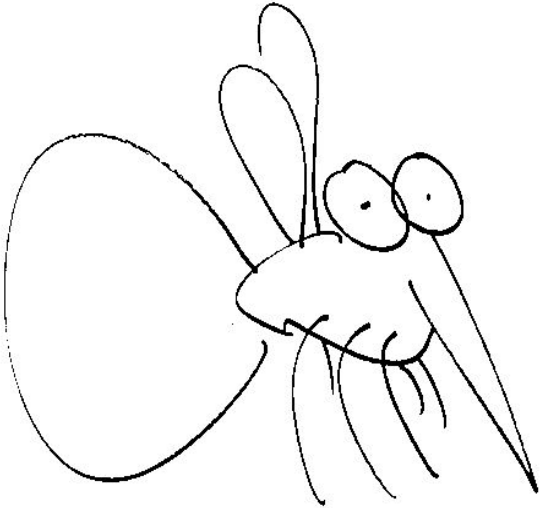
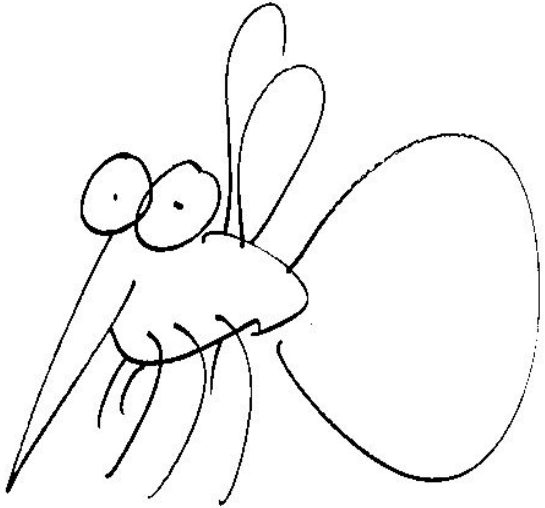
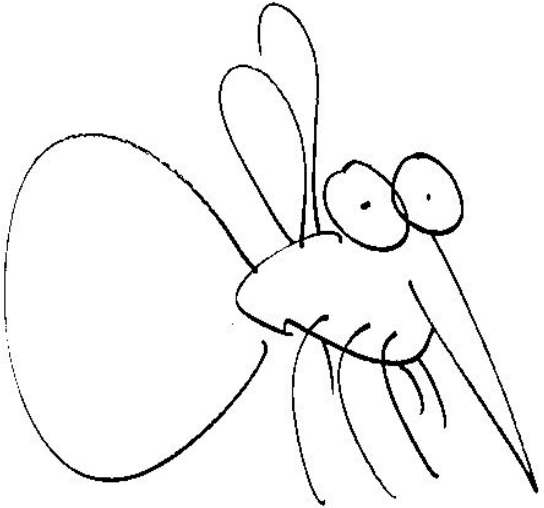
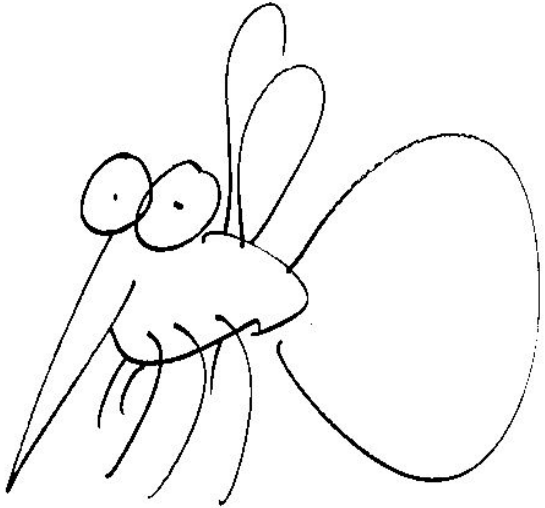


DSI
Project 1





Background



What is dengue and why is it a problem?

MINISTRY OF HEALTH
SINGAPORE

For Public | For Healthcare Professionals | e-Services | Who We Are

Understanding Dengue Fever

Dengue fever is a disease caused by the dengue virus which is transmitted to humans via the bite of an infective mosquito. There are four different serotypes of dengue virus (DENV1 to 4) circulating in the world, including Singapore. Hence, individuals can be infected with dengue up to four times. First-time dengue infections can be severe, especially among the elderly and those with pre-existing medical conditions, and repeat dengue infections have been associated with a higher occurrence of severe dengue. Dengue haemorrhagic fever and dengue shock syndrome can be fatal. Together with the National Environment Agency (NEA), we provide regular weekly updates on all dengue cases and track dengue-related deaths in Singapore which are reported quarterly.

How Dengue Is Transmitted

Dengue fever is transmitted to humans via the bite of an infective Aedes mosquito. A mosquito becomes infected after it takes a blood meal from a dengue-infected person. It becomes infective after an extrinsic incubation period of 8 to 12 days. The mosquito then remains infective for the rest of its lifespan. When a person is bitten by an infective mosquito, they may develop symptoms after an intrinsic incubation period of 4 to 7 days (ranges from 3 to 14 days). Notably, up to 75% of dengue infections are asymptomatic. Dengue fever does not spread from person to person.

Source: https://www.moh.gov.sg/diseases-updates/dengue

Monitoring of dengue clusters in Singapore

Definition	Alert Level
High-risk area with 10 or more cases	Red
High-risk area with less than 10 cases	Yellow
No new cases, under surveillance for the next 21 days	Green

Source: https://www.nea.gov.sg/dengue-zika/dengue/dengue-clusters

FIGHT ZIKA AND DENGUE

The Zika and Dengue viruses are both transmitted by the female *Aedes* mosquito. Zika is generally mild and most people infected with the virus do not develop symptoms.

Do the Mozzie Wipeout

LAWAN ZIKA DAN DENGGI

Kedua-dua virus Zika dan Denggi disebarkan melalui nyamuk *Aedes betina*. Zika umumnya adalah penyakit ringan dan kebanyakan orang yang dijangkiti virus ini tidak menunjukkan sebarang tanda.

Get rid of stagnant water at home to protect our families and neighbourhoods:

Hapuskan takungan air di rumah untuk melindungi keluarga dan kejiranan kita:

Turn the pail
Telungkupkan bekas air

Tip the vase
Buangkan air pasu bunga

Flip the flower pot plate
Telungkupkan pangkalan pasu bunga

Loosen the hardened soil
Gemburkan tanah yang keras

Clear the roof gutter and place BTI insecticide
Bersihkan alur bumbung dan butiskan racun serangga BTi

Protect Yourself
Lindungi Diri Anda

Apply insect repellent
Sapukan ubat penghalau serangga

Wear long-sleeved shirts and pants
Pakai baju berlengan panjang dan berseluar panjang

Symptoms
Tanda-Tanda

Note:
Other symptoms may include red eyes, joint pain, muscle ache and headache.
Nota:
Tanda-tanda lain termasuk mata merah, sakit sendi, sakit otot dan sakit kepala.

Do seek medical attention immediately if you feel unwell.
Dapatkan rawatan perubatan segera jika anda rasa kurang sihat.

Together, we can prevent Zika and Dengue in our neighbourhoods.

- Please cooperate with our NEA officers – allow them into your home for inspection and to spray insecticide to kill any mosquitoes.
- Join your neighbourhood's Mozzie Wipeout activities.

Bersama-sama, kita boleh mencegah Zika dan Denggi di kawasan kejiranan kita.

- Sila bekerjasama dengan pegawai NEA kami dengan membenarkan mereka masuk ke rumah anda dan memeriksa serta menyembur racun serangga untuk membunuh nyamuk-nyamuk.
- Sertai aktiviti Mozzie Wipeout kejiranan anda.

For more information, visit www.nea.gov.sg or www.moh.gov.sg
Untuk maklumat lanjut, lungsuri www.nea.gov.sg atau www.moh.gov.sg

OUR LIVES. OUR FIGHT.
DO THE MOZZIE WIPEOUT TODAY
LAKUKAN KEMPEN MOZZIE WIPEOUT HARIINI.


骨痛热症由雌性伊蚊传播，而积水是伊蚊产卵的温床。采取下列行动，以防伊蚊在家中滋生繁殖。
டெங்கி பொன் ஏடிஸ் கொசுவின் மூலம் பரவுகிறது. அங்கமைக் கொசுக்கள், தேங்கியுள்ள நீரில் இனப்பெருக்கம் செய்கின்றன. உங்கள் வீட்டில் கொசுப் பெருகுவதைத் தடுக்க, இந்த வழிகளை மேற்கொள்ளுங்கள்.
客厅及寝室
வசிப்பதை மற்றும் படுக்கை அறை
厕所
கழிப்பறை
厨房
சமையலறை
1 每隔一天更换花瓶里的水
ஒன்று விட்டு ஒரு நாள் பூச்சாடியுள்ள நீரை மாற்றிடுங்கள்
2 洗刷花瓶内侧，并用清水冲洗植物根部，以清除蚊卵
பூச்சாடிகளின் உட்புறத்தைத் தேய்த்துக் கழுவுங்கள். கொசு முட்டைகளை அதற்கு வெளியே வேற்றவை ஒடும் நீரில் கழுவுங்கள்
3 水桶等容器不使用时倒置存放
நீர் சேமித்தும் வைக்கைகள் (எ.கா: வாளி) வழிமுறை வைப்புகள்: பயன்படுத்தாதபோது அவற்றை ஈரமின்றி வைத்திருங்கள்
3 盖好不常用的沟渠管道，装置防蚊昆门
அரிதாகப் பயன்படுத்தப்படும் வழிகளிற் வடிகால் அடைப்பான்களை மூடி வைத்திருங்கள். கொசுக்கிடப்பு வாய்வுகளைப் பொருத்துங்கள்
4 盖好用不着水容器
நீர் சேமித்து வைத்திருக்கும் அனைத்துக் கொள்கலன்களையும் மூடி வைத்திருங்கள்
5 清除碗盘架的托盘积水
பாத்திரங்கள், உணவைவை வைக்கும் கட்டகத்தின் அடித்தட்டுகளில் நீரை அகற்றிடுங்கள்
6 盖好晒衣竿撑管
மூங்கில் கழிகளைக் கொடிகள் குழாய்களை மூடி வைத்திருங்கள்
有地住宅周遭环境
தனர வீடுகளைச் சுற்றியுள்ள இடங்கள்
1 清除沟渠内的落叶及枝干，并把种植在花圃内的树洞封上，避免树洞积水
சாக்கடைகளில் விழுந்துள்ள இலைகள் மற்றும் மரக்கிளைகளை அகற்றுங்கள். நீர் தேங்குவதைத் தடுக்க, தோட்டத்திலுள்ள மரத் துவாரங்களை மூடுங்கள்
2 每个月须疏通阻塞的屋顶檐槽，并加入 BTi 杀蚊药
மாதம் ஒரு முறை கூரை வடிகால்களில் அடைப்புக்களை அகற்றி, BTi பூச்சிக்கொல்லியை அதில் வையுங்கள்
2 在喂水池入造麦中加入蚊状杀虫药
நீர் சாந்து அமைக்கலில் மன் முன்கள் கலந்த பூச்சிக்கொல்லியை இடுங்கள்
4 每次维修检查后把门板盖紧，确保钥匙孔及门板周围的空隙都已封妥
பராமரிப்பும் பணி முடிந்தபட்ச பரிசோதனை முடிவதன் எதிரான மூடுங்கள். மூடிவைக்கும் கதவிலும் உள்ள சாவித்துவாரங்கள் மற்றும் இடைவெளிகளை அடைத்துவிடுங்கள்
组屋走廊
வீடக தாழ்வாரம்
5 每隔一天将花盆底盘彻底清除洗刷，以灭除蚊卵
கோ முட்டைகளை அகற்ற பூச்சொட்டுத் தட்டினை ஒன்று விட்டு ஒரு நாள் வெந்நீரில், சவர்க்கம், தண்ணாத் தேய்த்துக் கழுவுங்கள்
6 每隔一天铲松花盆内干硬的泥土
ஒன்றுவிட்டு ஒரு நாள் பூச்சொட்டித் தளாங்களின் இறுகிய மன்னைக் கிளறிடுங்கள்
7 清除用不上的容器，以免雨水滋积
தேவைபடாத கொள்கலன்கள் மழைநீரைச் சேமிக்காமல் இருக்க அவற்றை அப்புறப்படுத்துங்கள்
8 疏通排水孔，确保排水正常
நீர் வெளியேறும் துளைகளை அடைப்பில்லாமல்

全面检查并保护我们的家园

骨痛热症病例近期有激增的趋势，为了保护您家人的安全，预防伊蚊滋生并清除家中积水，以确保他们免受危害，以下为防范措施须知：

检查区域	灭蚊步骤	完成
 花草植物（例如花盆底盘，植物叶茎，干硬的泥土）	• 清除花盆底盘的积水 • 将叶脉清除干净 • 铲松干硬的泥土	☐
 家中水容器及积水处（例如花瓶，喂泉装置，水桶，马桶刷/牙刷架子，厨房餐盘架/盛水的托盘）	• 将水桶倒置存放，并抹干水桶边缘 • 倒掉花瓶中/刷子撑架的积水 • 定期更换喂泉的水，并刷洗表层 • 抹干厨房餐盘架/清除托盘中积水	☐
 晒衣竿撑管	• 盖好晒衣竿撑管	☐
 屋顶檐槽及院内沟渠	• 疏通阻塞的潜在滋生处，例如屋顶檐槽及沟渠，并放入Bti杀蚊药	☐

新增两个灭蚊步骤，全面确保您和家人的安全：

1. 在家中阴暗角落如床底与沙发底下，以及窗帘后喷杀虫剂

2. 使用驱蚊剂，穿上长裤长袖衣

nea.gov.sg/dengue
facebook.com/StopDengueNow
twitter.com/NEAsg

下载myENV应用程序，随时查阅每周热症警戒区及伊蚊滋生黑区的信息。

NEA

National Environment Agency

SG CLEAN

STOP DENGUE WITH B-L-O-C-K.

BREAK
up hardened soil

LIFT
and empty flowerpot plates

OVERTURN
pails and wipe their rims

CHANGE
water in vases

KEEP
roof gutters clear and place BTI insecticide

PROJECT WOLBACHIA SINGAPORE

What is Project Wolbachia?

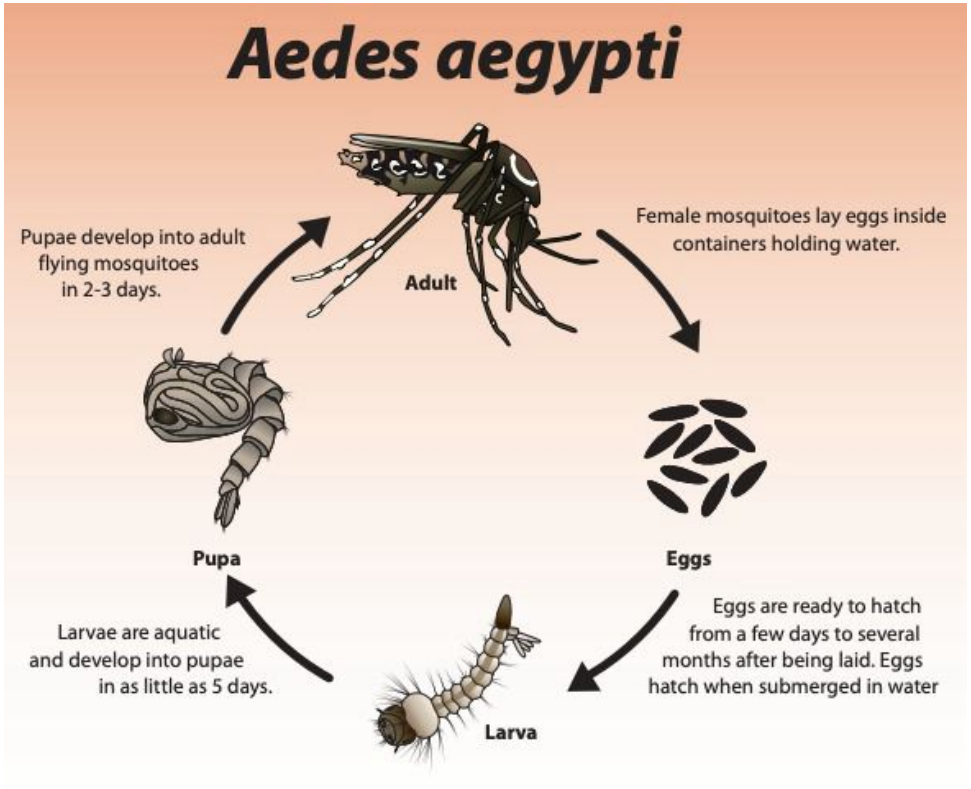
When female mosquitoes from the field, which do not carry Wolbachia, mate with males that carry Wolbachia, the eggs derived from these matings do not hatch.

Project Wolbachia Singapore studies the feasibility of using Wolbachia-carrying Aedes *aegypti* males to help suppress the population of these mosquitoes.

Wolbachia are naturally-occurring bacteria present in more than 60% of insects.

With a suppressed population, the expected outcome is that dengue transmission will be reduced hence decreasing the number of dengue fever cases in the country.

The life cycle of Aedes aegypti



Some facts about Aedes *aegypti*

Aedes *aegypti* has 4 stages, namely egg, larva, pupa and adult.

The entire life cycle, from an egg to an adult, takes approximately 8-10 days.

Adult mosquitoes can lay up to 100 eggs each time.

Eggs can stick to the sides of containers, and can survive drying out for up to 8 months.

Dried out eggs can still hatch when enough water is present to completely cover it, triggering the larva to emerge.

Source: https://www.cdc.gov/dengue/resources/factsheets/mosquitolifecyclefinal.pdf

Some other statistics on the Aedes aegypti

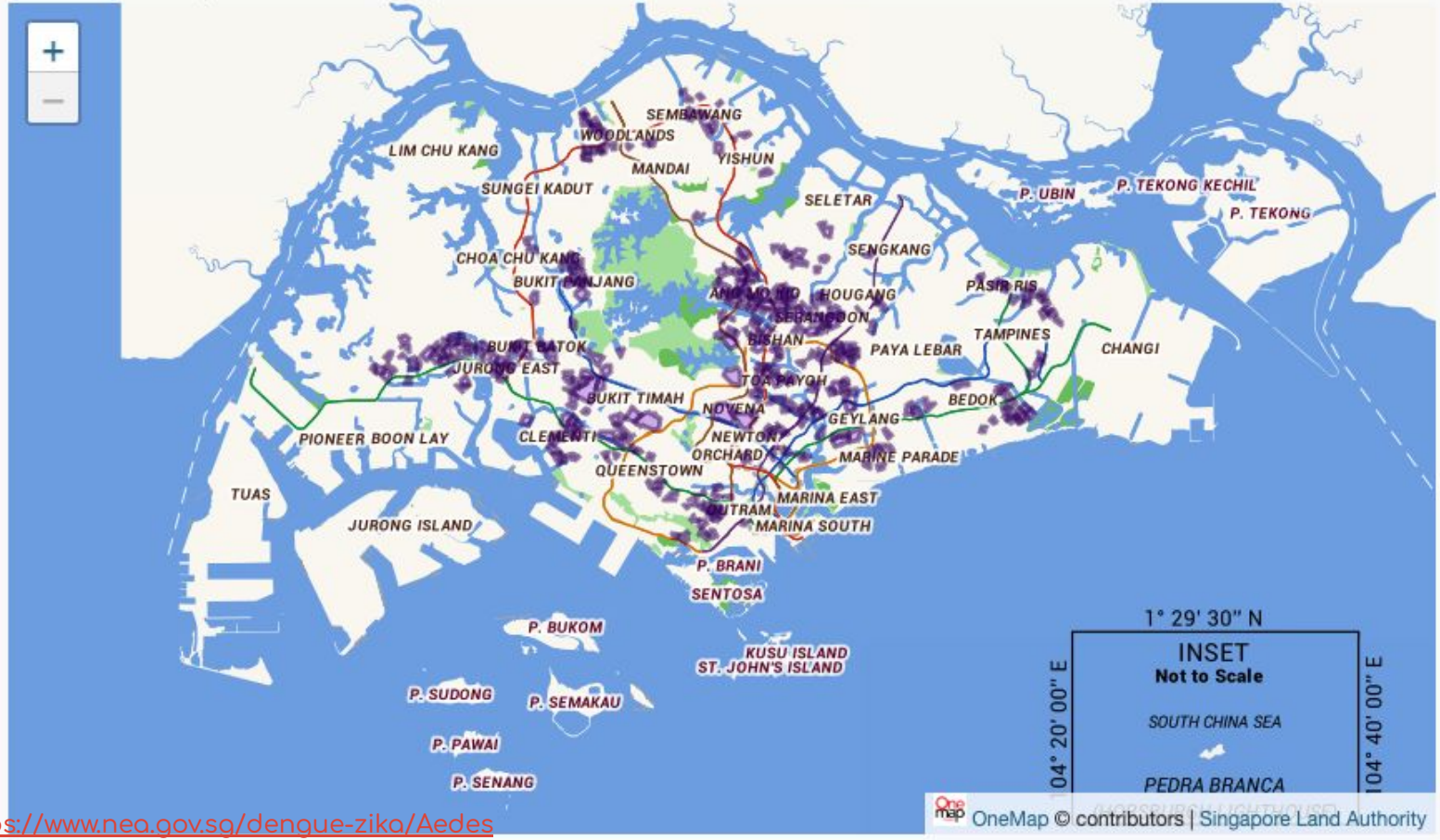
Persistent presence of *Aedes* and climatic and spatial factors Singapore's warm and humid climate year-round allows for favourable breeding and survival conditions for the *Ae. aegypti* vector. An increase in the ambient temperature between 25°C and 35°C accelerates the life cycle of mosquito vectors [40] and reduces the EIP of the dengue virus in the vector [41], thereby increasing the transmission potential of dengue virus [42]. For example, in Cairns,

were associated with reduced dengue [45]. Singapore has warmed over the past decades, with the number of months per year with mean temperature above 27.5°C (the optimal temperature for the survival of *Ae. aegypti*) exhibiting a positive trend between 1980 and 2021 (as measured at Changi meteorological station) [46]. With warming facilitated by climate change and urban

Source: https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0011400#sec003

Areas with Higher Aedes aegypti Mosquito Population

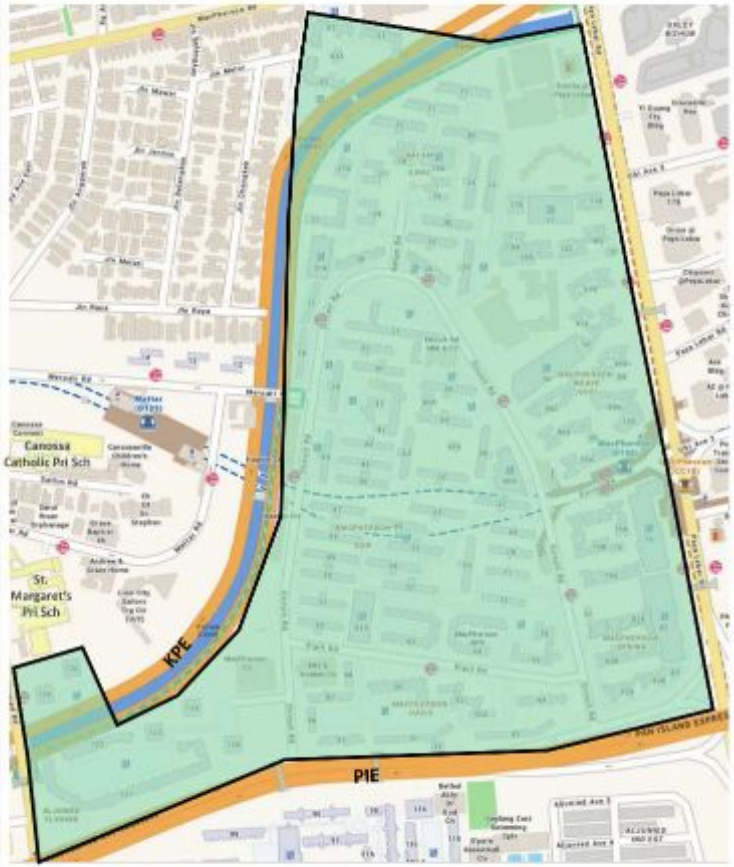
The information provided in this map is from October 2023.



Source: https://www.nea.gov.sg/dengue-zika/Aedes

Sample schedule of the release of Aedes aegypti

Geylang



Every Monday and Thursday morning

Bedok

Every Tuesday and Friday morning

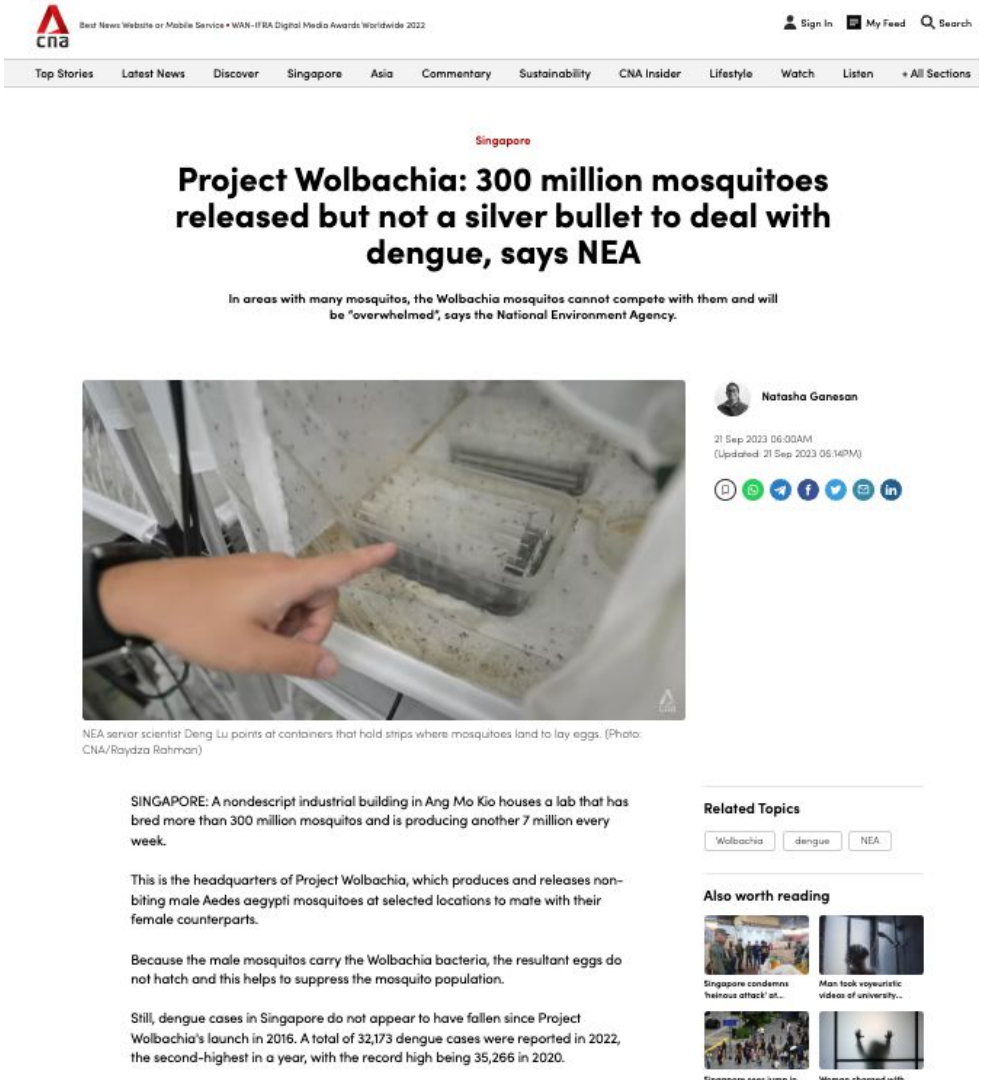
Every Tuesday and Friday morning

Is it working?

CNA, 21 September 2023

"Professor Tikki Pangestu, a visiting professor at NUS' Yong Loo Lin School of Medicine, also highlighted that there are several challenges in scaling up the project countrywide. These include high costs, manpower requirements, potential negative ecological impact on the ecosystem as well as overcoming public concern if more mosquitoes are released."

"(Dr Ng) added that it is not just the number of mosquitoes that matters, but whether the mosquitoes will survive long enough in the field to increase the effectiveness of Project Wolbachia."



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Singapore

Project Wolbachia: 300 million mosquitoes released but not a silver bullet to deal with dengue, says NEA

In areas with many mosquitos, the Wolbachia mosquitos cannot compete with them and will be "overwhelmed", says the National Environment Agency.

Natasha Ganesan

21 Sep 2023 06:00AM
(Updated: 21 Sep 2023 06:14PM)

NEA senior scientist Deng Lu points at containers that hold strips where mosquitoes land to lay eggs. (Photo: CNA/Raydza Rahman)

SINGAPORE: A nondescript industrial building in Ang Mo Kio houses a lab that has bred more than 300 million mosquitos and is producing another 7 million every week.

This is the headquarters of Project Wolbachia, which produces and releases non-biting male Aedes aegypti mosquitoes at selected locations to mate with their female counterparts.

Because the male mosquitos carry the Wolbachia bacteria, the resultant eggs do not hatch and this helps to suppress the mosquito population.

Still, dengue cases in Singapore do not appear to have fallen since Project Wolbachia's launch in 2016. A total of 32,173 dengue cases were reported in 2022, the second-highest in a year, with the record high being 35,266 in 2020.

Related Topics

'Wolbachia' | dengue | NEA

Also worth reading

Singapore condemns 'heinous attack' at...

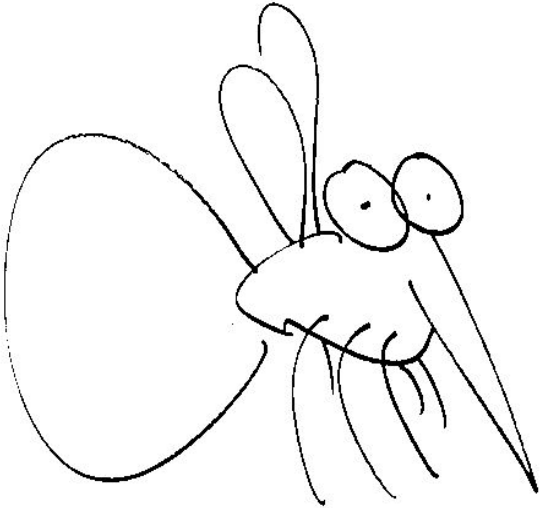
Man took voyeuristic videos of university...

Problem Statement

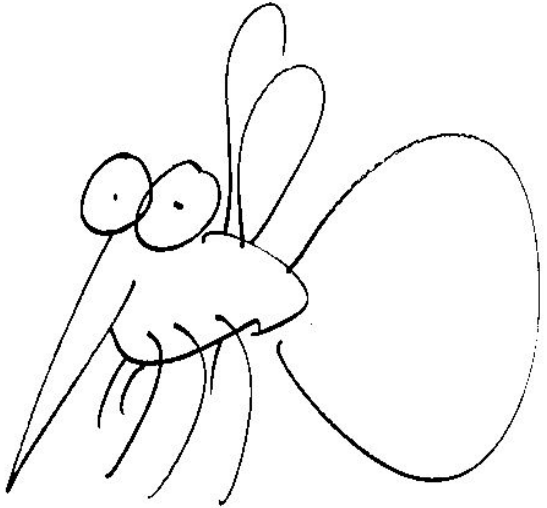
High incidences of dengue fever is a persistent issue in Singapore despite measures taken by the government to curb it. For example, an increase in rainfall could lead to an increase in the population of mosquitoes, which in turn leads to higher incidences of dengue fever.

With the implementation of Project Wolbachia, the drop in the number of dengue cases has been observed. However, the release of Wolbachia-carrying Aedes *aegypti* are currently carried out on a weekly basis, which could be resource intensive and have a negative ecological impact.

As mosquito activity is highly influenced by weather conditions, this project aims to analyse trends in Singapore weather and the number of dengue cases between 2014 to 2018. This analysis can be used to help NEA plan optimal time periods for the release of the male Wolbachia-carrying Aedes *aegypti* into the environment to enhance effectiveness of Project Wolbachia. This can in turn curb dengue transmission to decrease the number of dengue cases.



Analysis



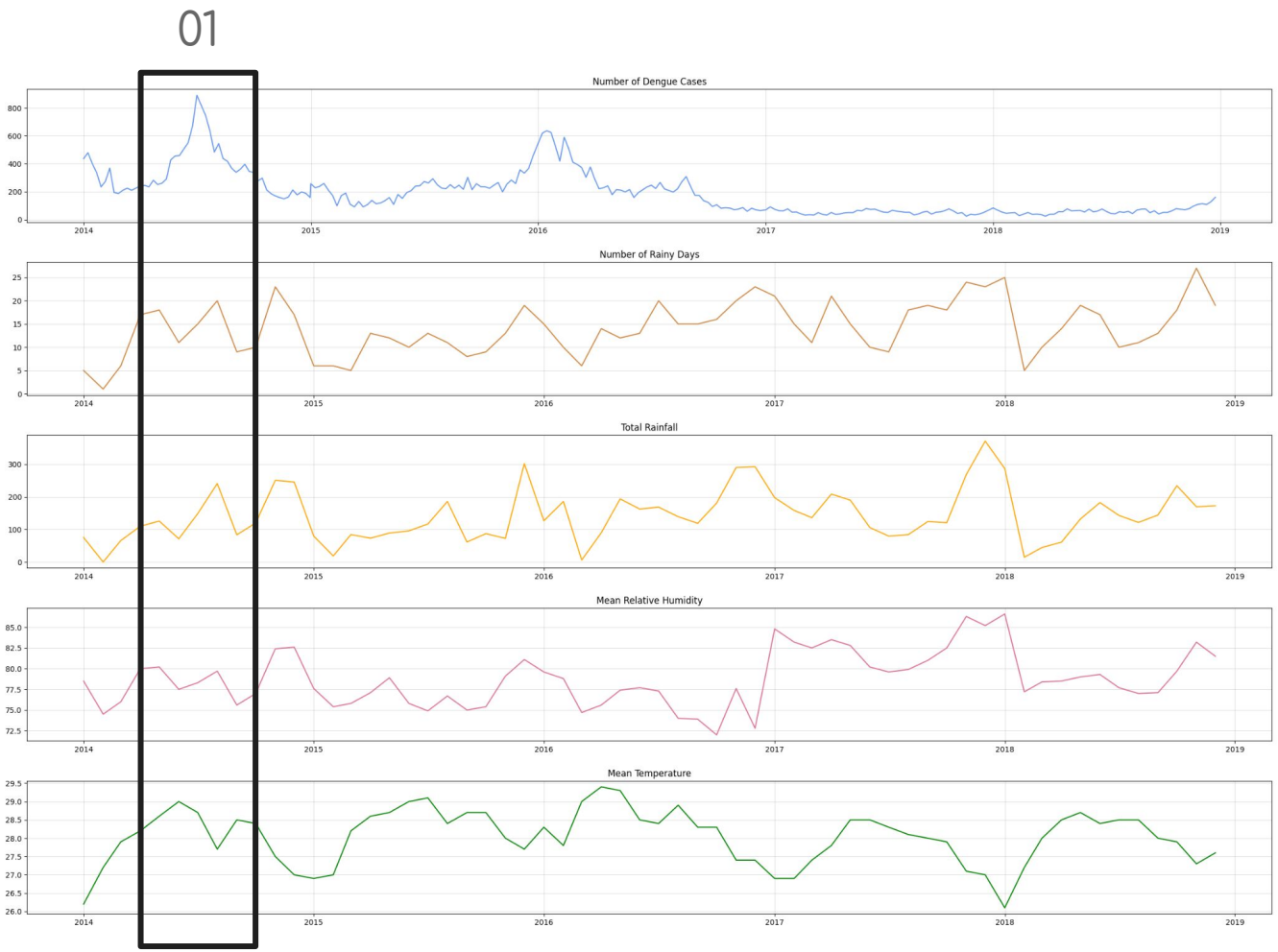
Data Dictionary

Feature	Description
Number of Dengue Cases	Number of dengue cases per week (comprises of dengue fever cases & dengue haemorrhagic cases), from Jan 2014 to Dec 2018
Total Rainfall	Total rainfall per month (mm), from Jan 2014 to Dec 2018
Number of Rainy Days	Total number of days with rainfall per month, from Jan 2014 to Dec 2018
Mean Temperature	Mean monthly temperature in SG (°C), from Jan 2014 to Dec 2018
Mean Relative Humidity	Mean monthly relative humidity in SG, from Jan 2014 to Dec 2018

ANALYSIS

01

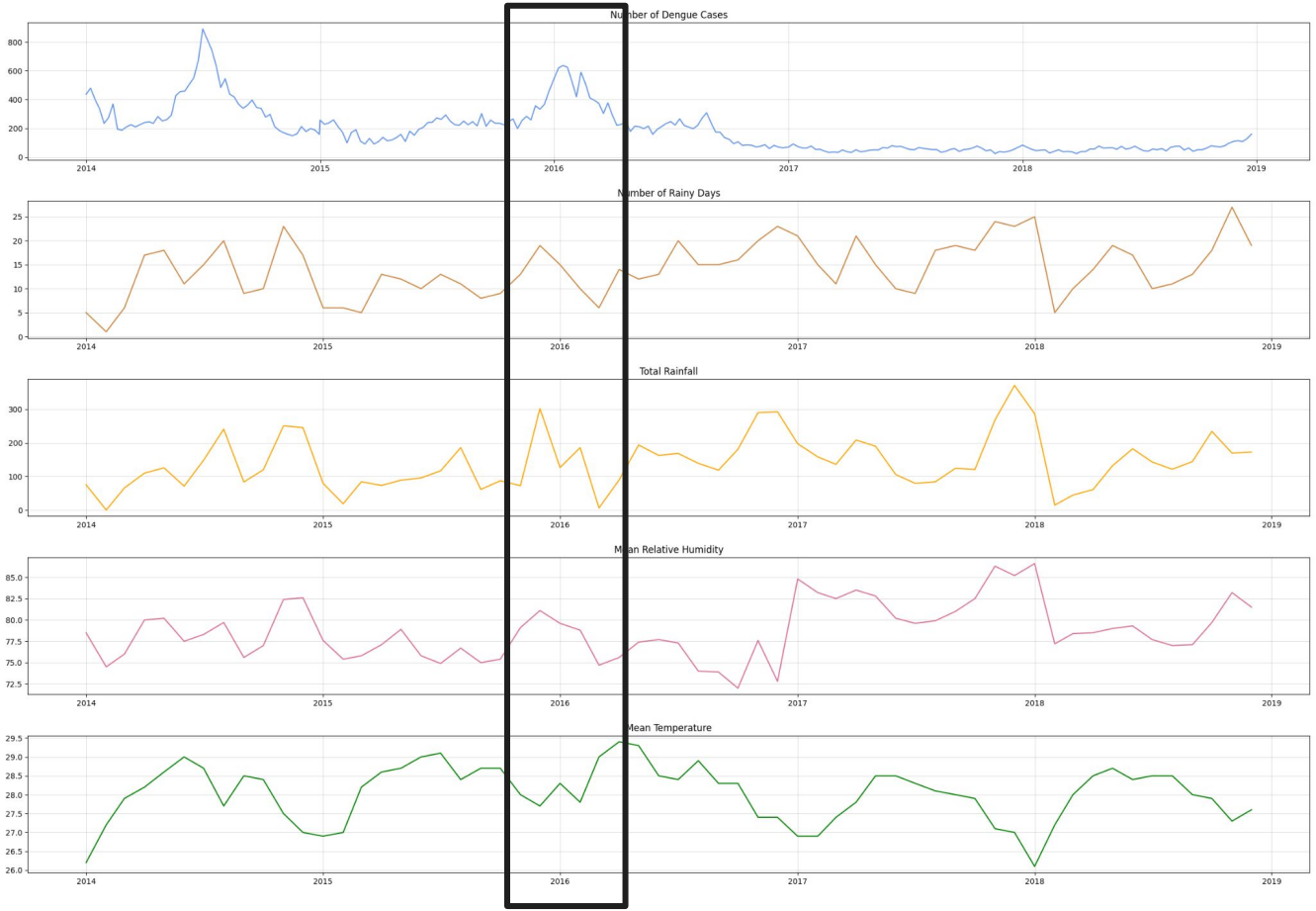
As weather conditions such as rainy days and total rainfall increased towards mid 2014, the increase in dengue cases was observed to peak during the similar period.



ANALYSIS

02

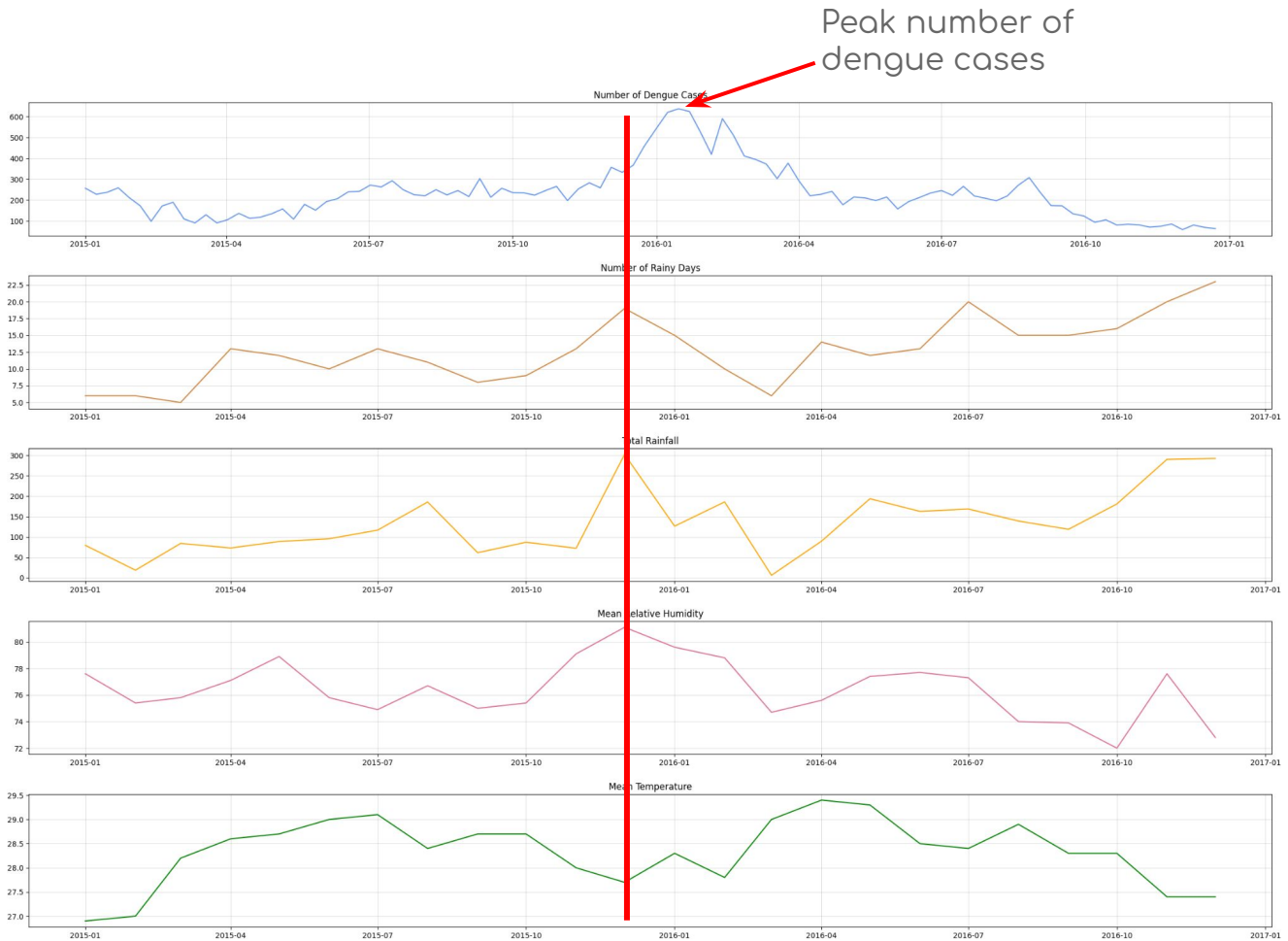
Towards Nov 2015, rainfall and temperature spiked. The peak in the number of dengue cases was delayed by approximately 1 month after the peak of the respective weather conditions.



Analysis

02

The peak of the rainfall and temperature values are observed to coincide with the start of the increase in number of dengue cases.



- Number of Dengue Cases
- Number of Rainy Days
- Rainfall
- Humidity
- Temperature

INSIGHTS

01 & 02

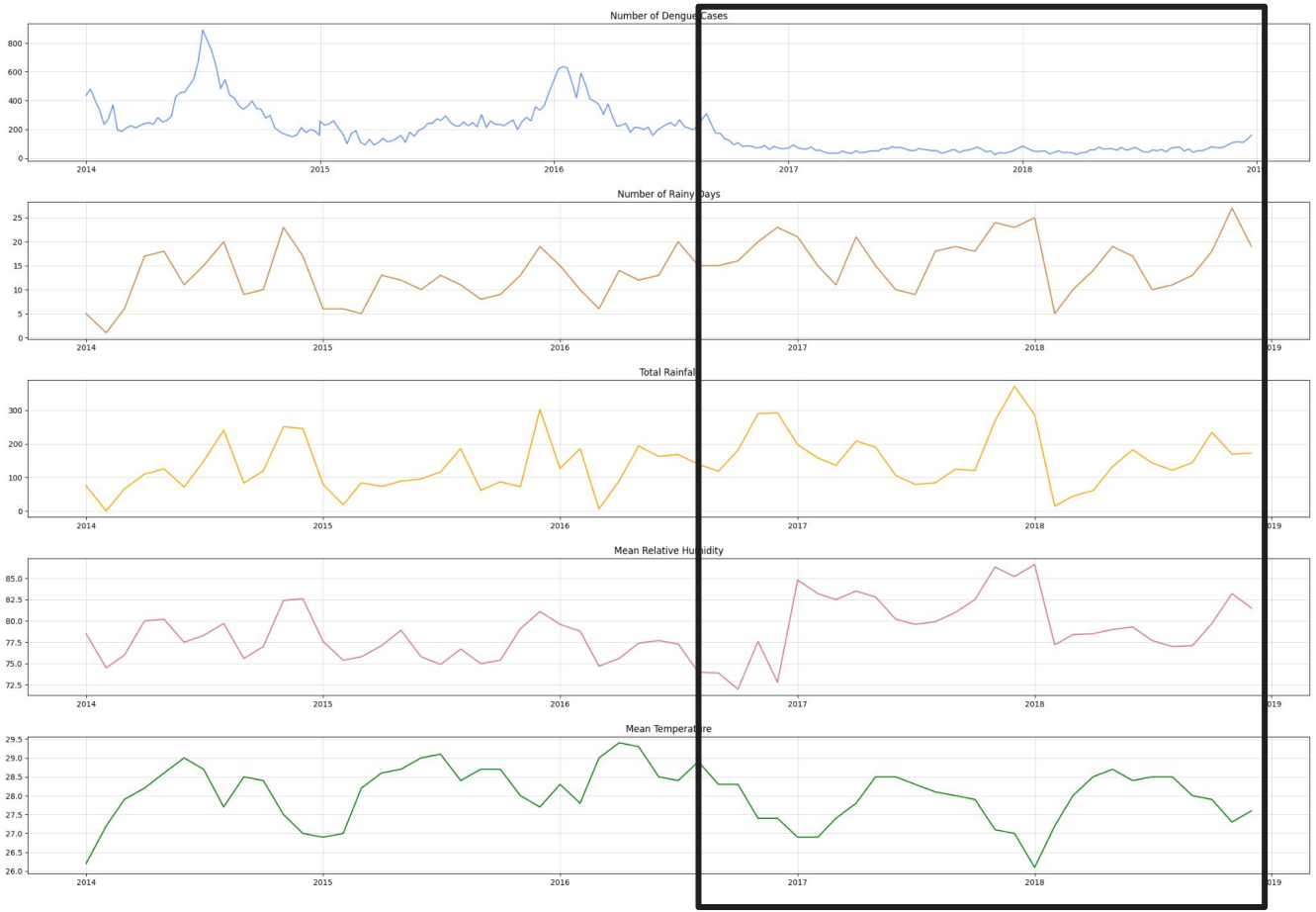
- With the relationship between number of dengue cases and weather conditions, given a known/ estimated weather conditions' profile, profile of increase in dengue cases could be determined
  - Approx. 1 month delay from spike/ dips in weather conditions' profile
  - Peak/dips in weather profile suggests initial increase in dengue cases

- According to available research, the optimal temperature for the survival of Aedes *aegypti* has a mean of 27.5 deg C, similar to the trend seen in the line plot.
  - "... overall the flight performance of Ae. aegypti tethered females was better below 27 °C."
  - "Connor [22] stated that Ae. aegypti is most active at 28 °C. Marchoux et al."

ANALYSIS

03

From Oct 2016 onwards, the number of dengue cases dropped even though there were spikes/ drops in rainfall, temperature and relative humidity.



ANALYSIS

03

Despite the typical spike in rainfall/ temp occurring at the end of 2016, further analysis of the dengue cases profile did not suggest an increase in number of infections.

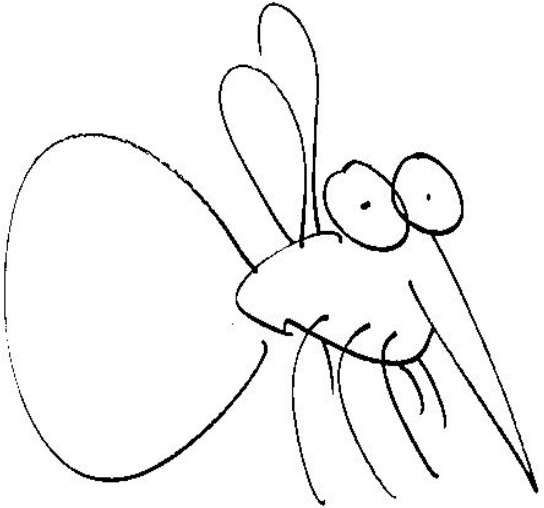
- Number of Dengue Cases
- Number of Rainy Days
- Rainfall
- Humidity
- Temperature

INSIGHTS

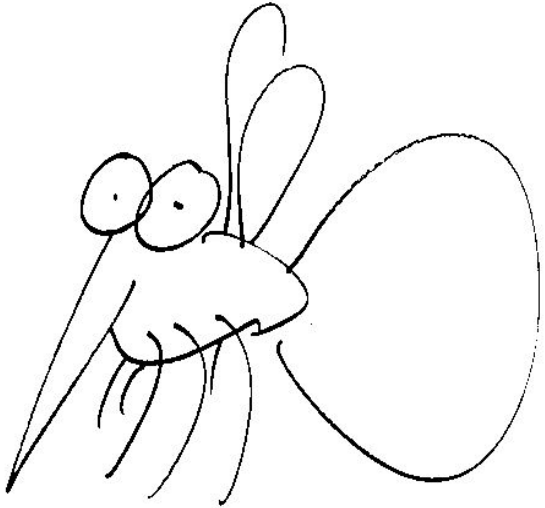
03

- The drop in number of dengue cases from Oct 2016 could be attributed to the launch of Project Wolbachia during the same time frame

- Number of dengue cases did not drastically increase despite the spike/ dip in weather conditions in Dec 2016 as compared to prior of project launch
    - Could indicate the effectiveness of the project in curbing mosquito breeding and reduction in dengue cases



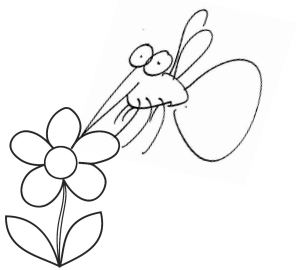
Our Recommendations



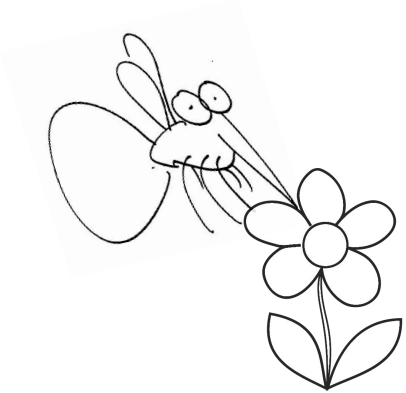
RECOMMENDATIONS

- Propose for time-specific release of Wolbachia mosquitoes to maximise cost-efficiency and optimal use of resources (e.g. manpower), while reducing ecological impact

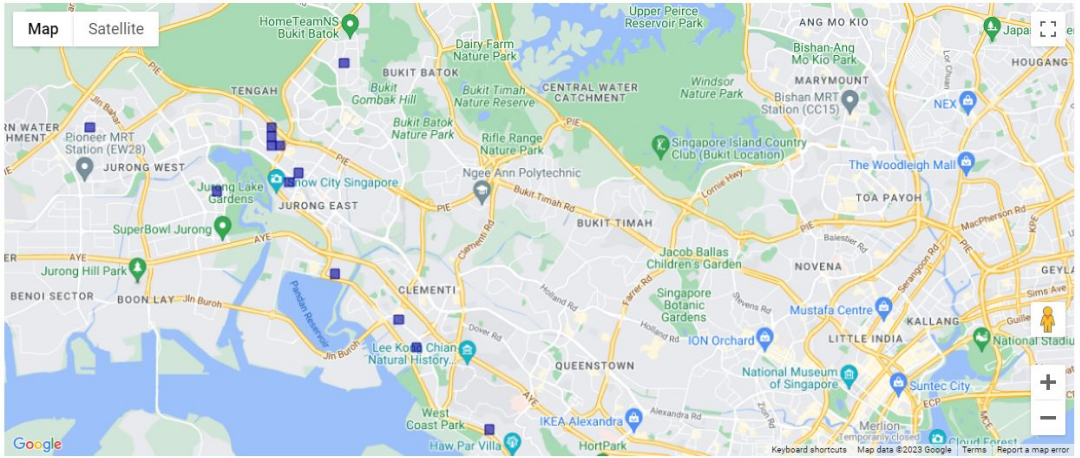
- Release of Wolbachia male mosquitoes are recommended to be 2-4 weeks before the spike in rainfall/ temperature profile
    - Spike in rainfall/ temperature suggests to initial increase in dengue cases
    - Life cycle of mosquito is approx. 2-4 weeks



RECOMMENDATIONS

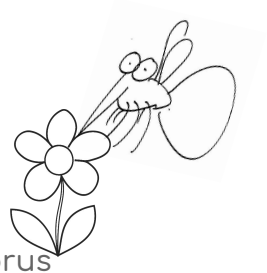


Aedes Mosquito Breeding Habitats - South West (GEOJSON)

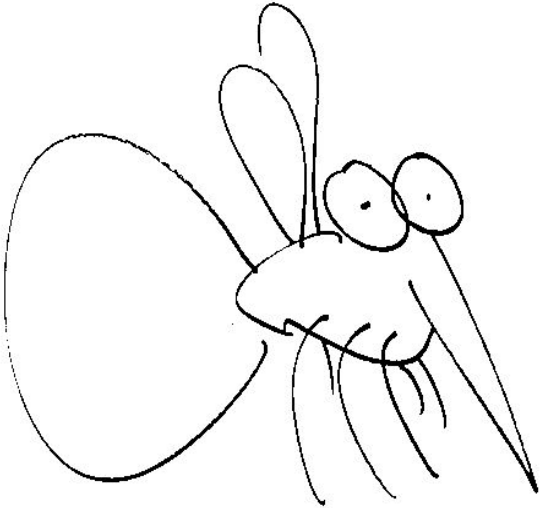


- Prediction of profiles in spikes/ drops in weather conditions would be critical in planning for the release of the mosquitoes
    - Prediction of weather conditions could be readily obtained for analysis; from wide availability of past historical data
    - Partnership with meteorological services for minimal error in weather prediction could be explored

References



1) The Effect of Weather Variables on Mosquito Activity: A Snapshot of the Main Point of Entry of Cyprus (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7068582/)
2) Singapore's 5 decades of dengue prevention and control—Implications for global dengue control (https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0011400#sec003)
3) Effects of the Environmental Temperature on *Aedes aegypti* and *Aedes albopictus* Mosquitoes: A Review (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6316560/#B24-insects-09-00158)
4) Mosquito Life Cycle (https://www.cdc.gov/dengue/resources/factsheets/mosquitolifecyclefinal.pdf)
   Vector-Borne Diseases Research Programme (https://www.nea.gov.sg/corporate-functions/resources/research/vector-borne-diseases-research-programme)
5) Wolbachia-Aedes Mosquito Suppression Strategy (https://www.nea.gov.sg/corporate-functions/resources/research/wolbachia-aedes-mosquito-suppression-strategy)
6) Project Wolbachia: 300 million mosquitoes released but not a silver bullet to deal with dengue, says NEA (https://www.channelnewsasia.com/singapore/project-wolbachia-mosquito-dengue-nea-facility-3773176)



Thank you!