D-E-N-G-U-E Predictor

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- Conclusion & Recommendations

Executive Summary

Executive Summary

This summary outlines findings of our project predicting dengue cases in Singapore using models such as SARIMAX, Linear Regression, and XGBoost. Key features engineered integrated into the model included 'Project Wolbachia' and an 'External Events' factor to account for events such as COVID-19, which raised the numbers out of the norm. Lagged values were also used to realistically predict the values for Linear Regression and XGBoost, however SARIMAX proved the most effective in forecasting future cases.

A cost-benefit analysis was also done to evaluate Project Wolbachia's impact on dengue in Singapore, concluding its effectiveness in reducing dengue-related costs and DALYs. Our recommendations include continuing Project Wolbachia as a proactive measure against dengue and utilizing SARIMAX for future predictions.

This project highlights the importance of predictive modeling in public health, aiding Singapore in managing dengue outbreaks and reducing associated burdens.

Mosquitoes and Dengue

Nature's own Terminator

Relentless Pursuit

Advanced Tracking

Extremely Adaptable

Persistent

Difficult to eliminate

Destructive

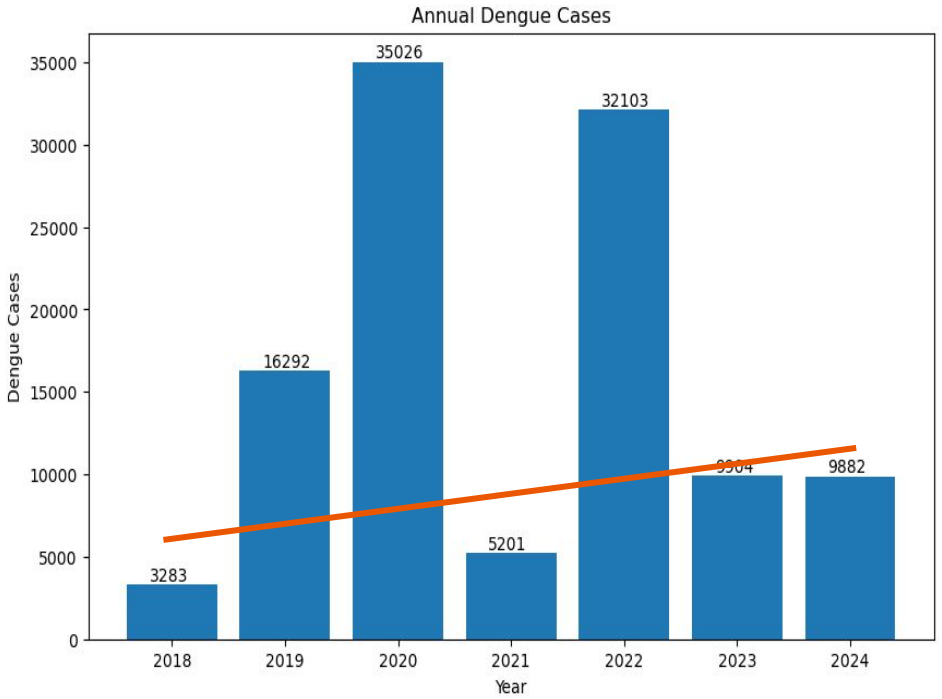
Mosquito as Disease Vectors

1. **Mosquitoes as Vectors**
   - Dengue
   - Zika
   - Chikungunya
   - Malaria..

2. **Widespread and Adaptable**
   - All continents except Antarctica
   - Urban and rural locales
   - Very receptive to climate change

3. **Economic liability**
   - estimated costs of US$20Bn globally and rising
   - wider socioeconomic impact across all ages

Rising Dengue cases in Singapore



NEA's approach to Dengue

1. **Prevention**
   Community monitoring and education programmes such as **B-L-O-C-K**

2. **Protection**
   Active management incl. fogging and spraying DEET i.e. **S-A-W**

3. **Research**
   Ongoing analysis on mosquito samples (using Gravitraps) and initiatives such as Project Wolbachia

Project Overview

Project Overview

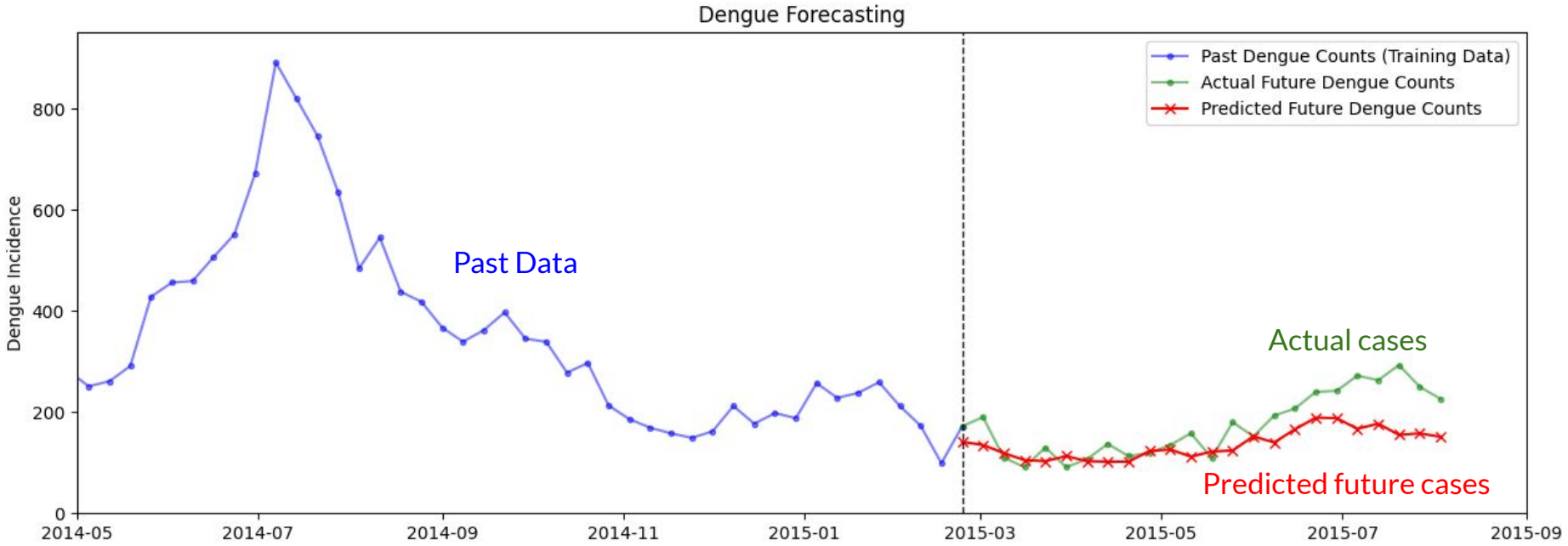
Forewarned is forearmed...

Use data science and ML to predict dengue cases over a short period (8 weeks) and a longer term (24 weeks)

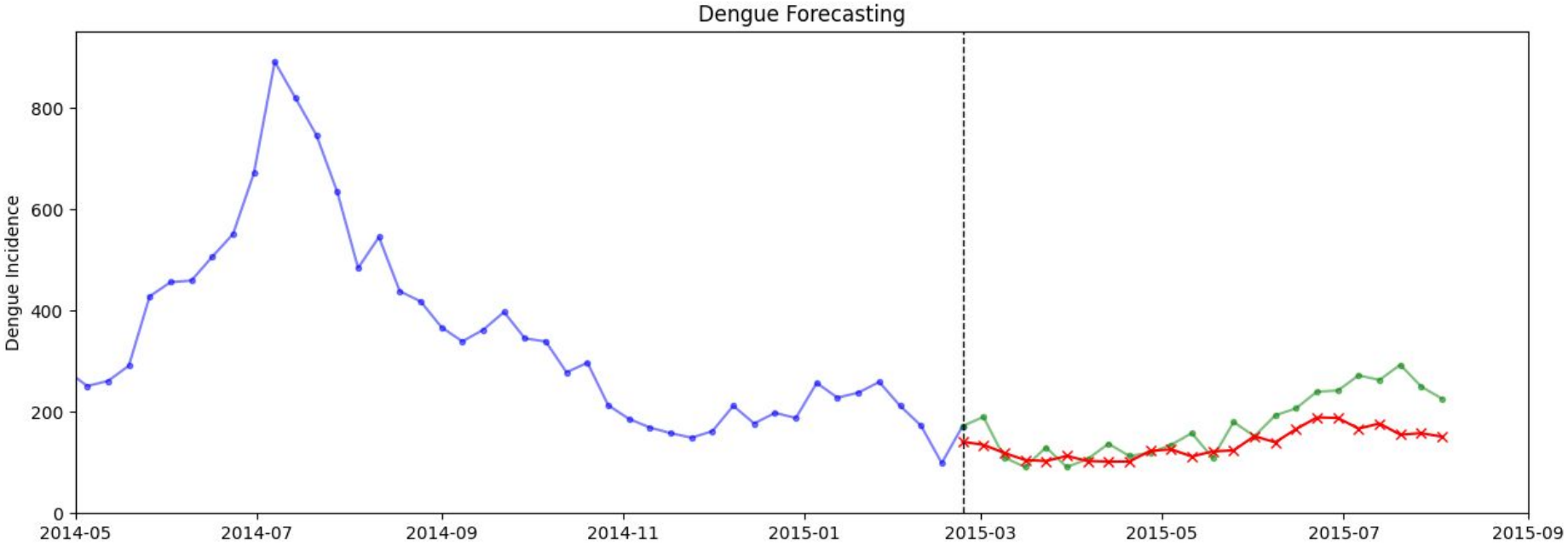
Present a cost-benefit analysis on Project Wolbachia with a focus on economic and long-term effects.

Methodology

Dengue Fever Forecasting



Model Training - Data



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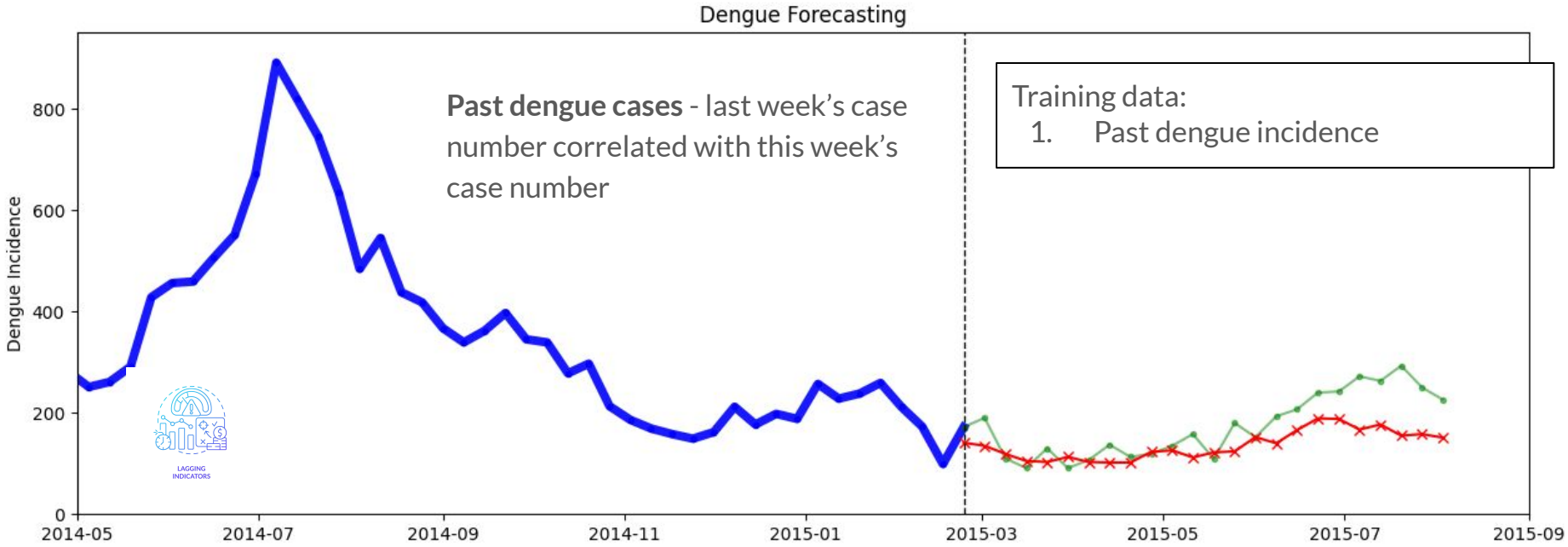

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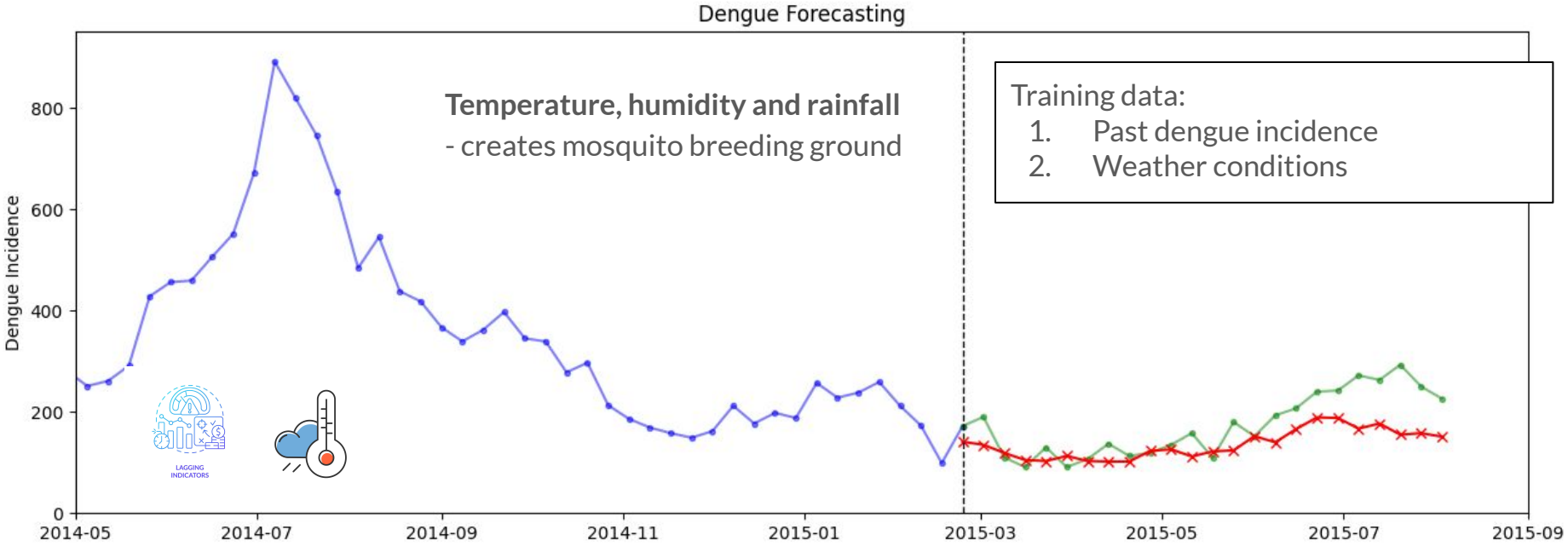

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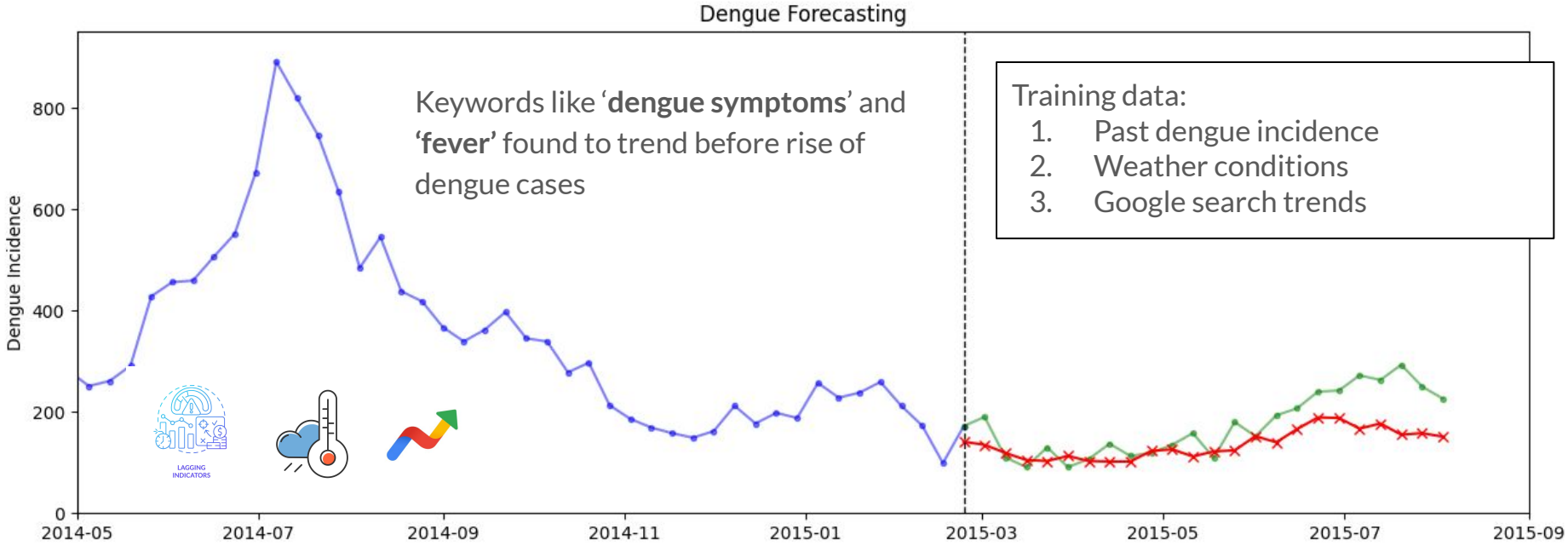
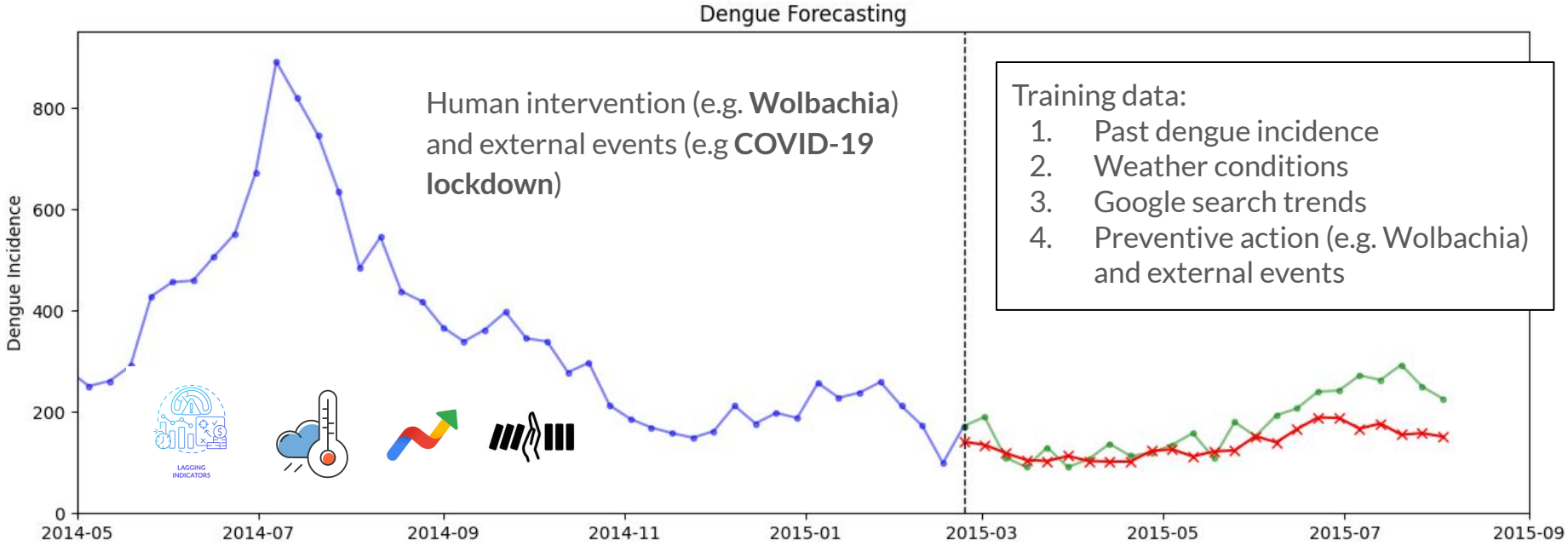
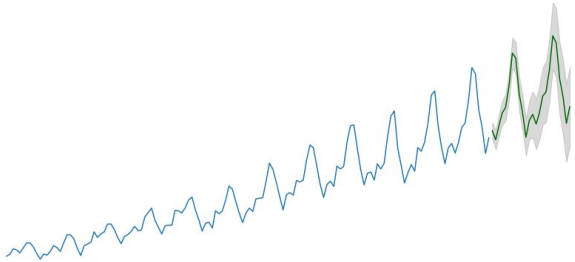


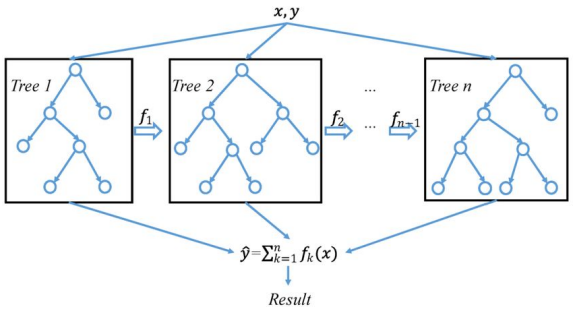
Model Training - Data



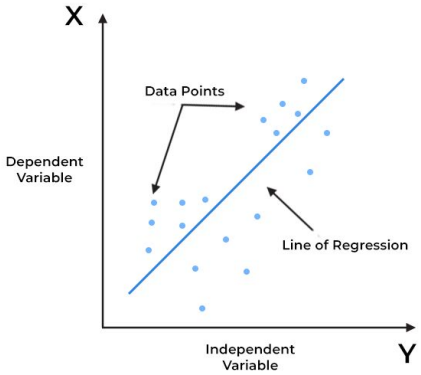
Model Training - Models



SARIMAX



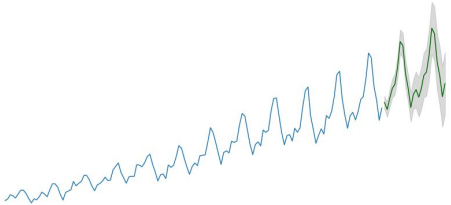
XGBoost



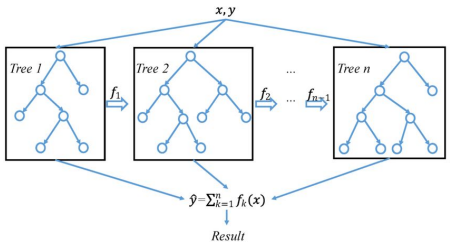
Linear Regression

Key findings

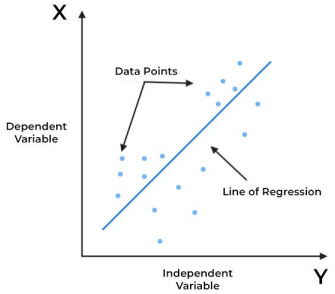
Model Comparison



SARIMAX



XGBoost



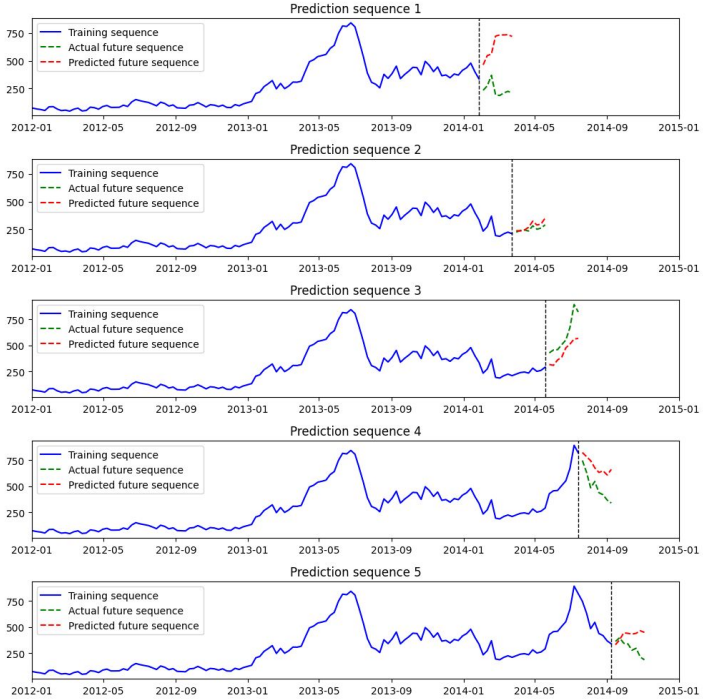
Linear Regression

Evaluating model performance on two forecast windows:

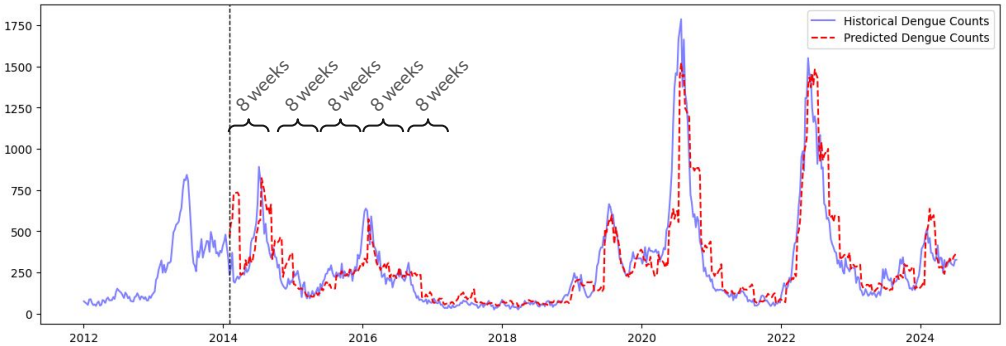
- Short-term forecasting - 8 weeks
- Long-term forecasting - 24 weeks

Metric: Mean Absolute Error (MAE)

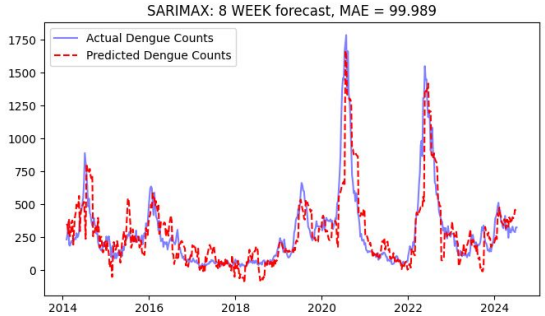
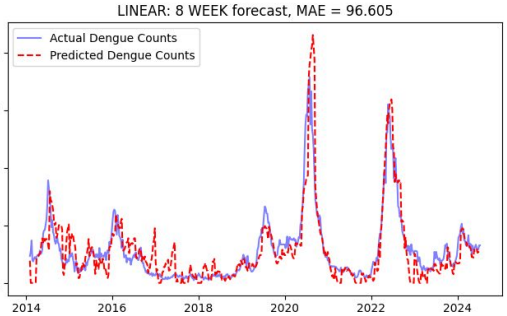
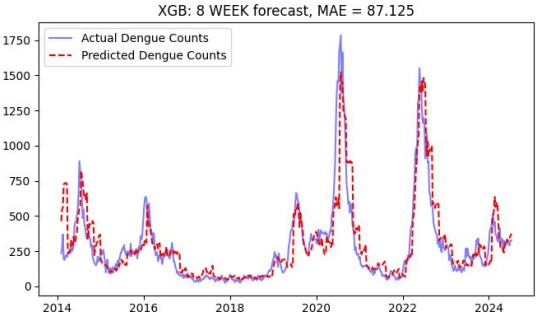
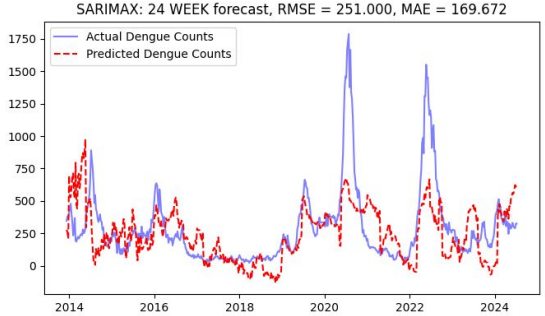
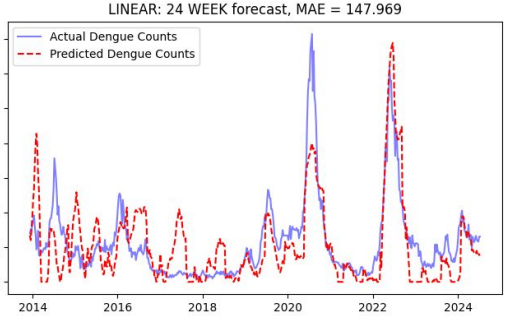
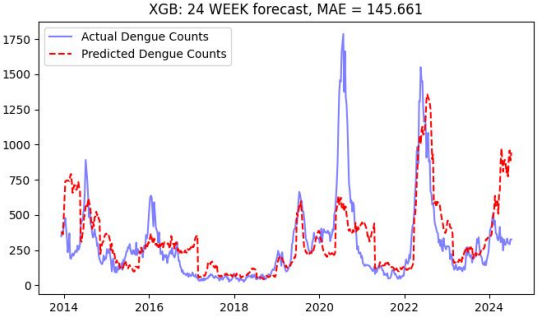
Model Comparison - Evaluation Approach



Time series split validation

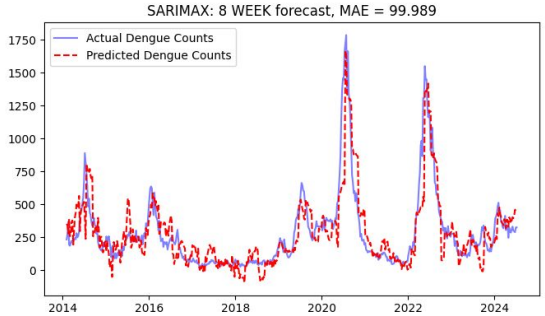
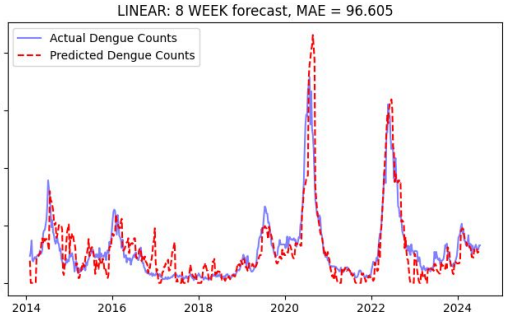
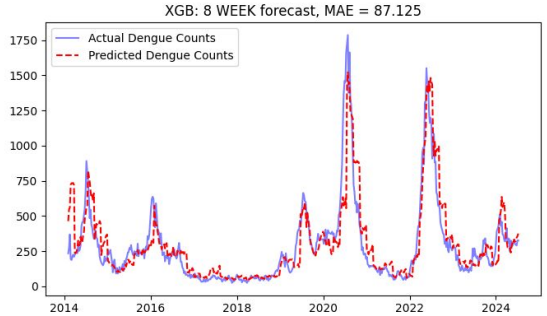
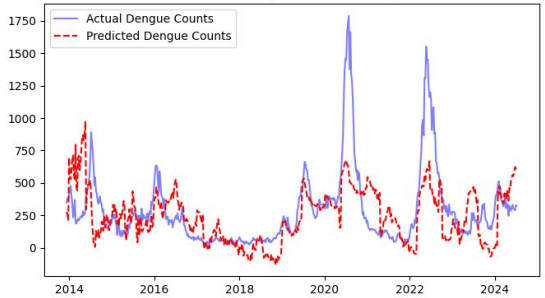
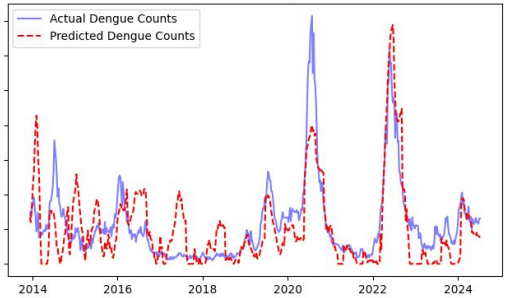
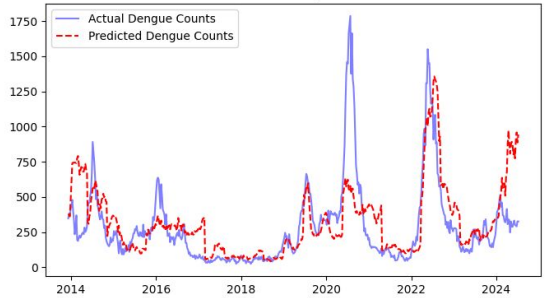


Model Comparison

	SARIMAX	LINEAR REG	XGBOOST
Short term (8 weeks)			
Long term (24 weeks)			

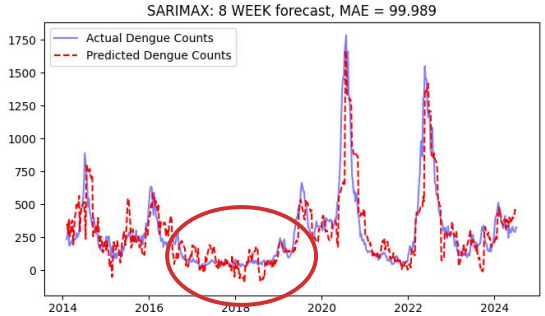
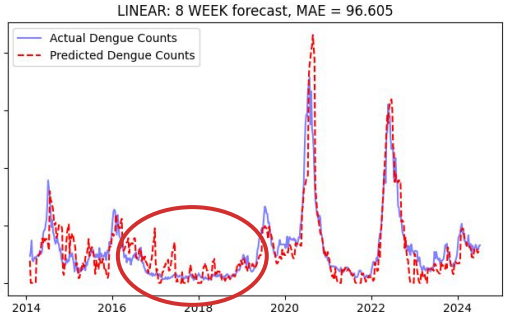
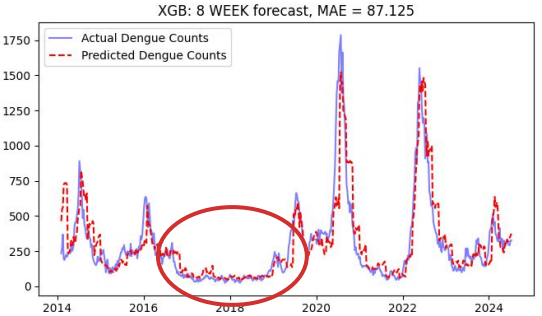
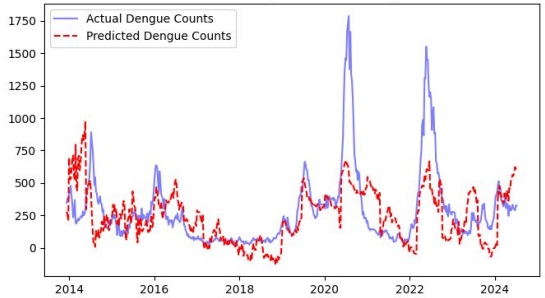
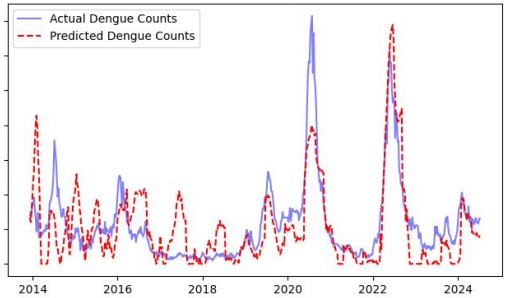
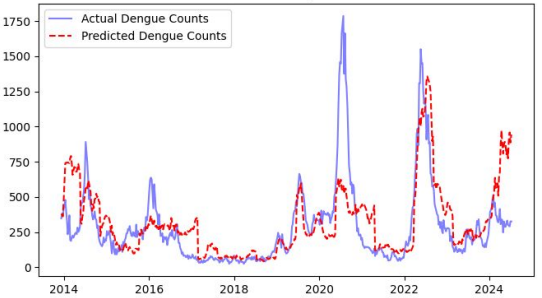
Model Comparison

Reduced performance for longer forecast window

	SARIMAX	LINEAR REG	XGBOOST
Short term (8 weeks)			
Long term (24 weeks)			

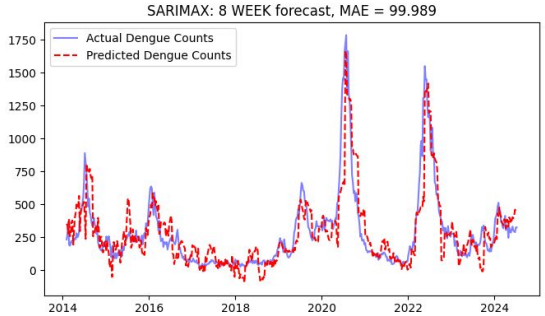
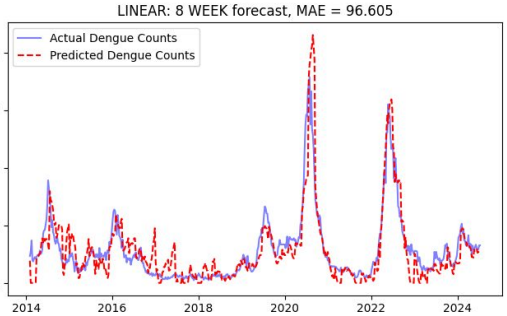
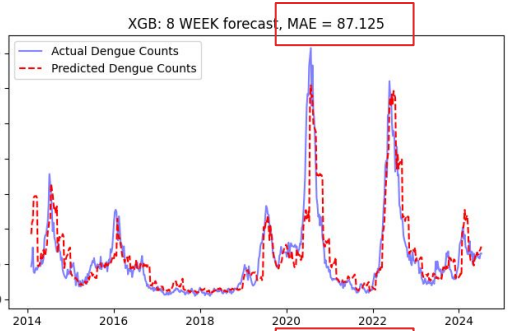
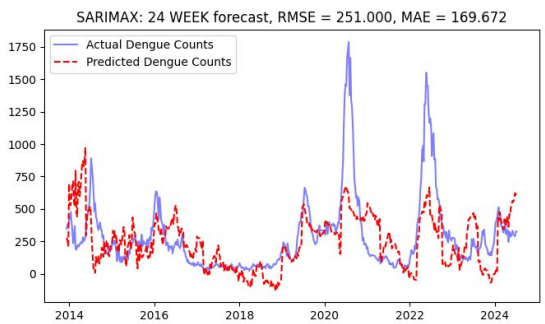
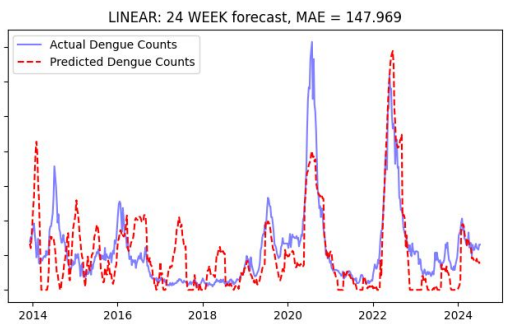
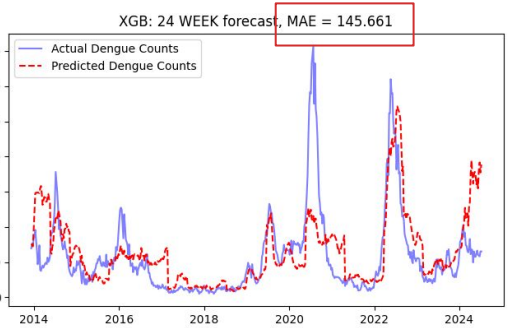
Model Comparison

Lower noise in XGBoost model

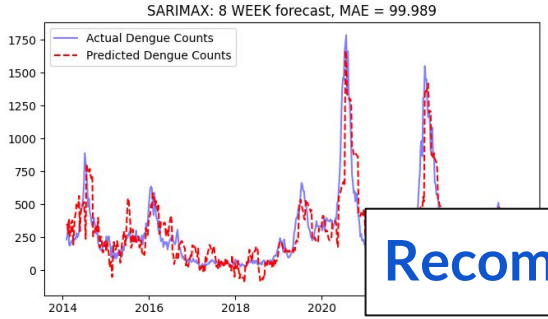
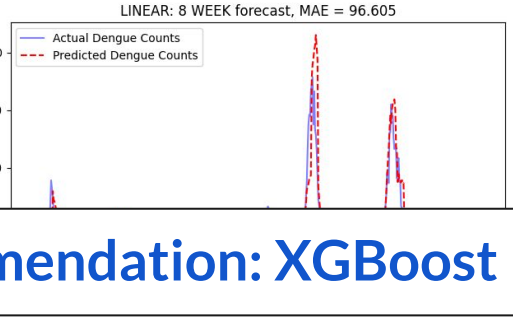
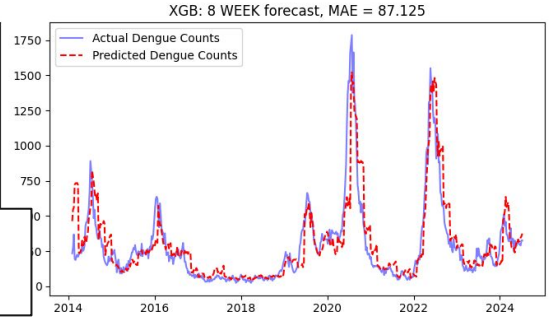
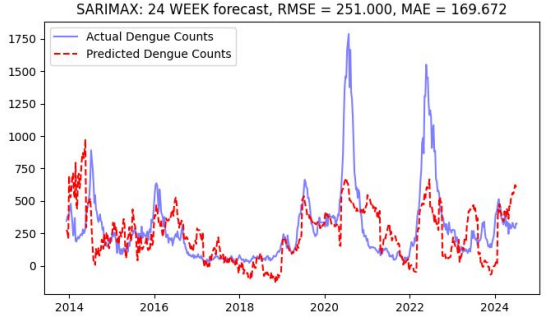
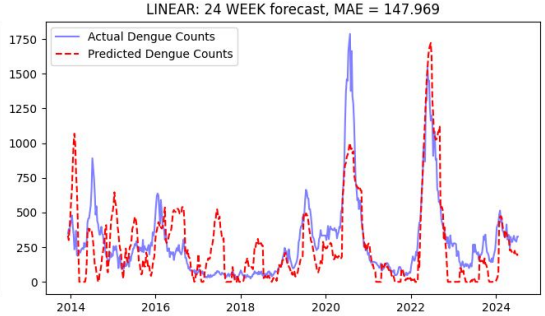
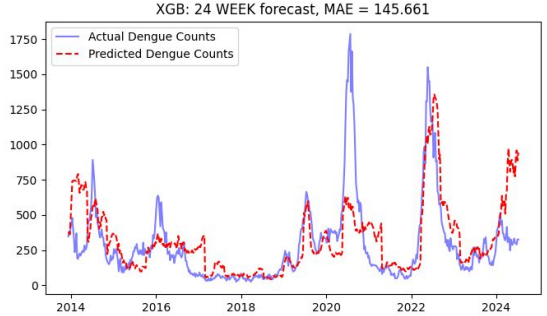
	SARIMAX	LINEAR REG	XGBOOST
Short term (8 weeks)			
Long term (24 weeks)			

Model Comparison

Lowest MAE for XGBoost model

	SARIMAX	LINEAR REG	XGBOOST
Short term (8 weeks)			
Long term (24 weeks)			

Model Comparison

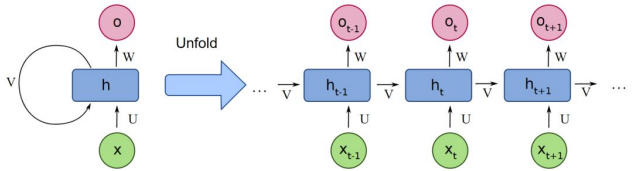
	SARIMAX	LINEAR REG	XGBOOST
Short term (8 weeks)			
Long term (24 weeks)			

Recommendation: XGBoost

Model - Future Work

Possible improvements:

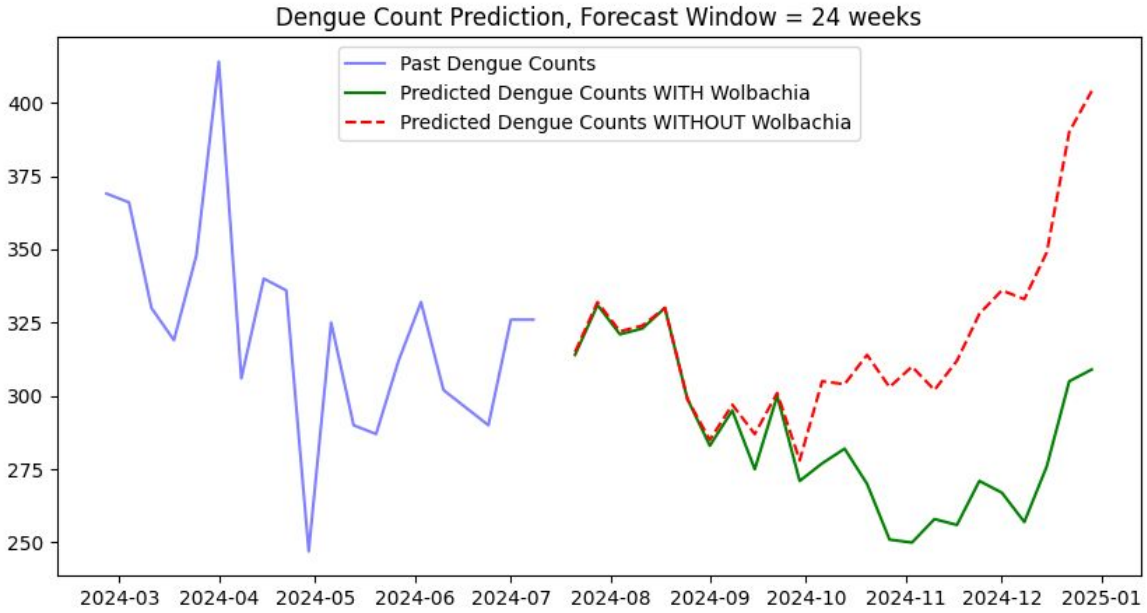
- Consider other models, e.g. Recurrent Neural Network (RNN)



- Additional data:
  - Normalized Difference Vegetation Index (NDVI) - vegetation cover
  - Dominant dengue virus serotypes, e.g. serotype 1 (DENV-1) associated with end 2023 dengue rise
  - Other public health intervention programs

Model Insight - Wolbachia Project

XGBoost: Dengue cases WITH Wolbachia vs WITHOUT Wolbachia



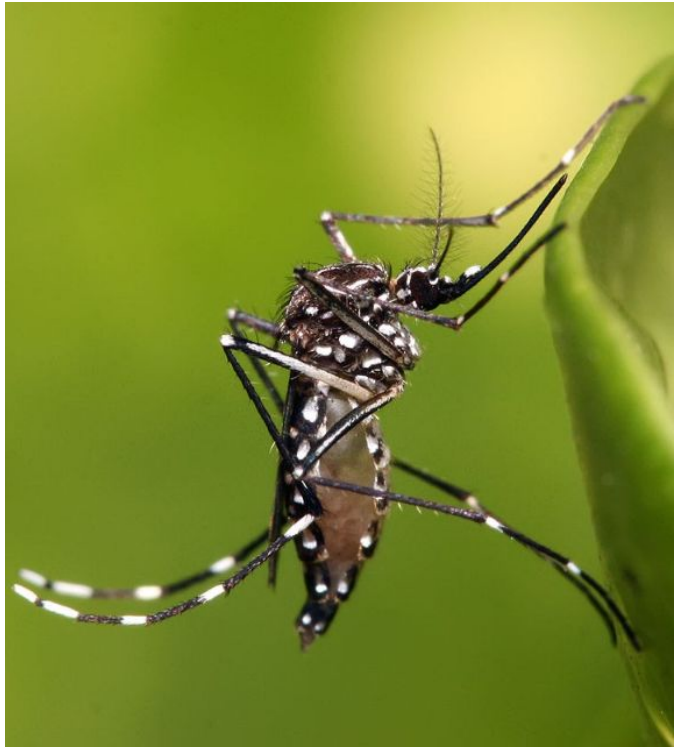
Recommendation:

Continue/enhance Wolbachia efforts

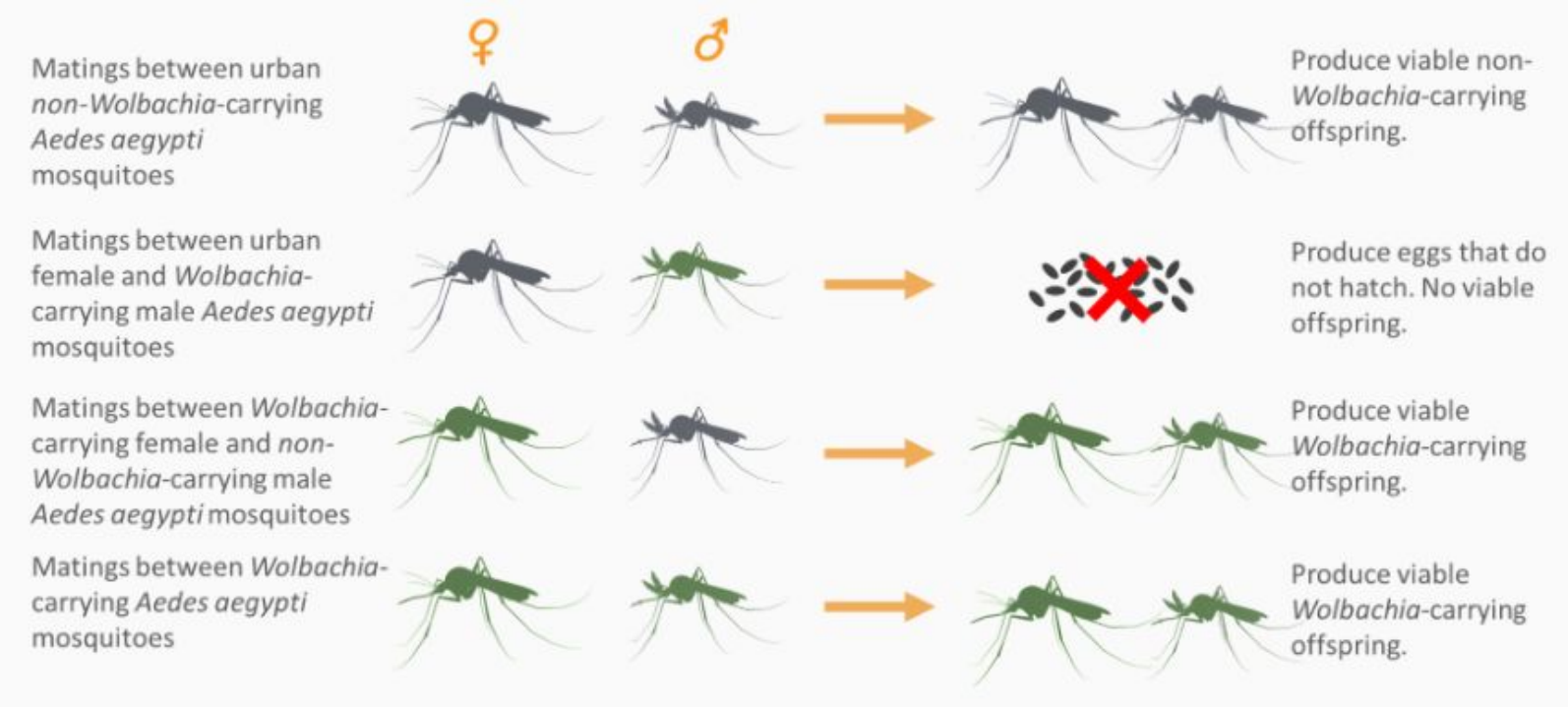
Cost-benefit analysis: Project Wolbachia

Project Wolbachia

- Wolbachia Bacteria
- *Wolbachia-Aedes* vs *Aedes aegypti* mosquitoes
- Controlled breeding and selection of *Wolbachia-Aedes* mosquitoes
- Introducing Wolbachia bacteria-carrying male mosquitoes into the field to reduce the number of Aedes aegypti mosquitoes within the whole population: Suppression & Replacement
- Multiple studies started in 2016, currently still ongoing and increasing release sites
- Resource and cost intensive



Project Wolbachia



Key Measures for Analyses

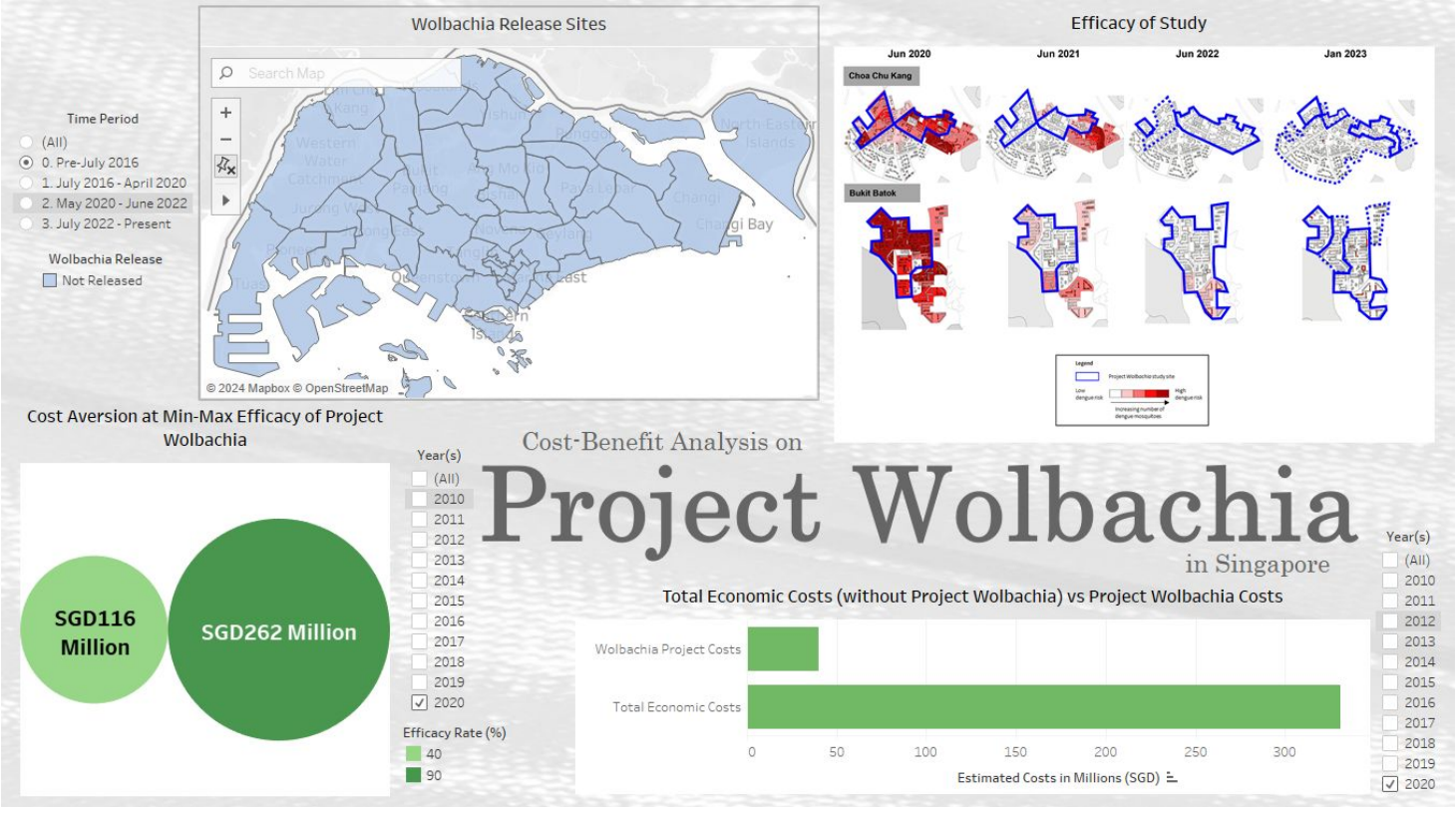
- Direct Costs
- Indirect Costs
- Disability-Adjusted Life Years (DALYs)
- Cost of Project

*We based our analyses from multiple sources, but mainly from a research article published in Singapore in 2021:

Economic impact of dengue in Singapore from 2010 to 2020 and the cost-effectiveness of Wolbachia interventions

Soh S, Ho SH, Seah A, Ong J, Dickens BS, et al. (2021) Economic impact of dengue in Singapore from 2010 to 2020 and the cost-effectiveness of Wolbachia interventions. PLOS Global Public Health 1(10): e0000024. https://doi.org/10.1371/journal.pgph.0000024

Project Wolbachia Dashboard



Project Wolbachia Dashboard

Mobile:

PC/Laptop: https://public.tableau.com/app/profile/mohamad.faeliq.ramley/viz/WolbachiaCostBenefit/ProjectWolbachiaSingapore

Conclusion & Recommendations

Conclusion & Recommendations

Conclusion

In conclusion, this project underscores the importance of predictive modeling in public health initiatives such as dengue prevention. By leveraging advanced data science techniques and integrating relevant features like Project Wolbachia, Singapore can better anticipate and manage dengue outbreaks, ultimately reducing the societal and economic burden associated with this mosquito-borne disease.

Recommendations

Based on the findings, it is recommended to continue investing in Project Wolbachia as a proactive measure against dengue outbreaks in Singapore. The XGBoost model is recommended for ongoing use due to its reliable forecasting ability and suitability for predicting future dengue case numbers.