

Denggi, Downpour and Drains: How does Climate Impact Dengue in Singapore?

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Introduction

- **Dengue** is the fastest re-emerging arboviral disease in the world
- **Importance:** The 1st vector borne disease in Singapore.
- **Virus:** The four serotypes of dengue virus circulate in the city.
- **Main vector:** *Aedes aegypti* while *Ae. Albopictus* is 2nd and transmits Chikungunya.
- **Burden:** repetitive outbreaks occurred during the last decade in Singapore.
- **Future:** Concerns that climate change could increase dengue outbreaks.

Problem Statement

Two features distinct dengue in Singapore (Figure 1):

- 1) dengue peaks during summer.
- 2) There is an increasing trend over years.

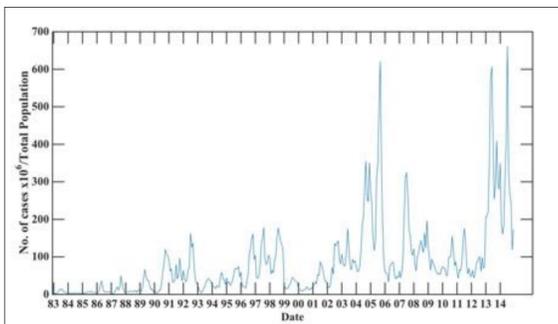


Figure 1: Dengue monthly cases in Singapore 1983-2014.

The summer peak of dengue coincides with the least rainfall intensities Figure 2.

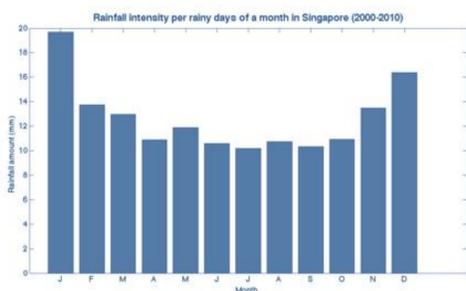


Figure 2: Average storm intensity in rainy days of month in Singapore (2000-2010)

How does the climate impact the seasonality of dengue in Singapore?



Figure 3. Inspection of drains for breeding of dengue mosquito in Geylang neighborhood.

Methods and Materials

Study area: Geylang Neighborhood, area 2.9 km², population 30,000.

- Field work:** entomological and meteorological survey in Geylang area:
- 1- Twice weekly breeding inspection surveys in Geylang.
 - 2-Twice weekly adult trapping survey in Geylang.
 - 3- Day-by-day monitoring persistence of positive breeding drains
 - 4- Real-time monitoring of local weather using meteorological data loggers

Retrospective data: relevant weekly epidemiological data obtained from ministry of health.



Figure 4. Aquatic and adult stages of *Aedes aegypti*

Results

- We found the main outdoor breeding habitat of dengue vector is drains in back alleys, **Table 1**.
- We documented the mechanistic effect of intense rainstorms on flushing of dengue breeding in the drains, **Figures 3 and 4**.
- Flushed breeding sites during November-December show a shorter permanency compared to those on August-September, **Figure 5 and 6**.

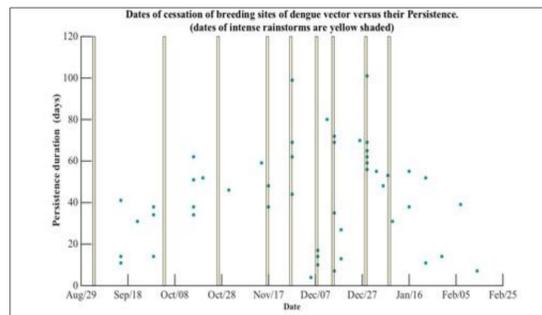


Figure 5: Flushing of dengue vector breeding sites in Geylang. Yellow bars shows dates of intense rainstorms recorded by the rain gauge and from a nearby station.

Table 1. Number of positive breeding habitats encountered in Geylang August-December 2014.

| Type of habitat | Aedes aegypti | Aedes albopictus | Culex spp. | Total |
|------------------|------------------|------------------|------------------|------------------|
| Main road drain | 0 | 0 | 7 (523) | 7 (523) |
| Back alley drain | 31 (3265) | 2 (180) | 5 (420) | 38 (3865) |
| Canvas sheet | 6 (300) | 0 | 0 | 6 (300) |
| Pail | 2 (40) | 1 (30) | 0 | 3 (70) |
| Plastic bag | 6 (150) | 4 (200) | 0 | 10 (350) |
| Flower pot | 0 | 2 (100) | 1 (70) | 3 (170) |
| Other | 2 (50) | 1 (40) | 2 (120) | 5 (210) |
| Total | 47 (3805) | 10 (550) | 15 (1133) | 72 (5488) |

[Number in parenthesis is the total count of aquatic stages].

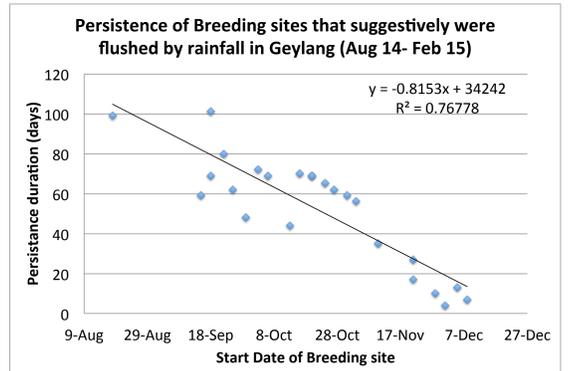


Figure 6. Persistence of flushed breeding sites (in days) during the period Aug 2014- February 2015

Discussion

- So far, we explained how dengue and climate are connected in Singapore.
- Data collection is continuing in Geylang to comprehend dengue temporal pattern over one year.
- Flushing of breeding sites depend on intensity of rainstorms, i.e. the more intense the storm the more probable to be washed out- **Figure 7**.

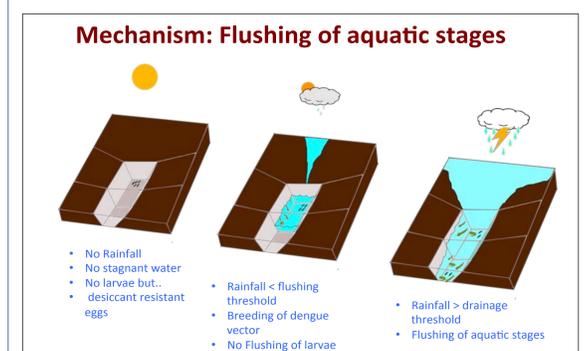


Figure 7: Flushing mechanism of dengue vector breeding explains how rainfall affect the disease.

Conclusions

- The peak of dengue in summer results from stagnation of outdoor breeding habitats particularly in back alleys' drains.
- Seasonality of dengue in Singapore is linked to the monsoons regimes.

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