Communicable disease surveillance and response system

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***Abstract*—** The latest studies estimate in Sri Lanka around 5 million people living in areas of dengue risk, over 32,000 infections so far in this year and more than 50 deaths. Though government of Sri Lanka has spent millions, precise system not yet been instigated. It is learned that the Public Health Inspectors (PHI) are the key people to be addressed to implement proper communicable disease surveillance system. Present manual system retard the entire process of reporting patients and breeding locations of mosquitos and other relevant information and never been adopted a centralized mechanism. Awareness and the active participation of the community is a vital factor to successes such a system. Hence this system is a participatory Web-Mobile and GIS based system which developed to address burden of dengue and other similar epidemic disseises in Sri Lanka. This system enriched with latest technologies in mobile applications, Web and Geographic Information Systems. This system is capable of monitor trends in the distribution and spread of dengue over time geographically for early response also possible to report dengue breeding locations and patient's locations with various related data using mobile applications further automated alerting system has developed for PHIs and related authorities based on community mapping. Drone mapping is used to map dengue risk areas, Water logged places, malfunctioning drainage systems, garbage dumps, and/or any potential endemic areas will be marked as risk areas with the use of aerial photos and videos. Live monitoring of the dengue risk areas using drone is a vital factor hence this system get the live streams from the high flying drones in-order to monitor present condition of the risk areas. Hotspot analysis and various statistics reports enhance the risks of individual's surroundings.

***Keywords*— Epidemic diseases, Web GIS, Drone Mapping, Mobile Applications**

I. INTRODUCTION

The lack of planning, inadequate housing, water, sewage, and waste management has created ideal conditions for dengue viruses and other epidemic diseases. The latest studies estimate in Sri Lanka around 5 million people living in areas of risk, over 32,000 infections so far in this year, and more than 50 deaths. Thus, ignored for many years, only recently has the potential magnitude of the dengue problem been acknowledged by policymakers and funding agencies. Government of Sri Lanka has spent millions to developed dengue reporting, analysis and prediction systems, thus never been able to reduce the impact of the dengue due to burden of practical applicability and lack of community participation. The aim of the research is to develop web-GIS based system to reduce the impact of the epidemic diseases and to improve the efficiency of the Public Health Inspectors (PHI) by introducing digital formats and also to increase the participation of the community.

II. METHODOLOGY

This system consist of two major web map engines, in-house (CRD) map engine and the ArcGIS server, images and the live video from drone will be stored in the CRD server while inputs from the mobile application store in both CRD server and the ArcGIS server. Public Health Inspectors (PHI) has to login with their user names and password to the same mobile application which use by the general public. If there is any dengue suspicion area general public can report those areas using mobile application which is highly user-friendly application. PHI's can report the risk areas as well as dengue patient locations. Drone mapping use to map the dengue risk areas using aerial photography and live stream for live monitoring of risk areas. When dengue breeding location reported by the community warning message will be sent to the PHI and relevant government authorities using ArcGIS Modelbuilder and Python scripts. Web application and a mobile application developed to report dengue patient who are admitted to the government or a private hospital by digitizing current manual procedures. General public can access to the web page and perform various analysis depends on their requirements.

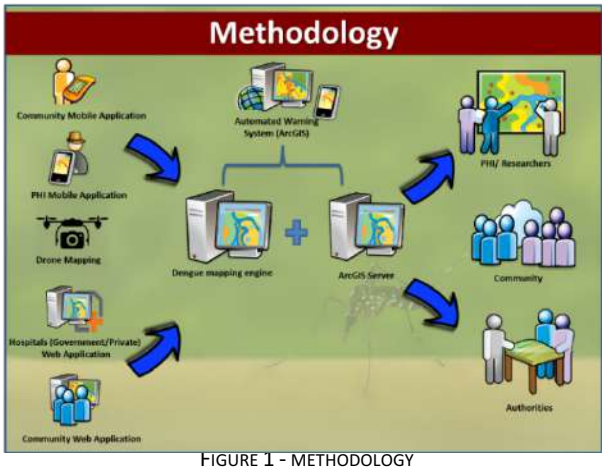

FIGURE 1 - METHODOLOGY

III. Experimental design

This research involved developing two different Android applications to address the aforesaid need. One Android application to report the dengue breeding locations, container type, etc… and to send data to MySQL database with the X, Y coordinates through HTTP header. The other Android application developed to reports dengue patient's information.

Php timer script running on Apache server will access to the store in My SQL and automatically store data in MS SQL Server Express. Incident's locations stored in MS SQL Server Express will be accessed through ArcGIS 10.1 in-order to analyse the risk and to send warning messages to the inhabitants who would possibly be affected with the calculated risk factors (High Risk Zone, Medium Risk Zone and Low Risk Zone) through e-mails and SMS and also SMS alert will be sent to the responsible PHI of the dengue reported area. This entire process has been automated using "Model Builder" in ArcGIS to increase the speed of the process and to reduce human errors.

For assigning calculated risk for individuals Visual Basic Script has been used and two separate python scripts have been used within the ArcGIS "Model Builder" to send emails and SMS. Furthermore the system will send detail report to the relevant government organizations through e-mail and SMS.

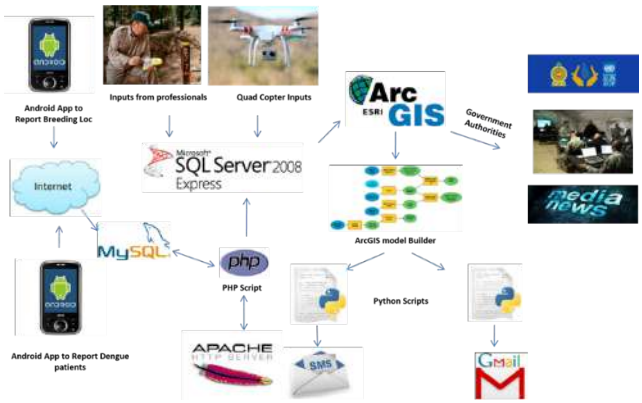

Figure 2 - Experimental design

IV. Results and Discussion

This system been tested in Dehiwala and Mount Lavinia areas during past two years and conducted awareness programs for the PHIs and other relevant authorities. As per the interviews with the PHIs this system is a vital requirement and reduced the complexity for their duties.

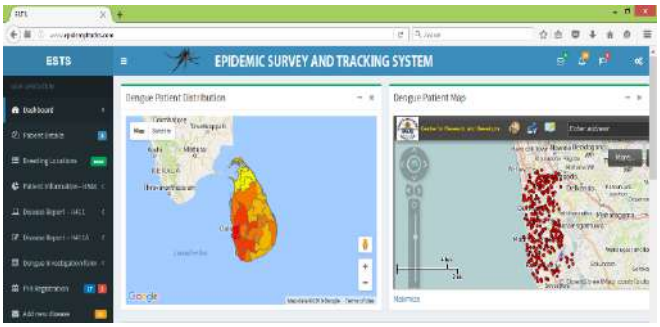

Figure 3–Main page

In the main page of the web system users can view the current threat of the dengue fever for individual district according to the number of reported patients and breeding locations. This thematic colour map changing automatically whenever new record is submitted to the system and also hotspot analysis can be seen which generated through the ArcGIS Server. Dengue analysis based on the Geography always provides better understanding, thus this system use ArcGIS server to analyse and display data.

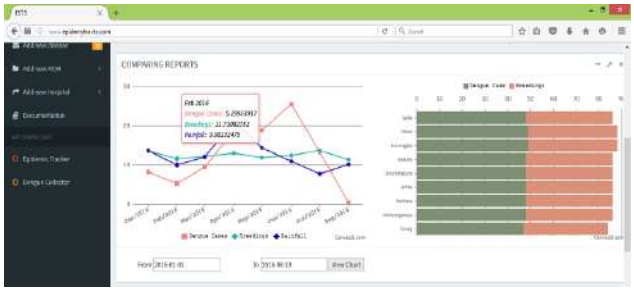

Figure 4–Statistical charts

Statistical analysis charts are developed by considering breeding locations, patients and the rainfall which can be use for the prediction and analysis.

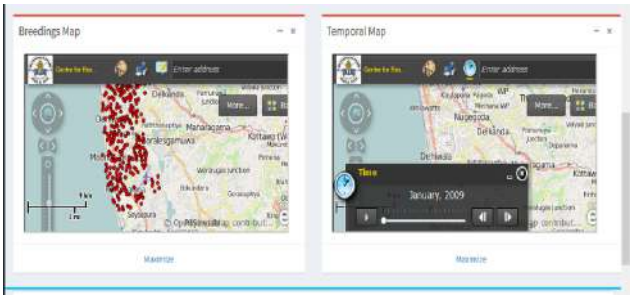

Figure 5–Andriod inputs and temporal analysis

Android mobile application is able to send data directly to the ArcGIS server which is one of the significant research finding in this research. Users also can view the breeding map and the temporal analysis of spreading dengue patient reported locations.

Figure 6 - Drone mapping

Drone mapping been used to map dengue risk areas. Water logged places, malfunctioning drainage systems, garbage dumps, and/or any potential endemic area marked as risk areas with the use of aerial photos and videos. Live monitoring of the dengue risk areas using drone is a vital factor hence this system get the live streams from the high flying drones in-order to monitor present condition of the risk areas and system displays the current position of the drone over the Google map using X, Y coordinates receiving by the GPS of the drone.

V. Conclusion

GIS play vital role in early warning systems, disaster management process and in epidemic diseases outbreaks. With the development of the new technology there are many options to be adopted and customize into our own systems. Selecting best and most suitable option is a vital factor since warning systems and epidemic analysis is dealing with human life and the valuable assets of the country.

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