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Spatial Risk Mapping for Dengue Fever Using GIS: A Case Study of Hyderabad

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Abstract: There is compelling evidence that changes in the climate of the earth occur which cannot be explained without taking into account human influence. Many vulnerability studies anticipate climate change will lead to increased occurrence of transmittable diseases, including Vector Borne Diseases (VBDs). VBDs are spread by the bite of infected mosquitoes and other insects (vectors). The breeding of species of mosquitoes is strongly associated with demographic factors. Mosquito populations and mosquito density is considered to be the key signs that determine and evaluates risk of dengue in any particular area. Measuring the population of mosquitos requires enormous exertions and use of the latest information ICT techniques. The incidents of dengue can be prevented by timely decision to implement vector control activities. Recent advances in Geographic Information System (GIS) and mapping new technologies have shaped novel opportunities for public health managers to improve, plan, monitor and assess health systems. GIS represents better explanation and analysis for the spread and control of such vector borne diseases. This study used GIS application to identify areas prone tosuch diseases. The results show that Latifabad is a major area prone to VBD followed by Bhitainagar, Qasimabad and Heerabad. The ability to identify likely areas of dengue incidence helps for quick and efficient disease supervision and prevention practices.

Keywords: Vector Borne Disease, Dengue, Hyderabad

1. INTRODUCTION

Viral disasters can result in painful and damaging outcomes not only affecting human but equally damaging economy of the specific region. It is hard to predict any possible appearance of a virus disaster. If we have the information to all or at least some early signs of incoming viral disasters, the main losses can be minimized while recovery plans can be executed at the right time. Normally, as the pressure of time, most decisions are made on the basis of past experiences rather than an adequate and reliable data(Westen, 2000). Contemporary global distribution of risk of infection with dengue virus and public health burden are poorly understood. (**Fig.1)** shows dengue transmission.

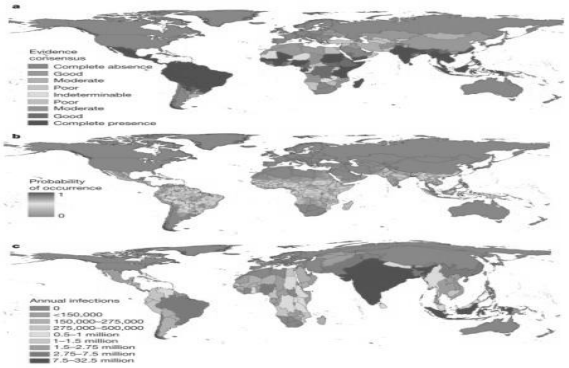

Fig.1. Dengue Risk Worldwide

Areas with a high & low probability of dengue occurrence are shown in red and green respectively. It has also been observed that Pakistan is in poor zone. Dengue is a vector-borne illness that causes a considerable public health burden. Several modeling studies have tried to predict the future global distribution of dengue. However, it is still a challenge to compare the resulting projections and is sometimes incongruous because of the differing approach of the model. The projected dengue distribution for 2050 is shown in **(Fig.2).**It also reported Pakistan in risky zone in forecast for dengue (Messina *et al.*, 2015).

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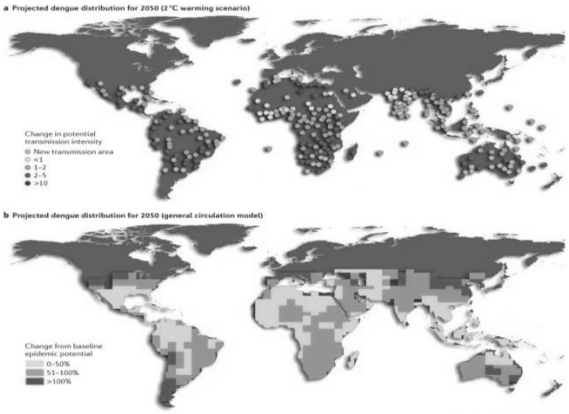

Fig.2. Dengue Forecast, 2050

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Globally, it has been reported that Dengue is a communal arbovirus infection but its burden is poorly quantified. It has been also analyzed that there is greater increase in dengue cases between 1990 to 2013.Dengue is responsible for 1.14 million disabilities in 2013 (Jeffrey *et al.,* 2016).

National Environment Agency (NEA) Singapore reported 455 dengue cases in January, 2015 and more than 86 cases reported in one week and these are higher cases recorded during a week in 2015 (NEA *et al.*,). According to relief web recent report, Hyderabad is one of the major risky areas for vector borne diseases as mentioned in (**Fig. 3).**

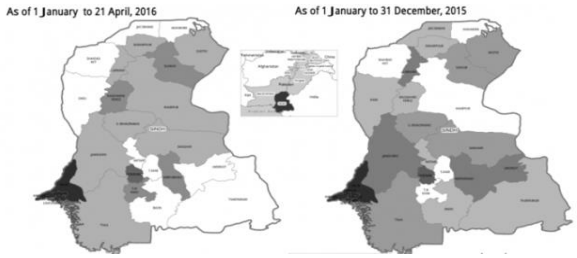

Fig.3. Dengue Outbreak Sindh (Systems, n.d.)

The mechanism of disaster handling might not be workable all the time; there's a legitimate demand of such reasonable mechanism that will give the correct information relating to any potential change in atmosphere resulting in incidence of any specific disaster. Warning system is such a method of getting sign before the event, which might cause the diminution of risks and injury (Basher, 2006). Though, it's quite impulsive to own comprehensive precise clue through early warning infectious agent disasters like earth quick or any biological hazard, however still varied parts might need a tentative framework. Early Warning System (EWS) may be more practical if we are able to coordinate and implant following four stages (**Fig.4).**

Fig.4.Elements of EWS

In disaster relief, information sharing is an important issue to be considered. Mapping irregular events such as illnesses or contaminants allow public administrators to investigate the cause of pollution, identify source of epidemics and generate more hypotheses for further research. More importantly, high-risk areas can be spatially identified. Mapping is much easier and become used more intelligently with the development of the GIS. However, mapping only provides a visual presentation of irregular cases, but cannot definitively confirm the clustering of cases or spatial correlations (Wen. *et al.,* 2006).

This study uses GIS application to integrate the locational information for the incidence of DF and DHF, in conjunction with information toward land use and demography to spot area unit as that are liable to dengue fever disease. The power to spot the probable areas for dengue fever incidence leaves a prompt and effective application of disease control and prevention activities. The broad objective of this research is to develop a GIS based hazard map for risky areas prone to dengue.

2. RESEARCH METHODOLOGY

a. GIS Applications

Information provided by Geographical Information System (GIS) can be utilized by several applications including emergency control, environmental analysis, and national infrastructure protection, for numerous forms of analyses. Information provided by these geographical information systems should be accessible regardless of the mobility of these applications and users that access them(Hariharan, *et al.,* 2005).

b. Data Models in GIS

Computers need clear instructions to convert the data on the spatial features in graphical representations. Computer based systems can manage and display spatial data in two major methods; these are raster and vector approaches. An example of both models is as shown in (**Fig.5).**

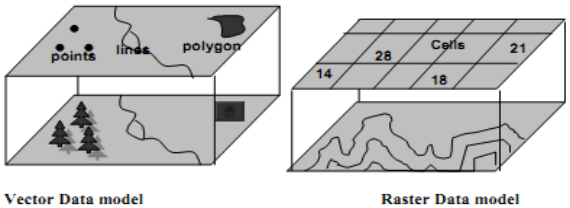

Fig.5.Vector and Raster Model

GIS is capable to integrate numerous spatial and non-spatial data sets for mosquitoes' habitats (Shafie, 2011).

c. Dengue Temporal Risk Analysis

In this study, Hyderabad city of Pakistan is considered for case study. In order to identify the areas which are at temporal risk, three years data was collected from Ministry of Health, Government of Sindh, and 4 months out-sample data was collected from four hospitals of Hyderabad. During in-sample data, 310 cases were registered, these cases were used as input variable to develop the distribution model using logistic regression estimation method. The selected town areas were then divided into 100 different square cells, each cell covering 150x150 meters width and length. Stepwise logistic regression analysis is used for developing spatial distribution model.

2. RESULTS AND DISCUSSION

In this research, satellite imagery and google earth maps are used to develop spatial map. Dengue cases are represented by distribution of blocks in city map. Shape files were successfully imported as data layers.**(Fig.6)** shows the spatial risk mapping of dengue outbreak in four selected towns of Hyderabad.

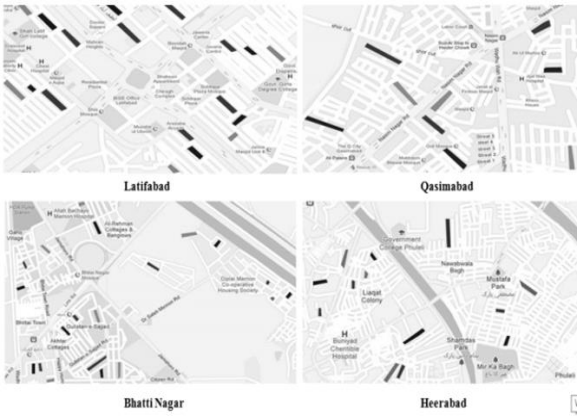

Fig.6. Spatial Vulnerability Maps, Hyderabad

In these maps, 3 different colors are being used to classify the risk of dengue incidents. Red color shows the highest possibility of dengue incidents, followed by Blue and Green colors representing moderate and lower possibility of dengue cases occurrences. From the historical cases and spatial distribution model of Hyderabad city, these maps confirms that Latifabad town is more prone to dengue incidents, followed by Bhitai Nagar, Qasimabad and Heerabad.

4. CONCLUSION

Worldwide, rapid urbanization, population growth and climate change result in enhanced vulnerability for population exposed to hazardous events. Therefore, disasters take huge loss of life and destruction. In developing counties like Pakistan, unplanned growth and insufficient infrastructure in urban and rural areas, it is essential that sufficient planning to reduce the impact of disasters should be designed and put in place. Information on disaster risks and GIS spatial nature play an essential role in handling risks, and its proper assessment.

A disaster risk map for dengue disease with respect to climatic changes has been projected in this study with use of information and communication technologies such as GIS. It is very important to have such forecast maps for vector borne disease so as to make proper remedial measures to reduce them. In this regard, it is important to have complete information about risk and associated factors so that the level of risk can be minimized. The risk evaluation will help to make decisions about risk countermeasures and priorities. It is proposed that immediate steps must be taken to control the dengue breaks in these towns to save public health and make sure that these factors which are responsible for dengue outbreak must be avoided.

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