International Journal of Social Sciences and Humanities Invention 10(05): 7853-7860, 2023
DOI: 10.18535/ijsshi/v10i05.02
ISSN: 2349-2031
https://valleyinternational.net/index.php/theijsshi

Mosquito-borne Diseases and Climate Change Implementing Strategies

Dana Diaz Lim

Southern Leyte State University
Tomas Oppus

Abstract
Mosquito-related diseases is one and are a serious public health concern, particularly in tropical areas like the Philippines. Its increase has been attributed to climate change, though, contradicting reports show inconclusive relationships between mosquito borne diseases and climatic factors.
This paper presents the mitigation and adaptation action towards climate change and the correlation of climatic factors such as temperature, wind speed, relative humidity, and rainfall to the cases of mosquito-borne diseases. The data gathered from the survey were evaluated using the mean percentages. Pearson correlation was utilized to determine the extent of correlation between the incidence of mosquito-borne diseases and climatic factors. Results showed a significant correlation between temperature (p=0.020) only.
The adaptation and mitigation actions are shown to have challenged the existing plan and implementation strategies since commendable action towards climate change is not evident to all groups studied that could also be a contributory factor for the incidence of mosquito-borne diseases.

Keywords: adaptation, mitigation, climate change, climatic factors, mosquito-borne diseases.

1.0 Introduction

The projected global increase in the distribution and prevalence of infectious diseases with climate change suggests a pending societal crisis (Laferty, 2015). The World Health Organization even stressed that climate change has led to changes in the frequency and intensity of extreme weather events and their potential health impacts. In the updated Philippine Development Plan 2017-2022 report, countries in the tropics like the Philippines have been cited by the World Bank and Climate Analytics as one of the countries most vulnerable to climate change with its high exposure to extreme weather events and according to Zu et al. (2019), the Dengue incidence rate in the Philippines increased substantially.

Dengue incidence was linked with climatic factors such as temperature and rainfall in a study conducted by Su (2008) in Metro, Manila Philippines. Iguchi et al., (2018) concluded in a study conducted in Davao, Philippines that a significant but varying non-stationary periodicities between local meteorological variables and that dengue incidence increased substantially in the period 2013-2017 associating relative humidity (Xu et al. 2020).

Many studies confirm that climate change can amplify health problems in vulnerable regions (McMichael & Lindgren, 2011) through the emergence of mosquito-related diseases (Russell, 2009). According to Anderson (2012), despite being threatened by climate change, many sectors offer a currently untapped opportunity to combat climate change. Since the causes of climate change are at least partly linked to human actions, these actions need to be identified and changed. So, this paper presents an opportunity to assess if the prevalence of mosquito borne diseases have something to do with climate change adaptation and mitigation.

On October 12, 2016, the Department of Health (DOH) has declared a Chikungunya outbreak in Maasin City, Southern Leyte (Geronimo, 2016). To date, about 300 cases have been reported in the city, and the increase in the number of cases has prompted the declaration of an outbreak. Dengue hemorrhagic fever was also reported starting in 2012 to which there are 122 cases and 93 cases in 2016 as reported in Southern Leyte Times Magazines. With climate change, it is imperative that educators and government officials can recognize the likelihood that climate change will increase the mosquito population and thus impact the transmission of mosquito-borne diseases. Thus this study determines the correlation between climatic factors and the incidence of mosquito-borne diseases and if it has something to do with the mitigation and adaptation strategies towards climate change. Every Southern Leyteños must be prepared and act responsively to mosquito-borne threats and understanding the strategies laid out from different agencies is highly essential. The right intervention will help in saving lives, maximize the use of resources, and improve the health and people of communities.

Conceptual Framework

Climate change is an area that is in dire need of publicity to help the public make informed decisions in its adaptation and mitigation action (Ochieng, M. Koske, J. 2013). In recent times, global attention had shifted to the issue of changes in climatic patterns and their attendant effects. (The Intergovernmental Panel on Climate Change 2007; National Environmental Standards and Regulations Enforcement Agency 2009; Mustapha and Oguntade 2011; Wright, 2013) and this alteration must be discourse.

The mitigation action that focuses on interventions to reduce the severity of the observed environmental problems thereby stopping many of the negative impacts of climate change and adaptation action that focuses on reducing the vulnerability of natural and human systems to the impacts of climate change and adapting to a changing climate through adjustments in social, ecological, or economic systems (Anderson, 2012). The challenge is not merely on adapting and mitigating but also the approach to sustainability.

According to World Health Organization (2017)**,** one of the groups of organisms that is challenged by climate changes is the mosquitoes, which is considered as one of the deadliest animals in the world that can carry and spread disease to humans causes millions of deaths every year. The organization further stressed that the worldwide incidence of dengue has risen 30-fold in the past 30 years, and more countries are reporting their first outbreaks of the disease. Zika, dengue, chikungunya, and yellow fever are all transmitted to humans by the Aedes aegypti mosquito**.**

Morin (2012) also stressed that mosquito vectors of diseases are especially sensitive to changes in climate, particularly temperature and precipitation. Vector-borne disease systems consist of multiple interacting components including the vector, agent, environment, and host. These elements interact with climate variables influencing disease transmission to humans. Disentangling the potential effects of climate variability and climate change on disease ecology is vital to forecast potential alterations of disease risk. In the study of Yu et al. (2011). Temperature can influence mosquito-borne disease transmission dynamics through multiple avenues. Vector populations are inherently controlled by temperature, and indices of mosquito population have been correlated with disease incidence (Dibo et al. 2008). Under climate change, predicted rainfall increases over most of Asia, particularly during the summer monsoon (UNFCC, 2016).

With all the studies conducted on climate change and its potential effect on mosquitoes, it is still best to consider intervention and control efforts climate change will amplify health problems in vulnerable regions, influence infectious disease emergence, affect food yields and nutrition, increase risks of climate-related disasters that could be substantially assisted by using information. This could be possible by reviewing the current strategies conducted by different agencies. Developing countries are much more vulnerable to the impacts of climate change. It is known that increasing environmental awareness among local officials leads to better planning and management of environmental resources (Shahid, 2012).

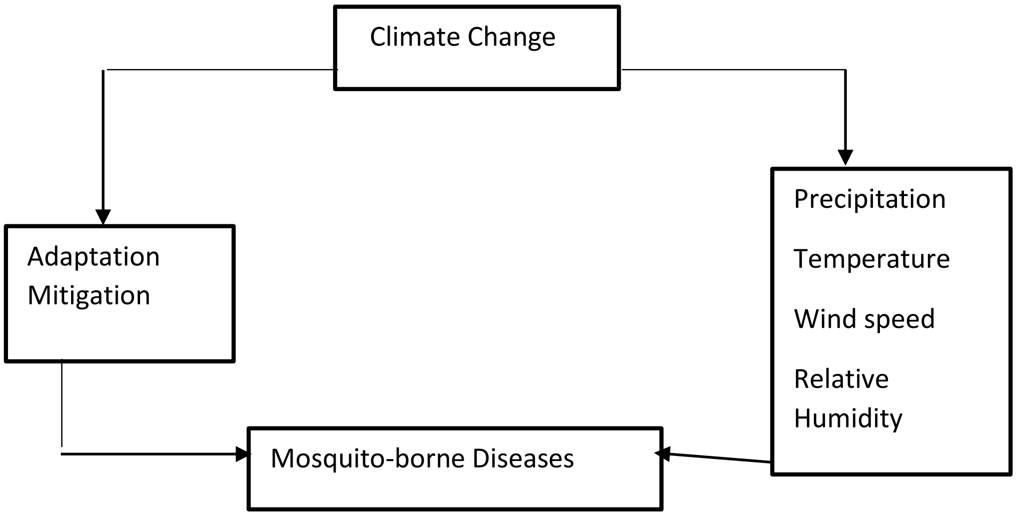

Figure 1. Conceptual Framework of the Study

2.0 Methodology

A descriptive quantitative survey design was used in this study. The method was used to gather pertinent facts and information on the adaptation and mitigation strategies towards climate change. A secondary data analysis method approach was also used in the study since secondary data were collected from the Department of Health (DOH) and Philippine Atmospheric Geophysical Astronomical Services Administration (PAGASA) concerning the number of incidence of mosquito-borne diseases and weather conditions in Southern Leyte from 2012 to 2017.

The data gathering started by asking permission from the mayor of a specified municipality to the heads of the different agencies or units. As soon as permission letters were granted ethical standards were considered. In the conduct of the study, respondents have been given the right to decide whether or not they get involved in the research. This fact was stated clearly in the questionnaire cover letter. As mentioned by Parahoo (2006), informed consent must be sought from research participants. Before consent is sought the researcher was given details of the nature and purpose of the study. Completion of the questionnaire by participants was taken as their way of giving consent to participate in the study. Participants were given adequate time to answer the questionnaire. Self- administered questionnaires potentially protect the anonymity and privacy of the respondents contributing to the confidentiality of the responses.

Stratified and simple random sampling techniques were used in selecting the respondents for the study. The respondents in this study were the school administrators/employees with an administrative function who are responsible for the implementation of mitigation and adaptation strategies on climate change, selected non-science faculty members who are responsible individuals for the input of concepts on climate change towards students, selected employee in the Local Government Units who will enforce policies on mitigating climate change and students and parents of whom will describe how the program on climate change is implemented. Secondary data on the incidence of mosquito-borne diseases from 2012 to 2016 also were collected from the Provincial Office of the Department of Health (DOH), while data on the amount of rainfall (mm), wind speed (mps), humidity (%), and temperature (°C) were collected from the Philippine Atmospheric Geophysical Astronomical Services Administration (PAGASA).

There were a total of three hundred thirty-six (336) respondents of the study in six municipalities of Southern Leyte of which 3 municipalities have the highest mosquito-borne diseases incidence which is Maasin, Macrohon, and Pintuyan while the other three municipalities have the lowest incidence of mosquito-borne disease recorded in the Provincial Department of Health from 2012-2016 which is Libagon, Liliang, and Hinundayan. From each of the six (6) municipalities, thirty (30) college/senior high school students per municipality were chosen for a total of one hundred eighty (180) students, ten (10) college non-science teachers for a total of sixty (60), six (6) from administration non-teaching staff a total of thirty-six (36), three (3) from Rural Health Unit for a total of eighteen (18) respondents and seven (7) from Local Government Units for a total of forty-two (42) respondents. The data gathered from the survey were evaluated using the mean percentage and for the relationships of the variables, Pearson correlation was used.

4.0 Results And Discussion

Figure 1 shows the prevalence of dengue fever between wet and dry seasons in which a reported 56 cases in August 2014 with 2 reported mortality. This is just minimal compared to cases that fall during the rainy season. According Schultz (1993) in his study of dengue vectors in Manila, Philippines that show a low population of *Ae. aegypti* from February through May, during the dry season, and higher populations from June through September, during the rainy season.

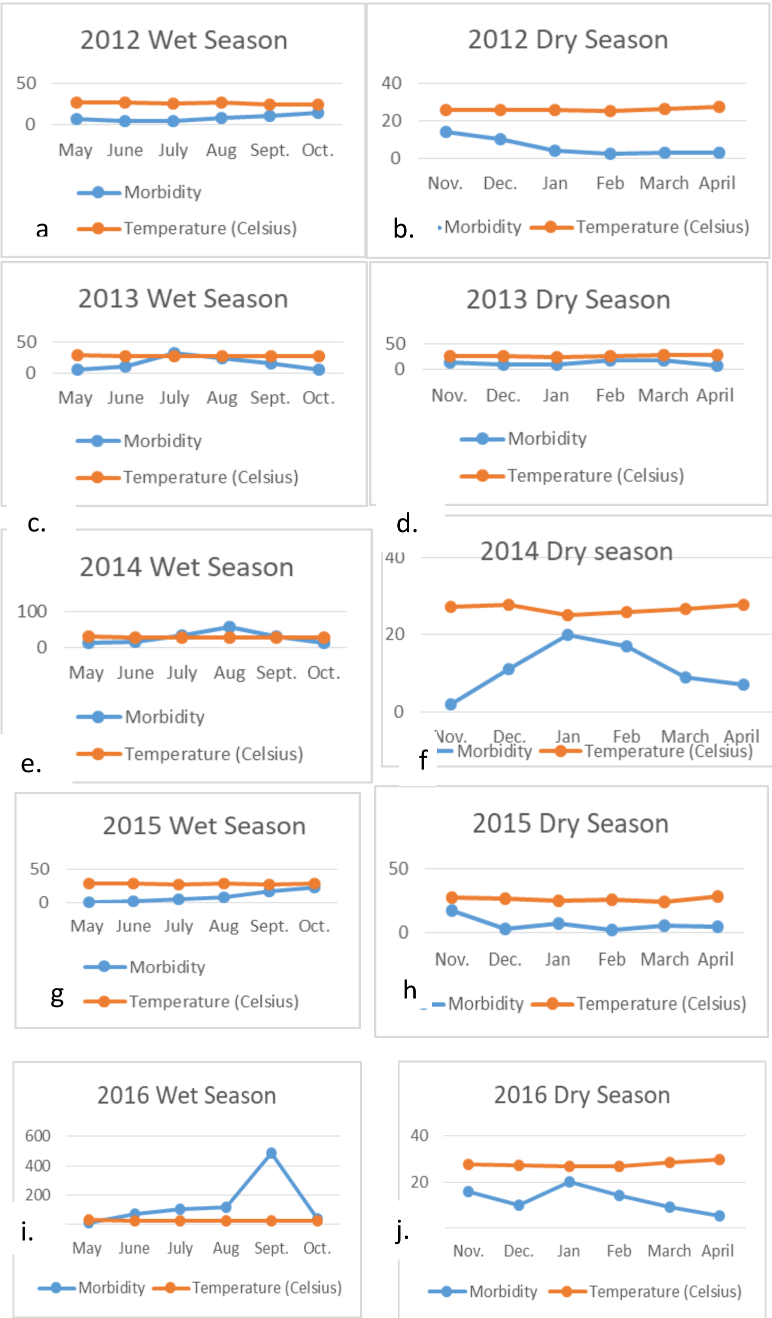

Figure 1 (a)- (j). Morbidity Relative to Mosquito Incidence in Southern Leyte During Dry and Wet Season (2012-2016)

(source: PAGASA Southern Leyte; DOH Provincial Epidemiology and Surveillance Unit Southern Leyte)

Furthermore, the figure showed a higher prevalence of mosquito-related diseases between July to November to which a reported high mortality cases of 450 individuals affected with chikungunya in 2016 and 56 cases of dengue fever in August 2014. As observed there was an extreme case of mosquito incidence in 2016 for the presence of chikungunya since no incident was reported from 2012-2015. The number of dengue cases that fall during the rainy season might attribute to the increasing number of mosquito-related diseases. An earlier study by Su (2008) addressed the reasons for dengue fever epidemics in terms of rainfall and Sumi et al. (2016) assumed that dengue fever epidemics are correlated not only with rainfall but also relative humidity and temperature. This can be attributed to the life cycle duration of mosquitoes and the requirement of an adequate number of cases for the spread, which is in turn affected by population density. But the extreme cases of chikungunya can be explained that a carrier of the virus was in the place that triggered the mutation of the said virus which leads to the declaration of an outbreak since *Aedes mosquito* is already common in Southern Leyte. In the study of Rezza et al. (2007) that the high virus vector fitness seems to be confirmed by both the successful introduction and rapid spread of the infection from one infected human host, that the high density of the vector at the time of arrival of the index case, as anecdotally reported by villagers, was probably a major determinant of the outbreak.

The present study found out that there was no significant correlation between mosquito-borne cases and the climatic factors – wind speed, humidity, and rainfall investigated within the period 2012 – 2016. This simply means that the aforementioned climatic factors cannot affect the reproduction of Aedes mosquitoes which lead to diseases. A weakly association with local rainfall and dengue fever was observed by Jury (2008).

Table 1. Correlations between the incidence of mosquito-borne diseases and climatic factors

Variables	Pearson correlation	P-value	Remarks
Morbidity and Temperature	-.265	0.020*	Significant
Morbidity and Wind Speed	.199	.063	Not significant
Morbidity and Humidity	.146	.133	Not significant
Morbidity and Rainfall	.147	.131	Not significant

As emphasized in the study of Picardal and Elnar (2012) that there was no significant correlation between dengue cases and the climatic factors like that of temperature and rainfall investigated in Eastern Visayas within the period 2006 – 2010. Dhimal et al. (2015) confirmed that increased rainfall reduced the abundance of Ae. aegypti and increased relative humidity also reduced the vector abundance. Mosquito-borne disease transmission can be sensitive to rainfall since it can alter the abundance and type of aquatic habitats available to the mosquito for the deposition of eggs (oviposition) and the subsequent development of the immature stages (Shaman & Day, 2007).

On the contrary, many studies confirmed the effect of rainfall on the prevalence of dengue as reported in Brazil (Goncalves Neto and Rebelo, 2004), in the Americas (Guzman and Kouri, 2003), in India (Chakravarti and Kumaria, 2005), in Thailand (Gratz, 1993; Indarathna et al, 1998; Wiwanitkit, 2005), and most recently in the Philippines (Sia Su, 2008). The differences in the reported results might be attributed to variations in the amount of monthly precipitation relative to their geographical locations. The relationship between mosquito-borne cases and climatic factors such as wind speed, humidity, and rainfall describe being uncorrelated in this study.

However, a correlation was observed between the incidence of mosquito-borne diseases and temperature since the p-value is lower than 0.05. This simply means that the temperature affects the prevalence of mosquito-related diseases. Many studies reported previously that temperature is a major factor that influences normal metamorphosis of the dengue-carrying mosquitoes particularly at the larval stage (Focks et al, 1993; Hlaing et al, 1998; Tun Lin et al, 2001; Dellate et al, 2009; Picardal & Elnar, 2012). While the study of Sumi et.al. (2016) suggests that dengue fever epidemics are correlated with rainfall in the Philippines. Furthermore, the effects of temperature and humidity on the adults Ae. aegypti, as well as many others, have been extensively studied. Each degree rise in mean temperature increased Ae. aegypti abundance (Dhimal et al., 2015). Mogi et al. (1996) compared desiccation survival times of adult Ae. albopictus and Ae. aegypti under 90% and 70%

relative humidity (RH) and 25˚C. Ae. aegypti was found to be more resistant to desiccation than Ae. Albopictus (Dickerson, 2007).

Although the reported wind speed, relative humidity, and rainfall of the present study are not correlated with the incidence of mosquito-borne diseases. This could possibly be attributed to the variations in the weather conditions in the province. Sia, Glenn (2008) quoted the study of Kanchanapairoj et al. (2000), which gave contradicting evidence on the relationships of dengue incidence with climatic factors and it remains inconclusive. Morin et al. (2013) also stressed that relationships between climate variables and factors that influence dengue transmission are complex. This complexity may at least partly explain inconsistencies in statistical associations between dengue and climate.

Adaptation action towards climate change

The chart below presents the adaptation and mitigation action towards climate change.

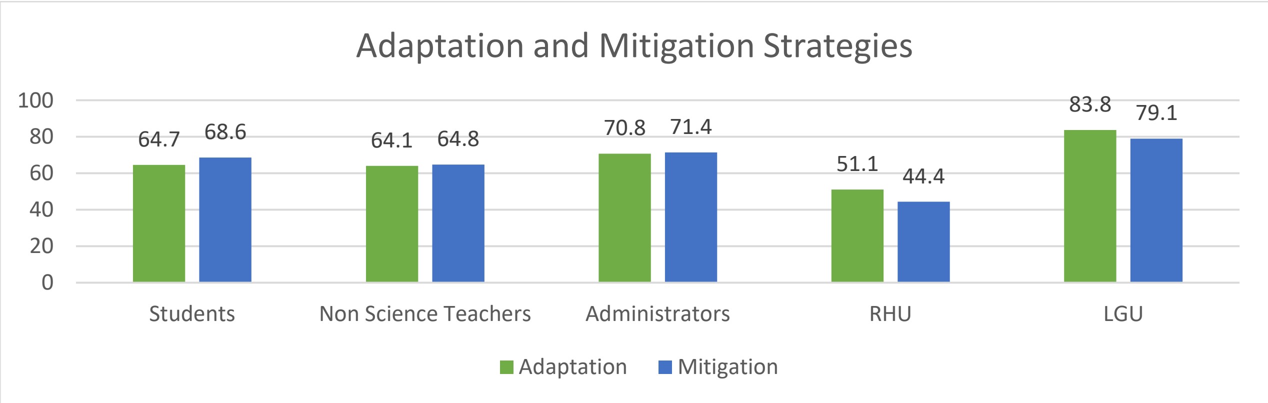

Figure 1: Adaptation Strategies towards Climate Change

Figure 1 reveals that the selected respondents in the Local Governments Units and from school administration have only a good adaptation action towards climate change. In this study, the group from the Local Government Units exhibited excellent knowledge, good attitudes, and very good practices towards climate change. But this does not entail that down streaming of adaptation strategies on climate change were also excellent. This could be explained with a number of factors like the adaptation strategies set by the government is not well understood of how it could be downstream to the layman or to the public or it is because of the limited resources that also limit the assigned agencies and personnel to promote utmost environmental protection. With the case of the personnel in the school administration since they are a priority to be sent in conferences or symposia regarding the implementation of adaptation strategies towards climate change but most likely environmental protection are quite least to be considered.

Though it is known that increasing environmental awareness among local officials leads to better planning and management of environmental resources (Shahid, 2012). But local and national government agencies should be partners with the school even before crises. Being the first responders, they have the civil responsibility of protecting the school community (Khan, 2008). In the study of Gruber (2015), that the involvement of education in local climate change adaption efforts raises the legitimacy of the process. Furthermore, Lin (2013) that all countries shall promote and cooperate in education and public awareness related to climate change and encourage the widest participation in this process, involving NGOs as well.

The rest of the respondents showed fair results on the adaptation strategies observed in the province. This means that the adaptation strategies in the province are not clearly grasped by college/senior high school students, non-science teachers, and employees of the rural health unit. In the dissertation of Feldman et al., (2017), they stressed that there is an overwhelming amount of information that is available to students; however, it is often misrepresented, politically inflated and falsified, and littered with misconceptions (Dawson & Carson, 2014; Gayford, 2002).

Meanwhile, the figure above shows the respondents' assessment of the current mitigation action established in the province, and representatives from the Local Government Units and school administration claimed that there are just good mitigation strategies. While a representative from students, teachers, and rural health units rated its existing mitigation as fair. The lack of interest and motivation to mitigate climate change at detailed action is quite evident might be because there is an issue in politics, so environmental projects become not a priority. While recognizing that LGUs and school administration have a wealth of knowledge on environmental issues but there seems a gap why mitigation action is not that strictly implemented that could be understood by everyone. According to Ross (1994), major environmental problems remaining are: the Environment Impact Assessment system which is seen as a bureaucratic requirement needed to obtain project approvals; political interference determines the outcome of some environmental reviews; questionable practices by public servants serve to discredit the system, and the treatment of projects in environmentally critical areas is less than satisfactory.

According to Egea et al. (2014), given the multi-faceted nature of personal mitigation behavior, it potentially encompasses a broad range of actions in private and public spheres of life, one-off and regular decisions, simple and more difficult steps, as well as low and high impact actions, as regards their effectiveness in mitigating climate change. Given the urgency of climate change mitigation, a profound shift is needed in personal behavior—from inaction or limited action levels—towards broader and greater levels of behavioral engagement. Such extra behavioral responses comprising additional mitigation actions and specific behavioral levels that go beyond what most people do—hold promise for a further incremental impact in addressing climate change.

Climate change adaptation and mitigation strategies and the incidence of mosquito-borne diseases

The data gathered in evaluating the current adaptation and mitigation strategies in selected municipalities in Southern Leyte showed a mean percentage value of 66.9% and 65.6% respectively both only have "fair" strategies towards climate change. While the incidence of mosquito-borne diseases in 2016 based on standard data of the human population and the incidence of dengue fever and an outbreak of chikungunya have a percentage value of 60.63%. This value might be lower if the adaptation and mitigation strategies have a higher percentage value that reaches "very good" strategies towards climate change. The importance of good environmental management might help decrease the incidence of dengue fever and chikungunya. As stressed by Reiter, Paul (2011) that higher global temperatures will enhance the transmission rates and extend the geographic ranges of mosquito-borne diseases. The histories of such diseases--malaria, yellow fever, and dengue--revealed that climate has rarely been the principal determinant of their prevalence or range; human activities and their impact on local ecology have generally been much more significant.

5.0 Conclusion

Temperature affects the incidence of mosquito diseases while the non-correlation of the climatic factors, such as, wind speed, rainfall, and relative humidity, to the incidence of mosquito-borne diseases specifies that there are other perplexing climatic factors that may influence the dynamics of the transmission of such diseases.

There is a gap between the environmental programs and the adaptation and mitigation strategies in place in response to climate change. The implementation of the different policies set by the government is not well understood by many as a result a fair rating was established on the implementation set by the institution managers.

References

1. Andreadis, Theodore G. (2012). Global Climate Change and Mosquito-borne diseases. http://www.nmea.org/2012andreadisabstract.thm
2. Bulto, P., Rodríguez A., Valencia A., Vega N., Gonzalez M., and Carrera A. (2006). Assessment of Human Health Vulnerability to Climate Variability and Change in Cuba. Environmental Health Perspective Journal
3. Chakravarti, A. & Kumaria, R. (2005). Eco – epidemiological analysis of dengue infection during an outbreak of dengue fever, India. Virology Journal
4. Dickerson, Catherine (2007). The effects of Temperature and Humidity on the eggs of Aedes aegypti (L.) and Aedes albopictus (Skuse) in Texas. Dissertation. Texas A & M University. Proquest.

5. Dhimal, M., Gautam,H., Joshi,H., O'Hara, R., Ahrens, B., Kuch, U., (2015). Risk Factors for the Presence of Chikungunya and Dengue Vectors (Aedes aegypti and Aedes albopictus), Their Altitudinal Distribution and Climatic Determinants of Their Abundance in Central Nepal. PLOS Neglected Tropical Diseases.
6. Fisman, David N. (2008). Climate change and infectious diseases in North America: the road ahead. Canadian Medical association.
7. Goncalves Neto, V.S. & Rebelo, J.M. (2004). Epidemiological characteristics of dengue in the Municipality of Sao Luis, Maranhao, Brazil, 1997 – 2002. Cad Saudi Publica.
8. Gould, D. J. (1970). Ecological control of dengue vectors on an island in the Gulf of Thailand. Journal of Medical Entomology.
9. Hribar, L., DeMay D., and Lund U. (2010) The Association between Meteorological variables and the abundance of Aedes taeniorhynchus in the Florida Keys. Journal of Vector Ecology. Wiley Online Library.
10. Jury, Mark. (2007). Climate influence on dengue epidemics in Puerto Rico. International Journal of Environmental Health Research
11. Kanchanapairoj, K., McNeil, D. and Thammapalo, S. (2000). Climatic factors influencing the incidence of dengue haemorrhagic fever in southern Thailand. Sonkla Med. J.
12. Lafferty, Kevin. (2009). The Ecology of Climate Change and Infectious Diseases. Ecological Society of America.
13. National Science Board. (2008). Science and engineering indicators 2012 Available from: http://www.nsf. gov/statistics/seind12/.
14. Picardal J.& Elnar A. (2012). Rainfall, Temperature and the Incidence of Dengue in Central Visayas, Philippines are not Correlated. CNU Journal of Higher Education.
15. Schultz, GW (1993). Seasonal abundance of dengue vectors in Manila, Republic of the Philippines. The Southeast Asian Journal of Tropical Medicine and Public Health
16. Service, M.W. (1980). Effects of wind on the behavior and distribution of mosquitoes and blackflies. International Journal of Biometeorology. Springer.
17. Shaman, J. & Day, J. (2007) Reproductive Phase Locking of Mosquito Populations in Response to Rainfall Frequency. PLOS one
18. Sia Su, G. L. (2008). Correlation of climatic factors and dengue incidence in Metro Manila, Philippines. Ambio.
19. Su, Glenn (2008). Correlation of Climatic Factors and Dengue Incidence in Metro Manila, Philippines. A Journal of Human Health
20. Sumi, A., Telan, E., Piolo M., (2017) Effect of Temperature, Relative Humidity, and Rainfall on Leptospirosis Infections in Manila, Philippines. Crossmark. Cambridge University Press
21. Wieringa, J. (1986) Roughness-dependent geographical interdependent of surface wind speed averages. Royal Netherlands Meteorological Institute, De Bilt.