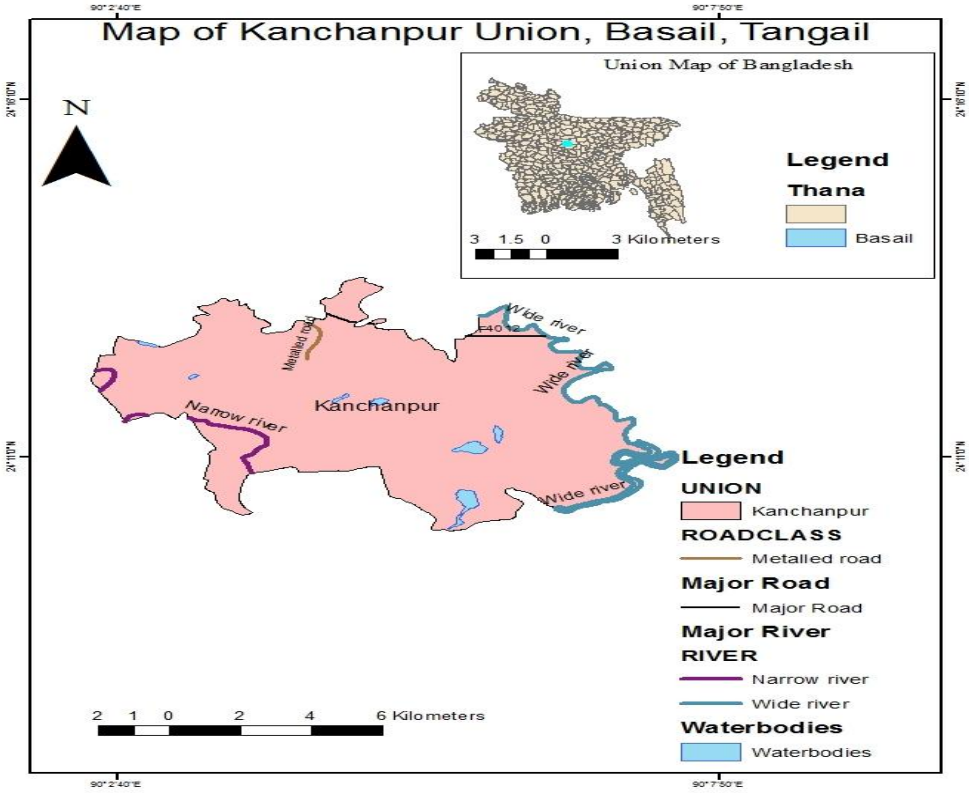

Figure 2: Location map of study area

Materials and Methods

The daily and monthly climatic data (temperature, rainfall data) of Tangail area for 28 years (1987-2014) were collected from climate division of Bangladesh Meteorological Department (BMD). The weather station (Tangail) data were collected on the basis of uniform spatial distribution and availability of maximum data length accuracy. From meteorological point of view, there are four distinct seasons in Bangladesh – winter season (December-February), Pre-monsoon season (March- May), Monsoon season (June- September) and Post-monsoon season (October-November) [6]. Water borne diseases like diarrhea, dysentery, abdominal pain, fever, helminthes and asthma data and number of patients affected from water borne diseases of Kanchapur union for 4 years (2010, 2012, 2013, 2014) were collected from Union Health and Family Welfare Center (UHFWC) manually. Then the collected data were analyzed by Microsoft Excel Package 2013. Climate factors such as yearly, seasonally and monthly maximum and minimum average temperature, rainfall and number of patients suffering from water borne diseases were compared and analyzed to find out the influence of climatic variability.

Results and Discussions

The climatic data contained monthly, annual average maximum and minimum temperature and annual rainfall for the period of 1987-2014. The data were analyzed to find out monthly, seasonal, decadal and annual changes.

Monthly variation of temperature and rainfall

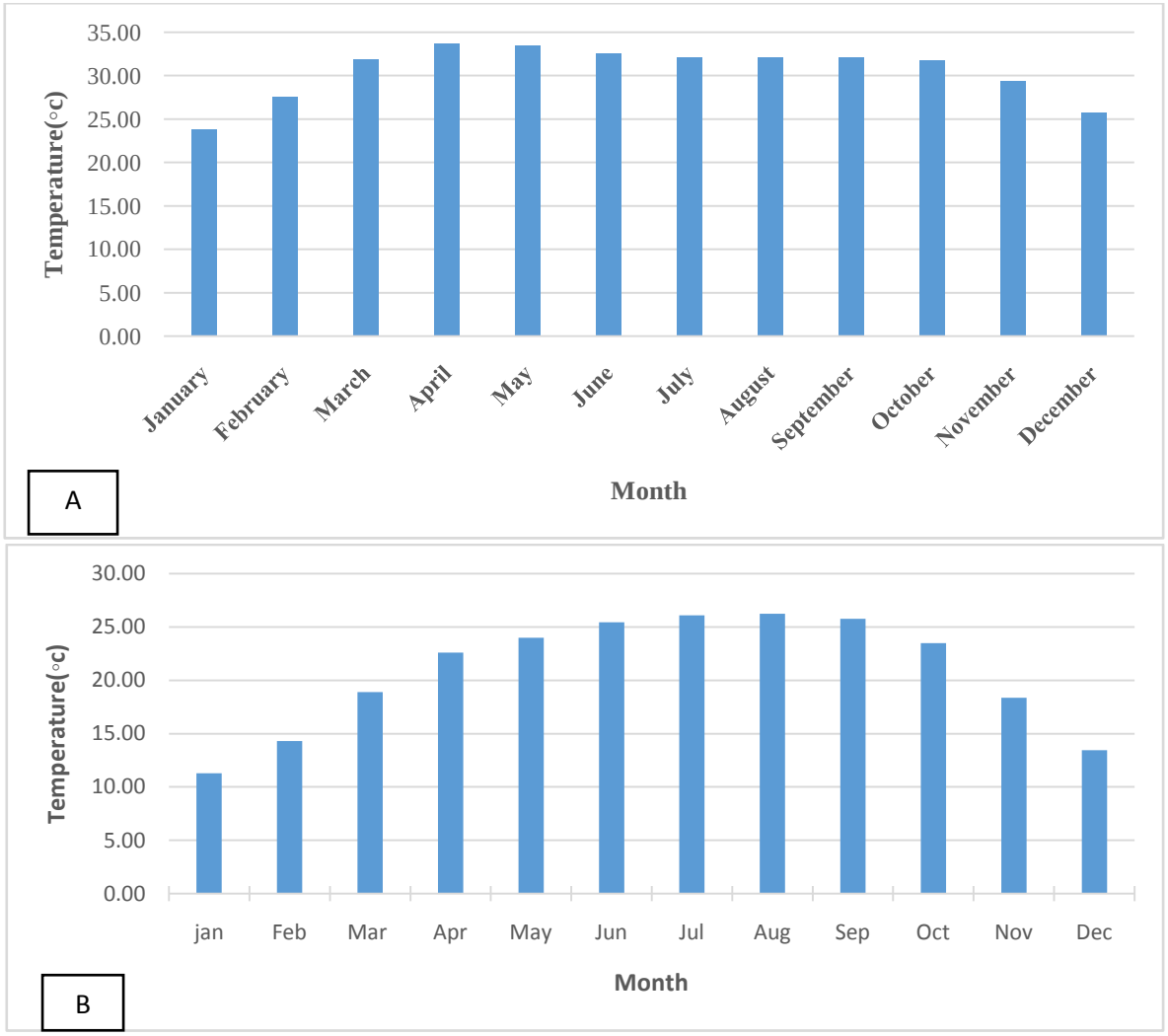

Figure-3: Long-term maximum (A) and minimum (B) monthly average temperature in Tangail from 1987-2014

Long-term maximum monthly average temperature remained high during pre-monsoon (March-April-May) (Figure-3A) while minimum monthly average temperatures were high in monsoon (June-July-August-September) (Figure-3B). The data shows that the highest maximum monthly average temperature was in April which was 33.67°C and next highest temperature was observed in May that was33.41°C while the highest minimum monthly average temperature was in August (26.25°C) and next highest minimum monthly average temperature in July, September and June were 26.10°C, 25.77°C and 25.45°C respectively. This is very much consistent with the long-term maximum and minimum average temperature in Rajshahi as discussed by Climate Change Cell (CCC) [7].

From Figure-4, it is clearly established that highest amount of rainfall is observed in the monsoonal period (June – September) and on the other hand, pre-monsoon and post-monsoon period very insignificant amount of rainfall are observed. Figure-4 illustrates that the highest amount of rainfall 317.36mm., 316.93mm., 266.50mm. and 279.25mm. are observed in June, July, August and September respectively. The second highest peak (252.68mm.) of rainfall occurs in May month of Pre-monsoon period. This result is very much similar with

variability and trends of summer monsoon rainfall over Bangladesh as discussed by Ahasan et al., [8]. But the significant amount of rainfall (157.46mm.) is observed in the October month of Post-monsoonal period.

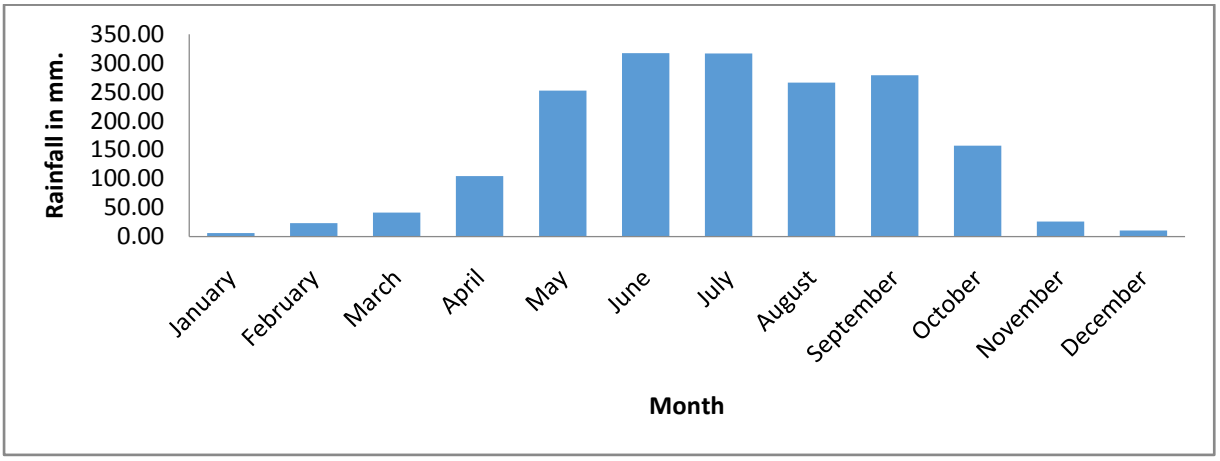

Figure 4: Long-term monthly variation of average rainfall in Tangail district from 1987-2014

Seasonal Variation of Temperature and rainfall

The seasonal trend analysis of temperature during last 28 years based on observed data of Tangail are discussed below-

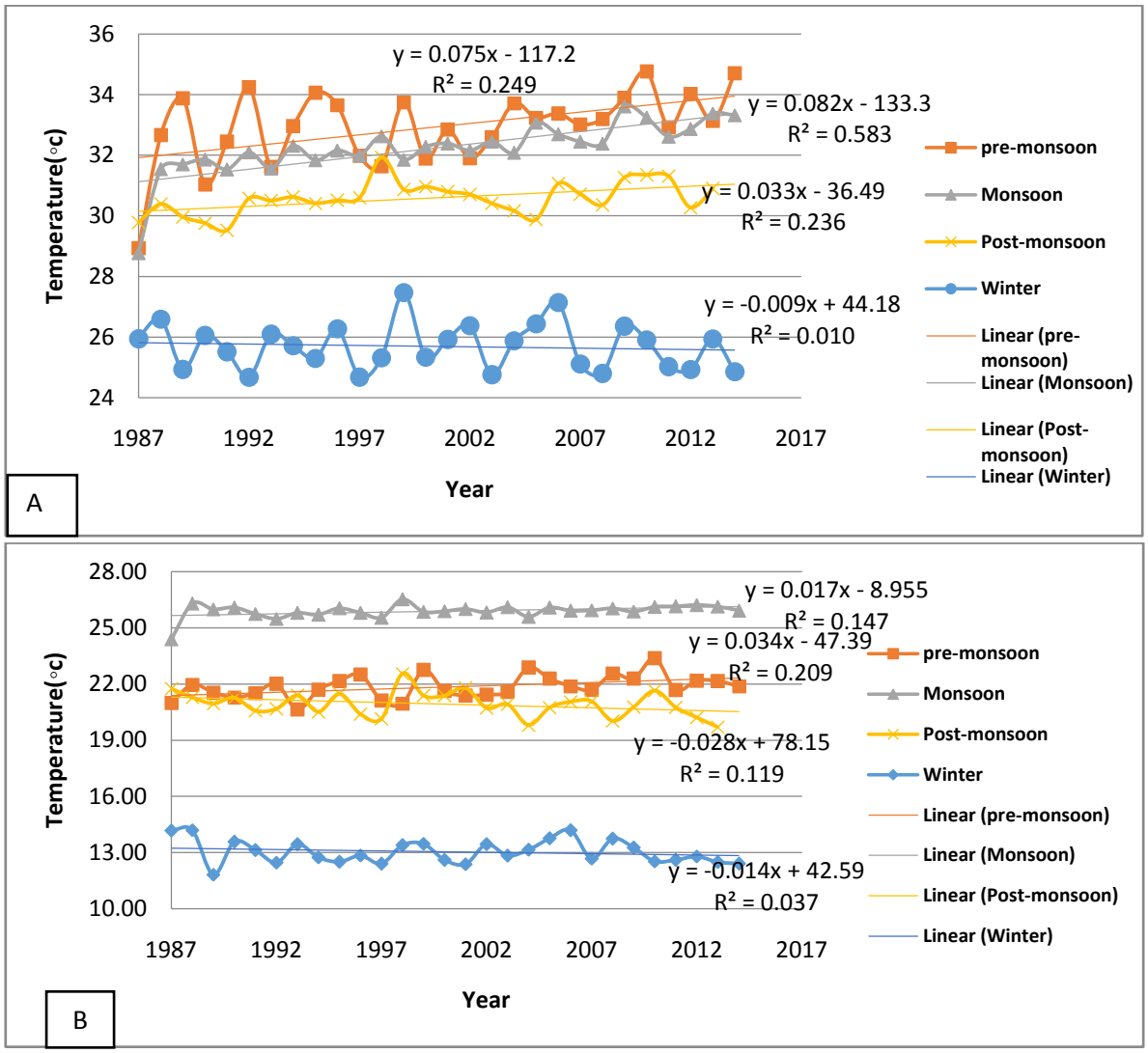

Figure 5: Seasonal variation of maximum (A) and minimum (B) average temperature from 1987-2014

From Figure-5(A), it is observed that out of four (4) seasons of maximum average temperature, an increasing trend is observed in Pre-monsoon, Monsoon and post-monsoon whereas a decreasing trend is observed during winter season.

From Figure-5(B), it is observed that out of four (4) seasons of minimum average temperature, the increasing trend is shown in Pre-monsoon and monsoon seasons while other two seasons like Post-monsoon and winter seasons show decreasing trend.

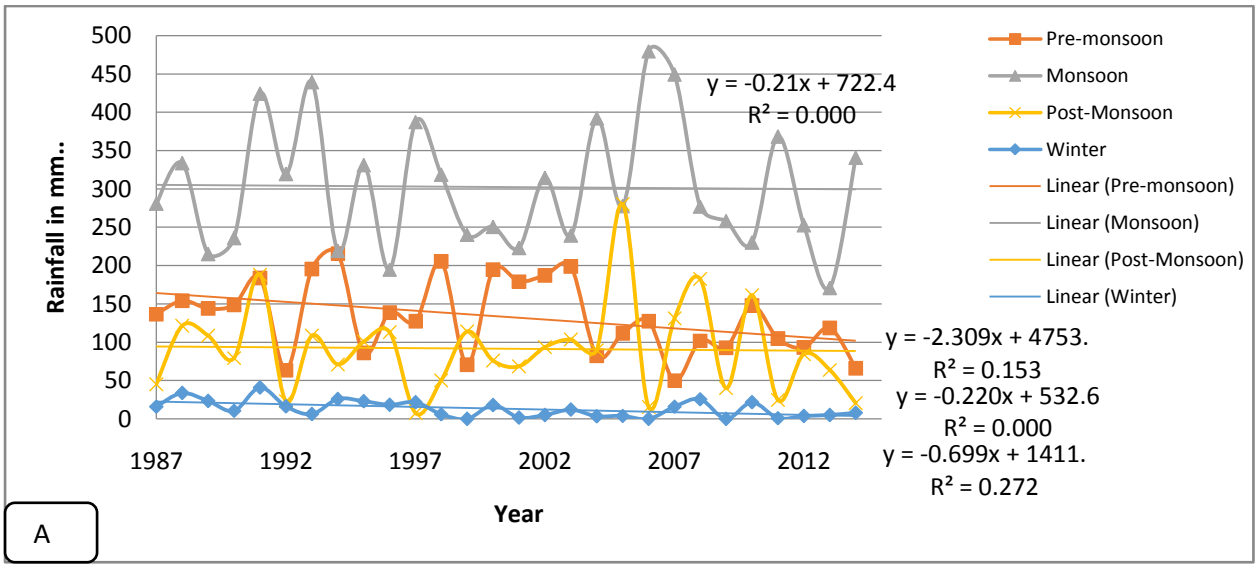

Figure 6(A): Seasonal variation of rainfall data in Tangail from 1987-2014

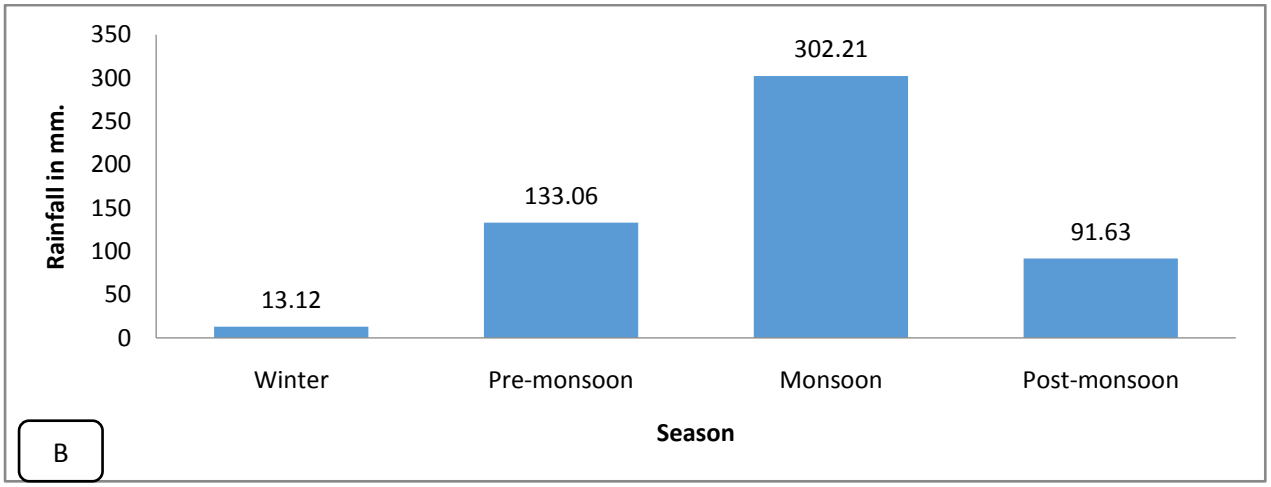

Figure 6: B) Seasonal distribution of average rainfall in Tangail from 1987-2014

Figure-6: A) Seasonal variation and B) seasonal distribution of average rainfall in Tangail districts from 1987-2014

From Figure-6(A), a trend analysis over Tangail for 28 years (1987 – 2014) shows decreasing trend for all four seasons. For monsoon and post-monsoon seasons, the linear trend is slightly decreasing trend associated with slope of regression -0.21 and -0.2204 respectively, whereas the trends of winter and pre-monsoon seasons are showing high decreasing trend slope of regression -0.6991 and -2.3095 respectively.

From Figure-6(B), it is clearly observed that the highest average rainfall (302.21mm..) is in monsoon period, the second highest (133.06mm..) is in pre-monsoon period, 91.63mm.. and 13.12mm.. are from post-monsoon and winter period respectively.

Seasonal variations of temperature and rainfall data for different years from 2010 to 2014 are shown in the following graphs (Figure-7 A, B, C)

Figure 7: Seasonal variation of average (A) maximum temperature, (B) minimum temperature and (C) rainfall variation from 2010 to 2014

It is clearly established from this graphical presentations, monsoon period is major contributor for making highest temperature for both Figures-7(A) and (B) while pre-monsoon and post-monsoon are also responsible for this. From Figure-7(A), in monsoon period, the highest (33.38°C) temperature is found in 2013 and second highest (33.32°C) is in 2014. In pre-monsoon period, the highest (34.76°C) temperature is found in 2010 and second one (34.70°C) is in 2014. In post-monsoon period, the highest (31.35°C) temperature is observed in 2010 and second one (30.90°C) is found in 2013. In winter period, the highest (25.93°C) temperature is observed in 2013 and second one (25.91°C) is at 2010.

From Figure-7(B), in monsoon period, the highest (26.14°C) temperature is found in 2013 and second one (26.12°C) is found in 2012. In pre-monsoon period, the highest (23.37°C) temperature is found in 2010 and second one (22.17°C) is in 2012. In post-monsoon period, the highest (21.64°C) temperature is found in 2010

and second one (20.21°C) is found in 2012 and 19.70°C is in 2013. In winter period, the highest (12.79°C) temperature is observed in 2012 and second one (12.53°C) is found in 2010.

From Figure-7(C), it is observed that monsoon period is showing higher amount of rainfall than other seasons in each year from which the highest (340.75mm.) rainfall is observed for the year of 2014. Then 252.5mm., 230mm. and 170.75mm. rainfall are observed for 2012, 2010 and 2013 respectively.

Decadal variation of temperature and rainfall

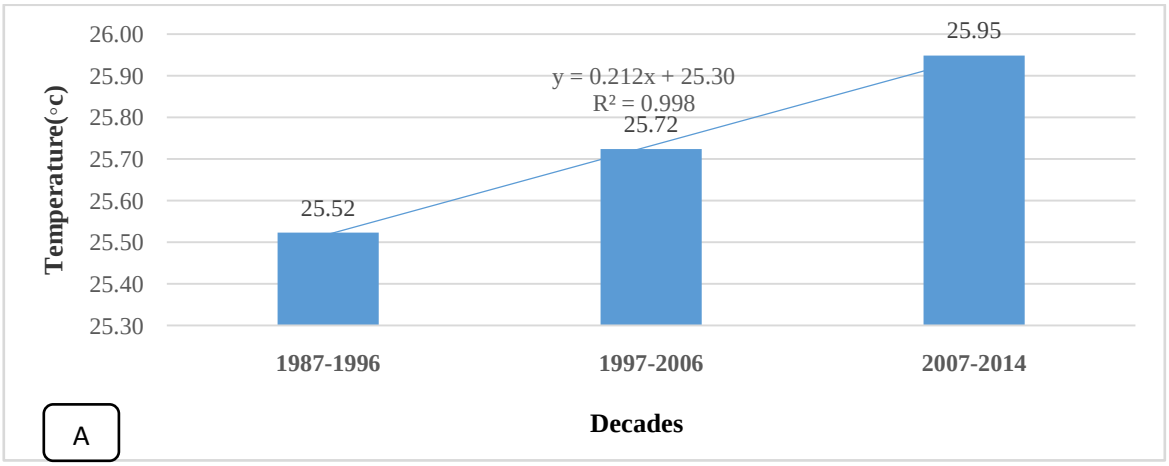

Figure 8(A): average temperature

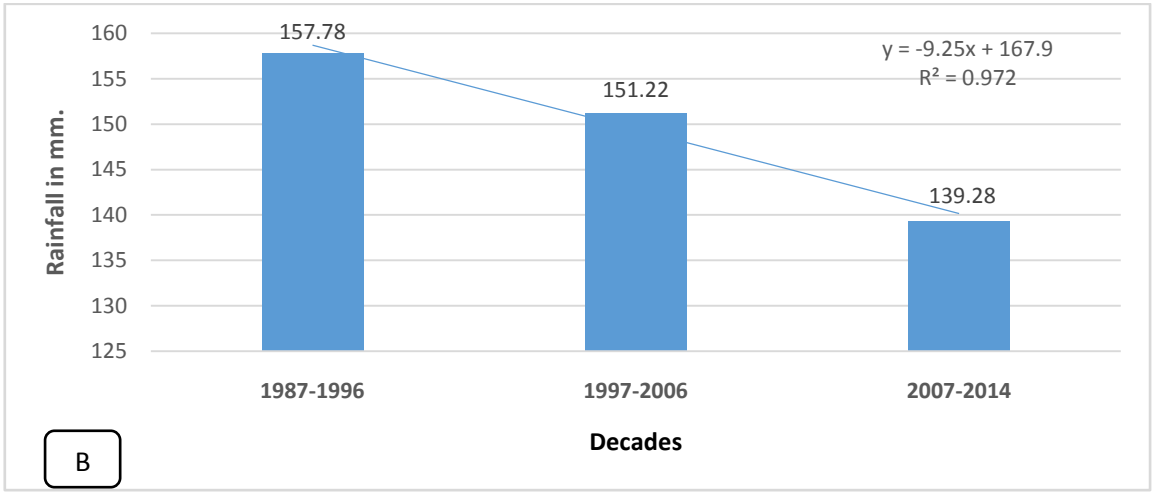

Figure 8(B): average rainfall

Figure 8: Decadal Variation of (A) average temperature and (B) average rainfall

An attempt has also been made to see the decade variation of temperatures as shown in Figure-8. Maximum (25.95°C) average temperature was recorded in the recent rears (2007-2014) and minimum (25.52°C) was recorded in 1987-1996. Decades average temperature from 1997-2006 was 0.2°C higher compared to 1987-1996. So, the slope of temperature variation in Tangail is 0.212 showing an increasing trend (Figure-8A). This is consistent with the decadal temperature variation of Cox's bazar area as discussed by Mahadi and Hossain [9].

From Figure-8(B), it is observed that Maximum (157.78mm.) average rainfall is recorded in the years of 1987-1996 and minimum average rainfall (139.28mm.) is in 2007-2018. Decade's average rainfall in the years 1987-1996 is 6.56mm. is higher compared to 1997-2006. So, the decade rainfall showing a decreasing trend in Tangail with a slope of - 9.25.

Annual Variation of temperature and rainfall

Annual mean maximum temperature of the area for the years (1987-2014) is shown in the following Figure-9A, 9B & 9C. A linear trend is established to determine the major changes of temperatures in the investigated area.

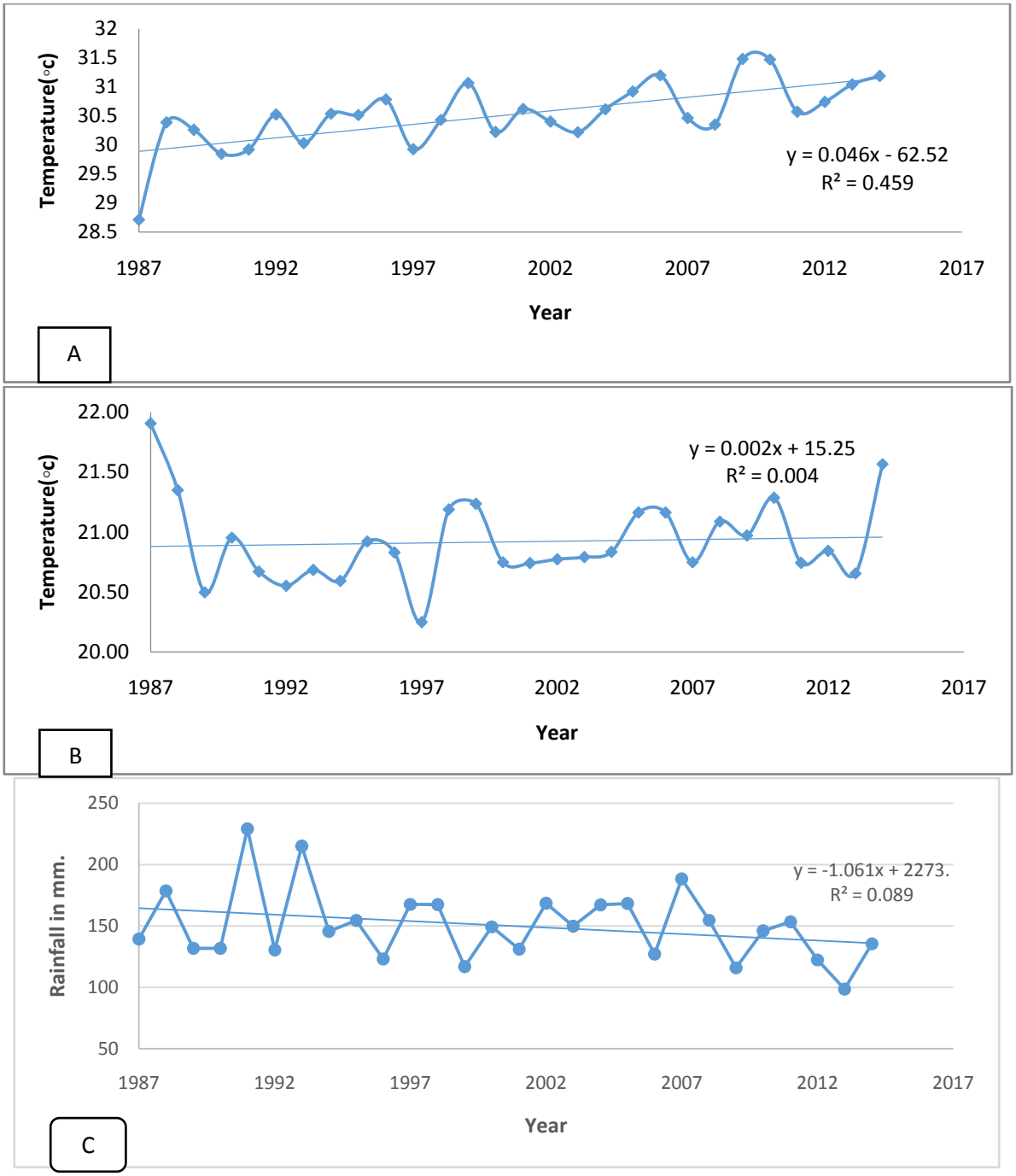

Figure 9: Annual average temperature and rainfall variations of Tangail; A) Maximum temperature, B) Minimum temperature, C) Rainfall amount from 1987-2014

The long-term changes of annual average maximum and minimum temperatures show an increasing trend while annual average rainfall pattern shows a decreasing trend over the study period (1987-2014) (Figure-9C). From Figure-9(A), it shows an average annual maximum temperature increase of 0.0465° C (slope of regression line) over the mentioned period and the highest value is in 2010 which is 31.47°C and the lowest in 1987 is 28.71°C. From Figure-9(B), the long-term changes in annual minimum temperature are also marked by a rising trend. In this case, it is increased, on average, by 0.0028°C. The highest point of average minimum temperature is in 1987 which is 21.90°C. Then the temperature was declined gradually before 1989. After that temperature was fluctuating. But overall trend is rising. The lowest point is in 1997 which is 20.25°C.

From the drawn Figure-9(C), rainfall pattern showing a decreasing trend of about -1.0614 is in Tangail area for the years from 1987-2014. The highest average rainfall (229 mm.) is found for the year of 1991and the lowest one is 98.5mm. in 2013. It is clearly established that the amount of precipitation shows a decreasing trend from 1987 to present time in Tangail area.

Health Hazards Data Analysis

Secondary data and information on some of the major climate sensitive diseases (e.g. diarrhea, dysentery, abdominal pain, fever, helminthes, asthma) were collected from local Union Health and Family Welfare Center (UHFWC) Kanchanpur, Basail, Tangail. The monthly incidence of diarrhea, dysentery, abdominal pain, fever, helminthes, and asthma over the period 2010-2014 was provided by the UHFWC.

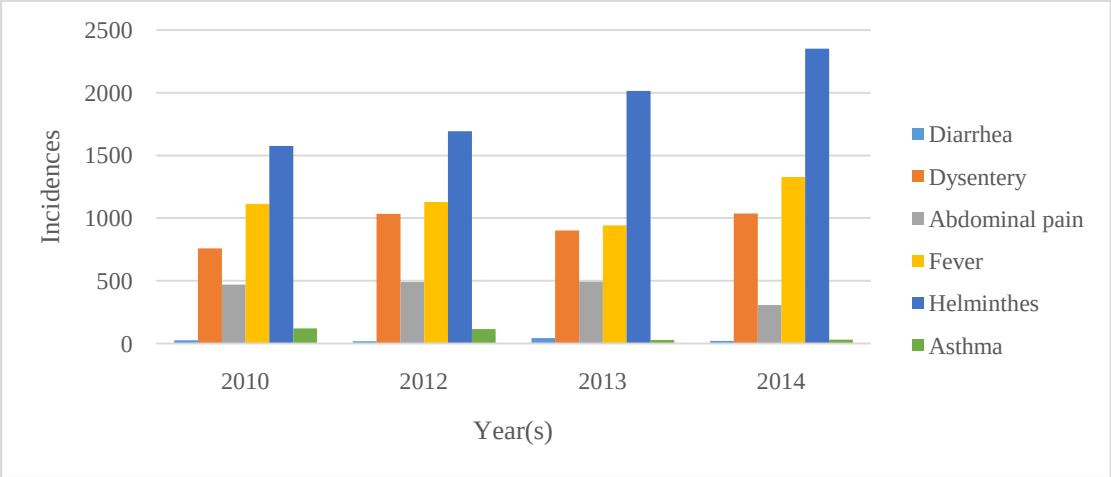

Figure 10: Trend of climate sensitive diseases in Kanchanpur area, Basail, Tangail

The pattern of occurrences of all three types of diseases show an increasing trend during 2010-2014. It can be seen from Figure-10, an increasing pattern of dysentery, fever and helminthes is observed. The highest incidence (1036) of dysentery was observed in 2014 while the lowest occurrence (759) in 2013. The highest incidence (1328) of fever was observed in 2014 while the lowest occurrence (942) in 2013. The highest incidence (2352) of helminthes was observed in 2014 while the lowest occurrence (1576) in 2010.

The pattern of occurrences of other three types of diseases show decreasing trend during 2010-2014. From the Figure-10, decreasing trend of abdominal pain, asthma and diarrhea is observed. The highest incidence (494) of abdominal pain was observed in 2013 while the lowest occurrence (307) in 2014. The highest incidence (115) of asthma was observed in 2012 while the lowest occurrence (30) in 2014. The highest incidence (44) of diarrhea was observed in 2013 while the lowest occurrence (18) in 2012.

Seasonal occurrences of all six types of diseases in each year over the period 2010-2014 were also observed. Occurrences of most of the diseases are remained highest during monsoon period.

Diseases data in percentages for different seasons are also presented in the following diagrams to understand the overall scenario. Distribution of specific climate sensitive diseases in different seasons and shown in Figures-11(A) to 11(F). Seasonal variation of number of patients in different years is shown in Figure-11(G).

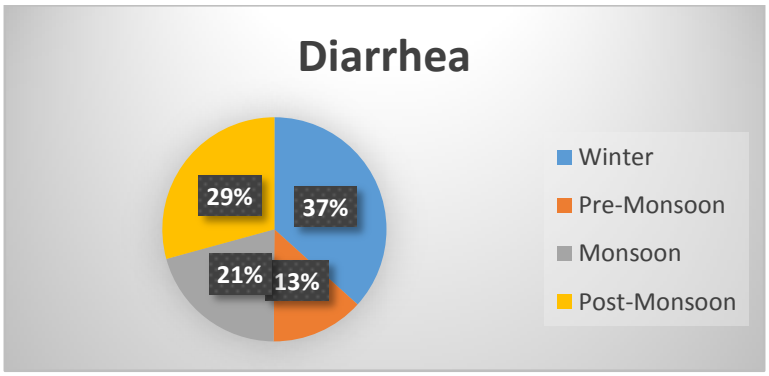

Figure 11(A): Seasonal variation of Diarrhea disease from 2010-2014

From Figure-11(A), the highest incidence (37%) of diarrhea was observed in winter season while the lowest (13%) in pre-monsoon season. The incidence of second highest (29%) of diarrhea was observed in post-monsoon season and 21% in monsoon season.

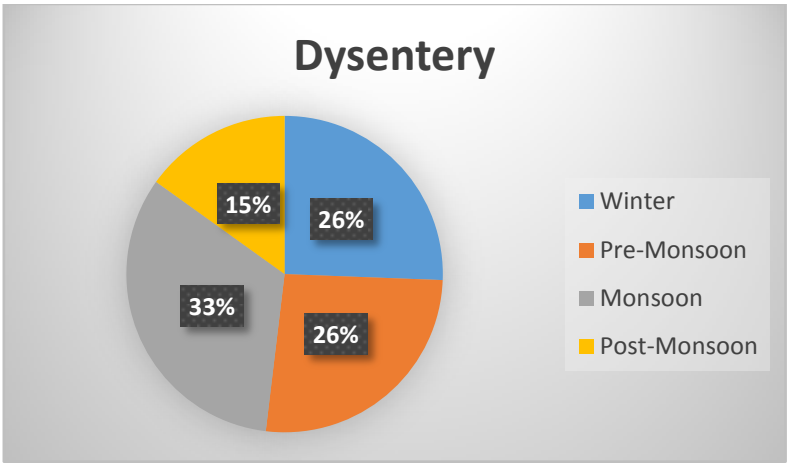

Figure 11(B): Seasonal variation of Dysentery disease from 2010-2014

From Figure-11(B), the highest incidence (33%) of dysentery was observed in monsoon season while the lowest (15%) in post-monsoon season. The incidence of second highest (26%) of dysentery was observed in pre-monsoon season and winter season.

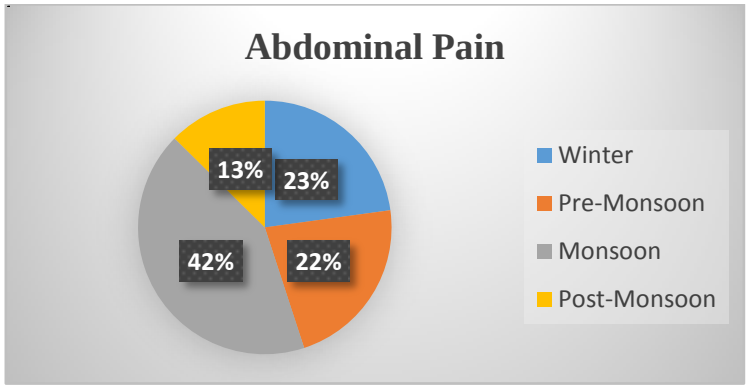

Figure 11(C): Seasonal variation of Abdominal Pain from 2010-2014

From Figure-11(C), the highest incidence (42%) of abdominal pain was observed in monsoon season while the lowest (13%) in post-monsoon season. The incidence of second highest (23%) of abdominal pain was observed in winter season and 22% in pre-monsoon season.

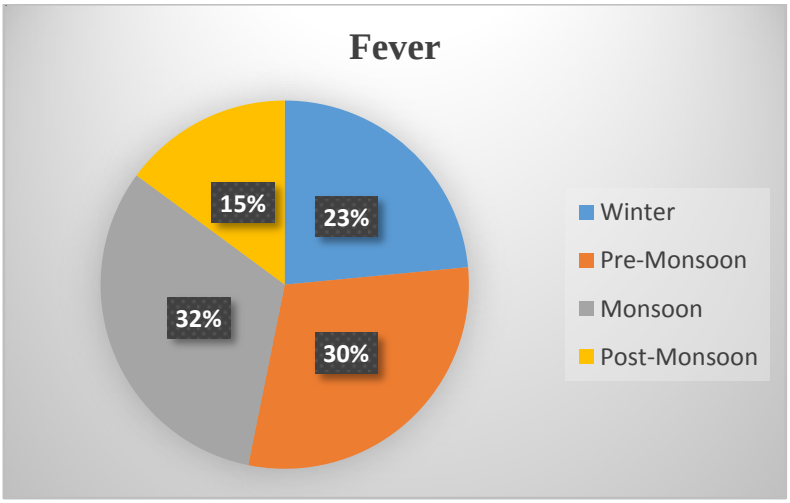

Figure 11(D): Seasonal variation of Fever from 2010-2014

From Figure-11(D), the highest incidence (32%) of fever was observed in monsoon season while the lowest (15%) in post-monsoon season. The incidence of second highest (30%) of fever was observed in pre-monsoon season and 23% in winter season.

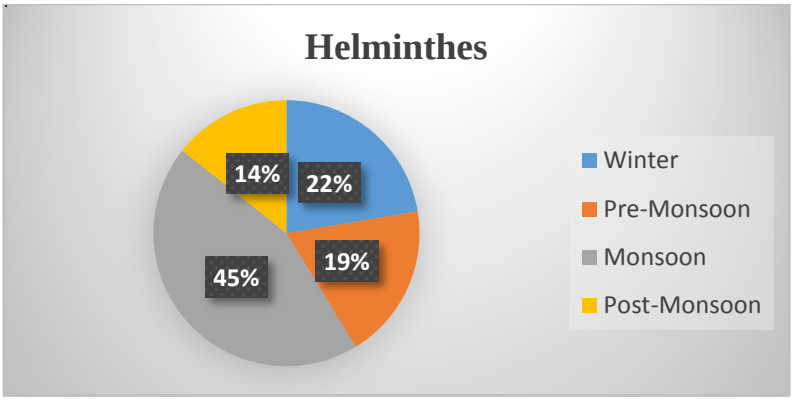

Figure 11(E): Seasonal variation of Helminthes from 2010-2014

From Figure-11(E), the highest incidence (45%) of helminthes was observed in monsoon season while the lowest (14%) in post-monsoon season. The incidence of second highest (22%) of helminthes was observed in winter season and 19% in pre-monsoon season.

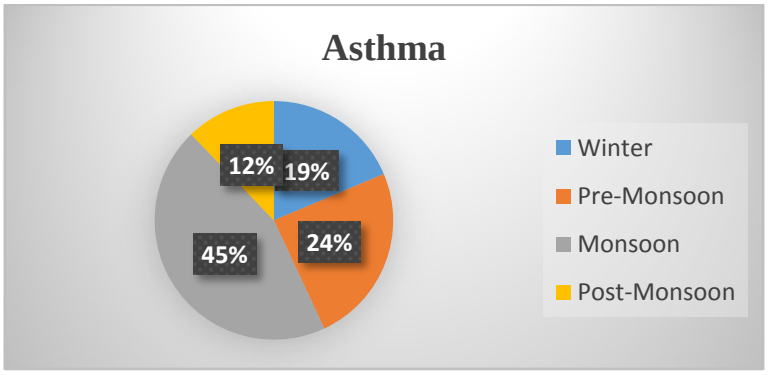

Figure 11(F): Seasonal variation of Asthma from 2010-2014

From Figure-11(F), the highest incidence (45%) of asthma was observed in monsoon season while the lowest (12%) in post-monsoon season. The incidence of second highest (24%) of asthma was observed in pre-monsoon season and 19% in winter season.

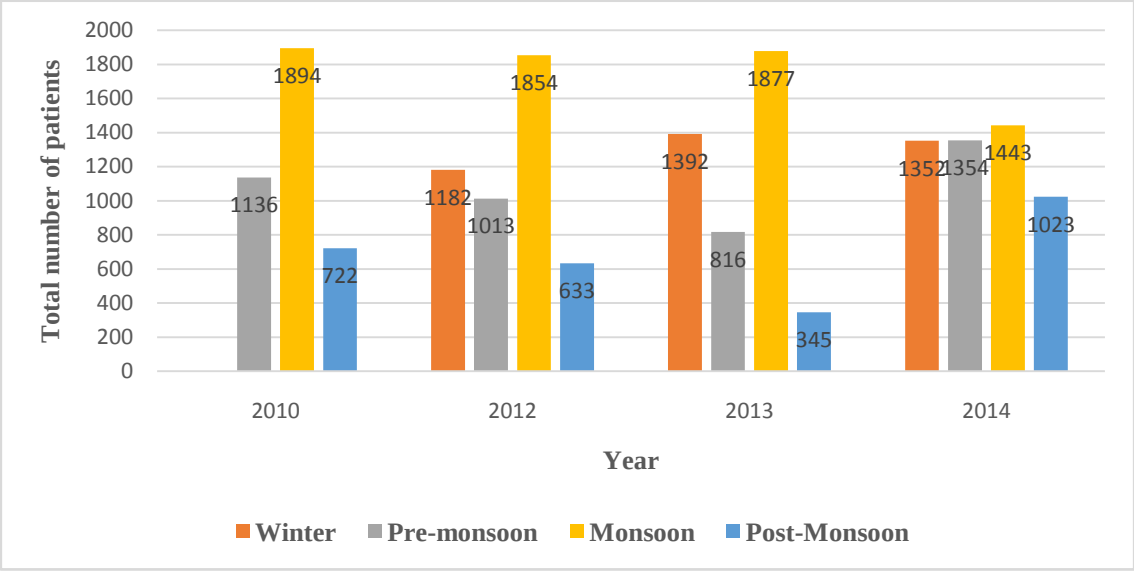

Figure 11(G): Seasonal variation of number of patients from 2010-2014

An attempt has also been made to understand the seasonal variations and number of patient's data with individual seasons. It is clearly established from Figure-11(G), in 2014, the monsoon season is showing the highest number of patients in each year. It is observed that the highest number of patients (1443) are observed in monsoon and lowest is 1023 in post-monsoon. The number of patients in pre-monsoon (1354) and winter (1352) are comparative less.

In 2013, the monsoon season is showing the highest number of patients (1877) and post monsoon is showing lowest number (345) of patients in the year. In winter season, the number of patients is also increased to 1392 and in pre monsoon period, the number of patients is dropped to 816.

Also In 2012, the monsoon season is also showing the highest number of patients in the year, which is 1854 and lowest is 633 in post-monsoon. It is also observed that for this particular year, the total number of patients are 1182 and 1013 in winter and pre-monsoon respectively.

In 2010, the monsoon season is showing the highest number of patients (1894) in the year and the post-monsoon is showing lowest, which is 722. The number of patients in pre-monsoon season is 1136 which is slightly higher than post-monsoon season but lower than monsoon period. Based on the overall observations, an attempt has been made to establish the correlation between the rainfall pattern and number of patients during monsoon period as shown in Figure-12.

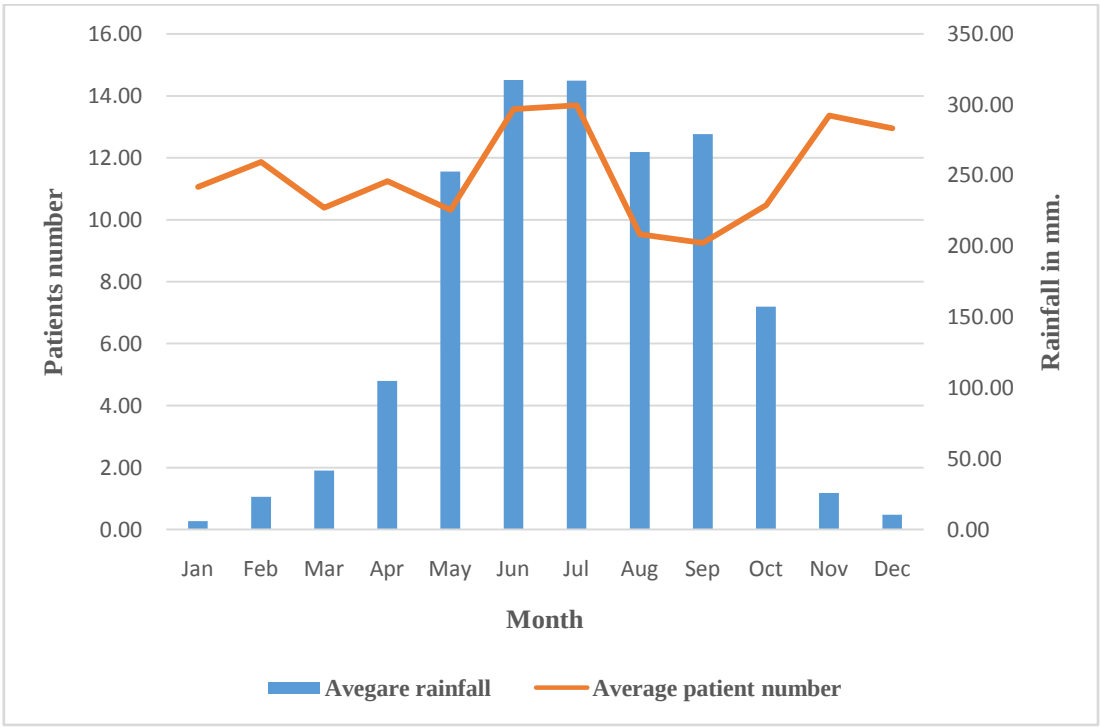

Figure 12: Correlation between average monsoonal rainfall and patient's number

From the Figure-12, it is clearly established that during monsoon period mainly June and July month, the number of patients are increased. Although monsoon is playing an important role to increase the patients number but pre-monsoon and post-monsoon are also responsible for increasing patient's number in the investigated area.

So from the overall analysis, it is clearly established that number of patents are increased during monsoon season, which might be the major contributor to create impact on health. The pre-monsoon is the second contributor for health hazards. Post-monsoon and winter seasons have little influence on health of the people of the study area.

Correlation between human health impacts and climate variables

To explore the association between climate variables and health impacts correlation was made using both secondary data. The results of the analysis are discussed below:

Climate factors such as seasonal and annual rainfall, annual average maximum and minimum temperature and some of the available climate sensitive diseases were analyzed to find out the linkage between climate data and

disease data to understand the overall impact of temperature and rainfall data on human health of the investigated area.

From monthly variation of temperature, Figure-9(A) and (B), it is clearly observed that the highest temperature (both maximum and minimum) is found in monsoon season and the second one is in pre-monsoon season from 1987-2014. From seasonal variation of temperature (Figure-5A), the monsoon (M=0.0751) and pre-monsoon seasons (M=0.0346) are also showing increasing trend of maximum temperature in the study area and from Figure-5(B), the monsoon season (M=0.0174) and pre-monsoon seasons (M=0.0346) are also showing increasing trend of minimum temperature in the study area. Figure-8(A) is also showing increasing trend (M=0.212) in terms of decade variations of average temperature. From Figure-9A and 9B, the trend of maximum (M=0.0465) and minimum (M=0.0028) temperatures are showing an increasing trend. By analyzing the health data, Figure-11(G) is also showing that the number of patients are highest in monsoon season from each of the year from 2010 to 2014 and pre-monsoon is the second contributor for increasing the number of patients.

From monthly variation of rainfall (Figure-4), it is clearly established that the highest rainfall (both maximum and minimum) is found in monsoon season and the second one is pre-monsoon season (May) from 1987-214 and from seasonal variation of rainfall (Figure-6A), the monsoon season is showing more or less straight line that is the trend is slightly decreasing (M= -0.21) and pre-monsoon season is also showing decreasing trend (M= -2.3095) in the study area and post-monsoon is giving decreasing trend (M= -0.2204) and winter season is also showing greater decreasing trend (M= -0.6991) than others. Figure-7(C) is illustrating the seasonal variation of average rainfall from 2010-2014 and it is clearly shown that the highest amount of rainfall is in monsoon season in each of the year and pre-monsoon season is showing the second highest rainfall amount. From annual variation of rainfall, Figure-(13C), the annual average rainfall is showing decreasing trend (M= -1.0614) and Figure-8(B) is also showing decreasing trend (M= -9.25) in terms of decade. Though the average rainfall trend is decreasing, the average rainfall in monsoon season of 28 years is the highest rainfall and pre-monsoon is the second followed by post-monsoon and winter season. By analyzing the health data, Figures-11(A-F) are also showing that the highest number of patients in most of the diseases are in monsoon season for each of the year from 2010 to 2014 and pre-monsoon is the second contributor for increasing the number of patients in most of the diseases. Only Figure-11(A) is showing the different situation that is winter season (37%) is the first and post-monsoon season (29%) is the second contributor to increase diarrhea disease.

From the overall analyses and above discussions, it is clearly established that monsoonal period is the main contributor for the increase in the number of patients suffering mainly from water borne diseases. After analysis of individual water-borne disease from 2010-2014, it can be seen that a higher percentage of patients suffer in monsoonal period than any other seasons. It relates with the effects of climate variables on Kala-zar Prevalence at Major Affected Districts in Bangladesh as discussed by Amin et al., [10]. It is also observed that pre-monsoon period is the second contributor for the increase in the number of patients of water borne diseases and other illnesses caused from various health related hazards in the study area. The result is more or less similar with the impacts of climate change on public health especially on Malaria in Rangamati, Sylhet and Faridpur districts as discussed by Amin et al., [11]. Because of the high temperature in pre-monsoon season and the relatively heavy rainfall at the end of pre-monsoon and beginning of monsoon, the waterborne diseases spread rapidly all over the area. So, it can be said that due to climate variability increasing the incidence of waterborne diseases and this result is very much consistent with the climate change and its impact on health in Bangladesh as discussed by Rahman [12]. Subsequently in the monsoon season, the situation deteriorates significantly with increasing number of patients and this spurt in number of patients continues till the beginning of post-monsoon season. The findings obtained in this study are very much consistent with the results discussed by Mboera et al., [4] in Tanzania.

Conclusion

The recent climate change and its variability on the human health in Kanchanpur union, Basail, Tangail district of Bangladesh has been evaluated in this research paper. For the better understanding of the variability of climatic conditions particularly temperature and rainfall, last 28 years (1987-2014) of secondary data of climatic

parameters and four (4) years of health data have been used of the study area. Average temperature was maximum (25.92˚C) in recent year 2007-2014 and the minimum (25.52˚C) in 1987-1996 whereas the average temperature of 1997-2006 was 0.2˚C higher and 0.23˚C lower than 1987-1996 and 2007-2014 respectively with the slope of 0.212.. Moreover, highest average rainfall (157.78 mm.) was recorded in 1987-1996 whereas 6.56 mm. higher than 1997-2006 and 18.5 mm. higher than 2007-2014 with a slope of - 9.25. So, this should be stated that average temperature is showing increasing trend and average rainfall is decreasing trend that is climate is showing variable nature. This research reveals that climate is showing variability in recent days (2007-2014) compared to last decades which is established by gradual increase and decrease of temperature and rainfall rate. It is established that climate has an impact on the human health in the investigated area mainly during monsoon period.

Finally, it also established that based on human health data analysis, number of patients were increased of about 1894 in 2010, 1854 in 2012, 1877 in 2013 and 1443 in 2014 year during monsoon period and monsoon is the prime season to increase health related hazards of the peoples of the study area. The pre-monsoon is the second dominating season to increase the number of patients suffering from water borne diseases. Post-monsoon and winter period have a little impact on health of the peoples of the investigated area.

Acknowledgement

This paper is part of the first author's M.S. thesis work submitted to the Department of Geological Sciences, Jahangirnagar University, Savar, Dhaka, Bangladesh. The author would like to acknowledge Department of Geological Sciences, Jahangirnagar University, Kagawa University, Japan and GRAM BANGLA Sangstha for providing their all supports, required permissions and facilities to carry out this research work. Thanks are also due to Union Health and Family Welfare Center (UHFWC), kamchanpur union, Basail, Tangail district for providing water borne diseases data of the study area.

References

[1]. Huq, S., 2001. Climate change and Bangladesh. Science, 294(5547), pp.1617-1617.

[2]. Mohit, M.A. and Mustafa, M.G., 1997. Institutional Development Programme for Local Level Flood Disaster Management and Rural Development in Bangladesh. Improved System for Disaster Mitigation and Environmental Management in Bangladesh.

[3]. Ahmed, M. F. and Rahman, M.M., 2008.Water supply and sanitation, ITN-Bangladesh. Center for water supply and waste management BUET, Dhaka, Bangladesh.

[4]. Mboera, L.E.G., Mayala, B. K., Kweka, E. J., and Mazigo, H. D. M., 2011. Impact of climate change on human health and health systems in Tanzania: a review, Tanzania journal of Health Research, Volume 13 (Supp11), Doi: http://dx.doi.org/10.4314/thrb.v13il.10.

[5]. Kistemann, T., Rechenburg, A., Höser, C., Schreiber, C., Frechen, T. and Herbst, S., 2012. Assessing the potential impacts of climate change on food-and waterborne diseases in Europe.

[6]. Ahasan, M. N., Chowdhury, M. A. M., and Quadir, D.A., 2008. Few aspects of the flood disaster caused by heavy rainfall over Bangladesh, Proceedings of SAARC Seminar on Application of Weather and Climate Forecasts in the Socio-economic Development and Disaster Mitigation, 05-07 August, 2007. Dhaka, Bangladesh, 79-94.

[7]. CCC, 2009.Climate Change and Health Impacts in Bangladesh. Climate Change Cell, DoE, MoEF; Component 4b, CDMP, MoFDM.

[8]. Ahasan, M. N., Chowdhary, M. A.M. & Quadir, D. A., 2010. Variability and trends of Summer Monsoon rainfall over Bangladesh, Journal of Hydrology and Meteorology, Vol. 7, No. 1.

[9]. Mahadi, A. and Hossain, A.T.M.S., 2014. Climatic Variations and Rainfall Induced Landslides Hazards of Cox's Bazar District, Chittagong, Banglaadesh. Bangladesh Geoscience Journal, Vol. 20, P. 1-18.

[10]. Amin, M.R., Tareq, S.M. and Rahman, S.H., 2015. Effects of Climate Variables on Kala-azar Prevalence at Major Affected Districts in Bangladesh. Journal of Environmental Science and Natural Resources, 6(1), pp.79-87.

[11]. Amin, M.R., Tareq, S.M. and Rahman, S.H., 2011. Impacts of climate change on public health: Bangladesh perspective. Global J of Enviro Res, 5, pp.97-105.

[12]. Rahman, A., 2008. Climate change and its impact on health in Bangladesh. In Regional Health Forum, (Vol. 12, No. 1, p. 2008).