Healthy City Tainan:
Clean Air and Disease Prevention

—— Tainan City

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Case Study 1	Mosquito Control Facilitated by GIS & IOT in the Cloud

Outbreak of Dengue Fever

Dengue fever is an environmental infectious disease that spreads in tropical and subtropical countries in Asia, Africa and the Americas through the Aedes aegypti and Aedes albopictus mosquitoes. In 2015, annual record high temperatures, torrential rains and typhoons in Tainan City created an appropriate environment for mosquitoes. As a result, Tainan experienced a record-setting outbreak of dengue fever with 22,754 cases and 112 deaths. The outbreak threatened public health and safety and damaged the economy. This event informedTainan City's objectives of overcoming climate change impacts by using scientific and technological methods to prevent and reduce the spread of dengue fever.

🏢 City Profile

Area: 2,191.65 km² (846.20 sq mi)
Population: 1,885,252

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Inclusive Solutions with Multi-sectoral Cooperation

In response to the dengue fever challenge, the city government took an interdisciplinary approach to set up mechanisms for cooperation and data sharing.

In April 2016, the Center for Dengue Prevention and Control was established. Separated into five divisions, the center coordinates communication among government, hospitals, experts in healthcare and the central government. The specific functions include developing annual plans, measuring vector mosquito densities, installing prevention and control measures, monitoring the outbreak, increasing public information access, formulating and deploying pesticides, managing city resources and imposing administrative penalties. The following figure sows the organization and the five divisions of the center.
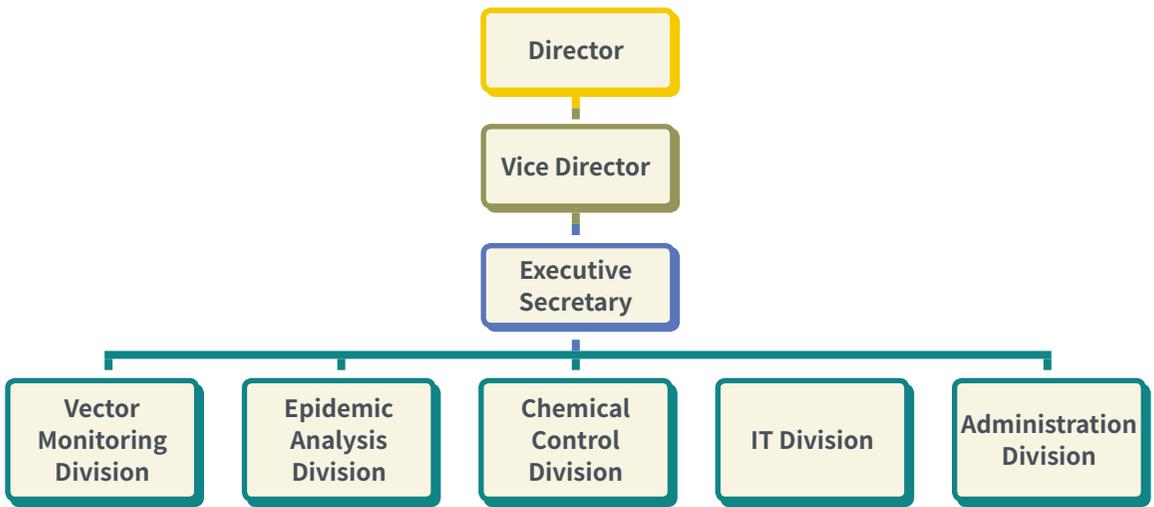

Organization of the Center for Dengue Prevention and Control

Tainan Dengue Epidemic Geographic Information System (TDEGIS)

Under the Center for Dengue Prevention and Control, the Tainan Dengue Epidemic Geographic Information System (TDEGIS) was set up as an inter-agency dengue prevention and control platform. The TDEGIS combines government prevention strategies and public engagement via information technologies such as big data analysis, cloud computing, IoT, and GIS. The ultimate goal is to integrate information and develop a thorough Dengue prevention network.

The household densities of vector-mosquitoes measured by field workers in all districts are uploaded to the GIS platform. The data collected are processed to identify hot spots and generate a table of Breteau index by village in real time so that prompt disease control measures can be taken accordingly in every district.

臺南市登革熱疫情 個案分布圖

境外各區統計人數
共計：19人

確診個案統計日期範圍
01/01/2018
至
11/15/2018
loading
區別　里別

0　1　6　51　151　(人)
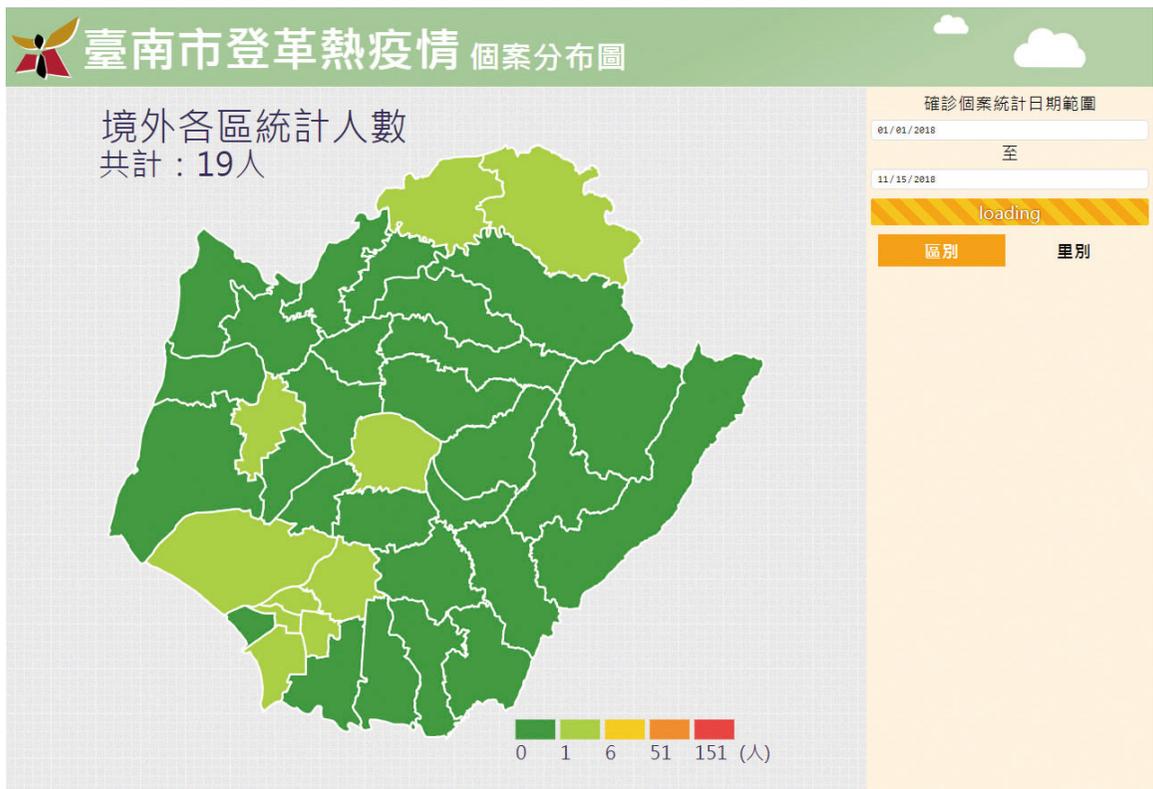
Tainan City Case Distribution Map©Public Health Bureau, Tainan City Government

As the GIS platform facilitates inter-agency coordination and communications, prevention and control efficiency is improved by 100 times in surveying vector-mosquitoes density, by 10 times in updating insecticide spraying maps and by 6 times in alerting and notification. The platform is also used for audits, statistics and analyses that further strengthen dengue prevention. The statistics section shows the correlations between variables to be taken into account in decision making.

Additionally, the administrative view of the platform provides a consolidated dashboard view of numbers and statistics, while the public view provides dengue situation updates on both web and mobile. The included data warehouses include "Diagnosed Fever Cases", "Mosquito Density Survey",

"Dengue Fighting Schedule", "Outdoor Chemical Epidemic Track", "Construction Case Information", "Building Site", "Enlisting Dengue Epidemic Prevention", "City Residents' Announcement on Empty Materials for Empty Land", "Temperature and Humidity Data in Tainan" and "Taiwan City Rainfall Data." All data is published online as open and readily accessible by the public. The figure below shows the operational system of the TDEGIS.
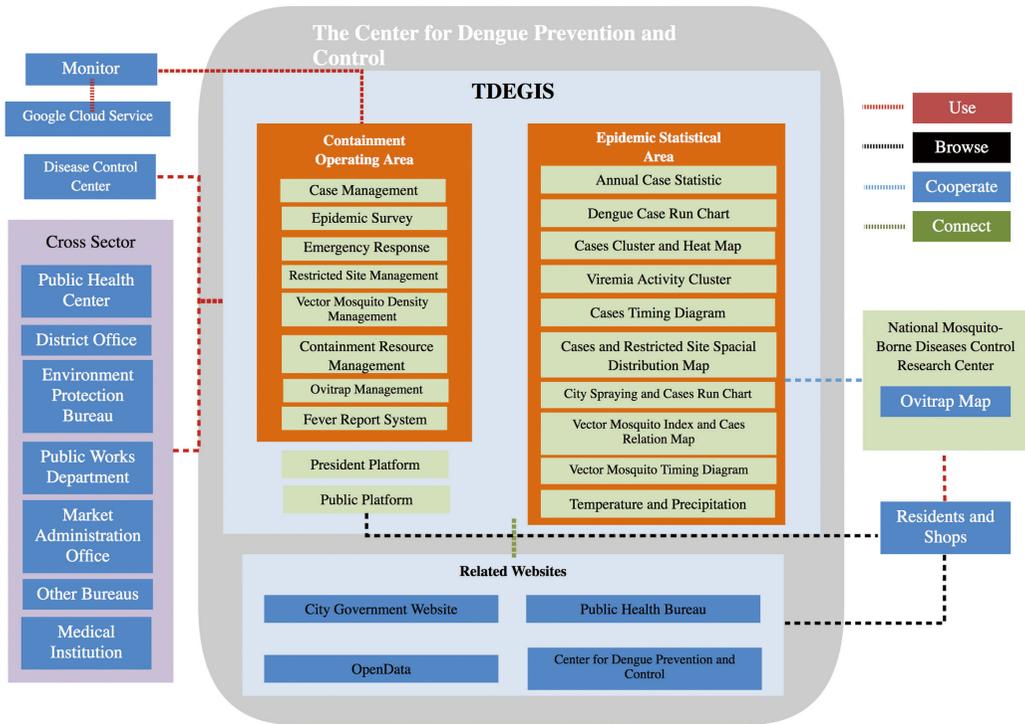
Operational Structure of TDEGIS

Implementing a Prompt Notification System

After the standard operating procedures (SOPs) were established and a map of hospitals and clinics offering rapid dengue tests was made available on the platform, users were able to consult the map to seek prompt and convenient medical attention. Hospitals and clinics can also immediately report a case with fever through the fever reporting system on the platform.

Reducing the Population of Vector-mosquitoes

The GeoJSON data is shared with National Cheng Kung University (NCKU) to co-create an app called "Mosquito Man", and smart mosquito lamps, and a smart electric mosquito killer were developed in cooperation with MediaTek to geographically locate vector-mosquito ovitraps. The data obtained through Internet-connected monitoring devices are transmitted to the GIS systems through Wi-Fi. Based on the climate data and the numbers of eggs in ovitraps in different districts, dengue hotspots are identified in order to facilitate fast and effective vector elimination. Furthermore, locations of high adult mosquito densities can be identified and tracked for changes in real time.

Mosquito Man APP ©Tainan City Government

Application of Cloud Computing

In a cloud environment, the Center for Dengue Prevention and Control obtains real-time information from those dispatched to the field to take photos, obtain geographic information and describe and record the locations of the ovitraps.

Mosquito Lamp©Tainan City Government

Results

Through the above strategies and cooperation on every level of society, the number of local dengue fever cases decreased to only 10 in 2016 and 0 by 2017. With this impressive statistical outcome, Tainan City received the 2017 IoT Innovation Award and the 2018 Smart City Summit and Expo Innovation Application Award for its disease prevention efforts.

The additional benefits of the disease prevention program are shown in the following table.

Community Well-being	· Prevention of public panic as the outbreak slowed · Return of tourists · Clean up support for affected households
Institutional Strengthening	· A well-structured organization and sustainable services · Improved administrative operations through innovative technologies · Accurate analysis and decision-making as efficiency improved · Better deployment with real-time data visualization · Involvement of public health and subject experts in decision making · Lowered resource and materials consumption over time
Environment Benefits	· Decrease in insecticide spraying · Improved land use

Additional benefits of the disease prevention program

Knowledge Sharing and Future Development

Although Tainan City has solved its local dengue fever problems, the increasing frequency of international travel has led to an increase in the number of dengue cases transferred abroad. Therefore, the city aims to use its expertise to share knowledge with other cities and prevent overseas disease migration. Tactics include dengue fever information campaigns at airports, exit-entry symptom monitoring for passengers and the NS1 fast screening test for dengue.

Other future objectives include strengthening the GIS system, integrating various resources, expanding monitoring and the IoT network for vector mosquitoes, and improving early detection and prevention of dengue fever cases.

Review Comments

1. The utilization of IT on disease prevention, and specifically dengue, is highly impressive.

2. The project is recommendable particularly to tropical countries that are often visited by typhoons because it will eliminate the transfer of disease from one country to another.

3. The project has demonstrated a good example to identify the risk of the city and find a good solution with technological tools. Similar methodology could be applied to cities which face the same risk.