The forecasting for dengue fever in Nakhon Si Thammarat Province , Thailand

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Abstract :

This project presents the forecast of dengue fever in Nakhon Si Thammarat Province, Thailand, by using Winters additive exponential smoothing and Winters' multiplicative exponential smoothing. The number of dengue fever data in Nakhon Si Thammarat are used since 2015 - 2019 and compared the accuracy of the forecast by MAD.

The results of the study revealed that from all the methods of forecasting studied The most accurate method is the Winters' additive exponential smoothing method, with the forecasting equation as follows :

$$F_{t+m}=214.9673221+1.893106655m+S_{t-L+m}$$

Keywords : Dengue Fever , Forecast , Trend , Seasonal

Research Question and Hypothesis :

Forecast Winters' additive exponential smoothing method is more accurate than Forecast Winters' multiplicative exponential smoothing method.

Introduction :

Nakhon Si Thammarat Province , Thailand, this area is high-risk for dengue fever. Dengue fever is a disease caused by infection with the dengue virus, where the *Aedes*. mosquitoes carry the dengue virus. (WHO 2017) There are four types of dengue virus, DENV-1, DENV. -2, DENV-3 and DENV-4 carry female *Aedes.* mosquitoes. When *Aedes*. mosquitoes suck the blood of a patient infected with dengue virus. The virus will enter into the mosquito's stomach and salivary glands with an incubation period of approximately 8-12 days. The epidemic followed by dengue fever. Dengue cases have been exposed to a particular strain of the virus will have a specific immune system. If exposed to a different strain of the virus from the first time, it can be dengue fever again. In general, the symptoms of the second time are more severe than the first. Each year, it was found that the distribution of all four strains circulated and the dominant infection varies from year to year causing an outbreak of disease throughout because people are not immune to the virus species.

Therefore, this project aim to predict future dengue fever in order to monitor and plan to prevent people in Nakhon Si Thammarat Province , Thailand.

Research Methods and Materials :

Study site

The study was conducted at Nakhon Si Thammarat Province , Thailand (8° 26' 24'' N , 99° 59' 7'' E) (Figure 1)

Figure 1. Map of Thailand and study site at Nakhon Si Thammarat Province , Thailand.

Data Collection

Data Collecting for dengue fever in Nakhon Si Thammarat Province, Thailand since 2015 to 2019 and dengue case data in Nakhon Si Thammarat Province, Thailand year 2020.

Environmental studies

We collect environmental information Daily temperature using GLOBE Observer.

Data Analysis

This is done by using the Winters additive exponential smoothing method and Winters' multiplicative exponential smoothing method as forecast by using formation of forecasting equations. Which gives different weights to each data. And the time series as variation process. The exponential smoothing methods are process to study influence on the variable.

The Forecast model Winters' additive exponential smoothing method as,

$$F_{t+m} = A_t + T_t m + S_{t-L+m}$$

Where

F_{t+m} represent the forecast at t + m time, where m is the number of time periods to forecast forward.

A_t represent an estimate of the level of data at month t .
$T_t m$ represent the trend estimate for the data at month t .
S_{t-L+m} represent the seasonality estimate of the data at month t .

Where $A_t = \alpha(y_t - s_{t-L}) - (1-\alpha)(A_{t-1} + T_{t-1})$

$T_t = \beta(A_t - A_{t-1}) + (1-\beta)T_{t-1}$

$S_t = \gamma(y_t - A_t) + (1-\gamma)S_{t-L}$

α , δ and γ represent the smoothing constants, where $0 < \alpha < 1$, $0 < \delta < 1$ and $0 < \gamma < 1$,

The Forecast model Winters' multiplicative exponential smoothing method

$$F_{t+m} = (A_t + T_t m)S_{t-L+m}$$

Where F_{t+m} represent the forecast at t + m time, where m represents the number of time periods to forecast forward.
A_t represent an estimate of the level of data at month t .
$T_t m$ represent the trend estimate for the data at month t .
S_{t-L+m} represent the seasonality estimate of the data at month t .

Where $A_t = \alpha \frac{y_t}{S_{t-L}} + (1-\alpha)(A_{t-1} + T_{t-1})$

$T_t = \beta(A_t - A_{t-1}) + (1-\beta)T_{t-1}$

$S_t = \gamma \frac{y_t}{A_t} + (1-\gamma)S_{t-L}$

α , δ and γ represent the smoothing constants, where $0 < \alpha < 1$, $0 < \delta < 1$ and $0 < \gamma < 1$

The forecast Comparation by using the Mean Absolute Deviation (MAD) from the two forecasting methods, Winters' additive exponential smoothing method and Winters' multiplicative exponential smoothing method Forecast model Mean Absolute Deviation (MAD)

$$MAD = \frac{\sum|\text{Real value} - \text{Forecast value}|}{N}$$

Results :

Forecasting results form Winters' additive exponential smoothing method , form can be obtained as follows:

$$F_{t+m} = 214.9673221 + 1.893106655m + S_{t-L+m}$$

The forecast results as shown in the table 1 :

Table 1. The results of Winters' additive exponential smoothing method forecast.

Year - Month	S_{t-L}	F_{t+m}
2563 - jan	-9.3850	207
2563 - feb	-36.9699	182
2563 - mar	-52.8268	168
2563 - apr	-66.7508	156
2563 - may	-58.4220	166
2563 - jun	6.8474	233
2563 - jul	83.6866	312
2563 - aug	56.7915	287
2563 - sep	42.7979	275
2563 - oct	26.3326	260
2563 - nov	63.0745	299
2563 - dec	30.0866	268
Total		**2813**

Forecasting results form Winters' multiplicative exponential smoothing method , form can be obtained as follows:

$$F_{t+m} = (266.3433649 - 3.067346384m)S_{t-L+m}$$

Table 2. The results Winters' multiplicative exponential smoothing method forecast.

Year - Month	S_{t-L}	F_{t+m}
2563 - jan	0.8893	234
2563 - feb	0.6471	168
2563 - mar	0.5295	136
2563 - apr	0.4278	109
2563 - may	0.4524	114

2563 - jun	0.9536	236
2563 - jul	1.5385	377
2563 - aug	1.3521	327
2563 - sep	1.2497	298
2563 - oct	1.1198	264
2563 - nov	1.4399	335
2563 - dec	1.2118	278
รวม		**2876**

Table 3. the results of the MAD value of the forecast.

Method	MAD
Winters' additive exponential smoothing	174.2111
Winters' multiplicative exponential smoothing	179.5290

The comparing of forecast data with the actual data as shown in the figure(2) below.

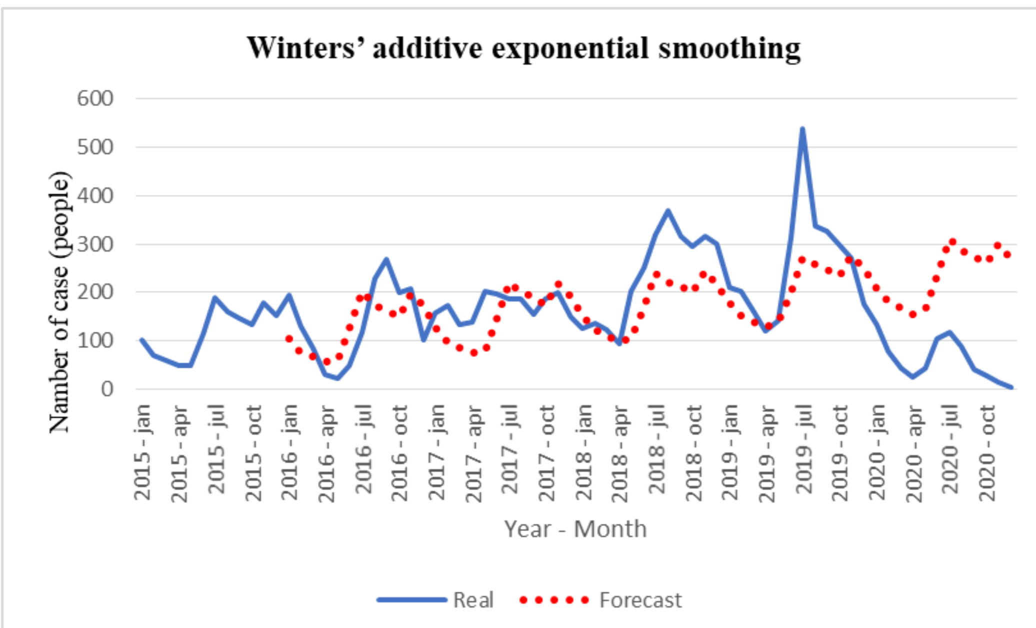

Figure 2. The graph shows the number of dengue cases. Nakhon Si Thammarat Province, Thailand Since the year. 2015 to 2019 and forecast of the number of dengue cases Nakhon Si Thammarat Province,Thailand year 2020

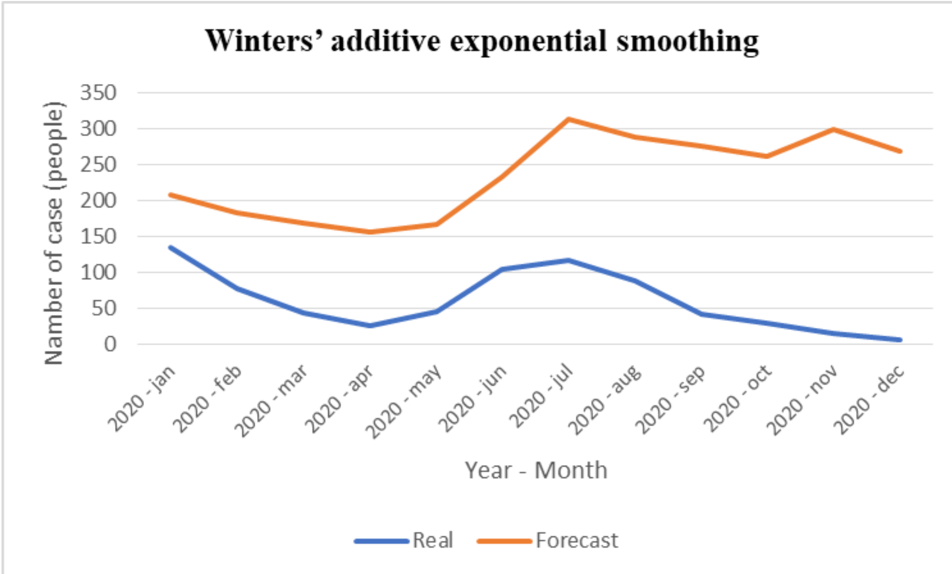

Figure 3. The number of dengue cases in Nakhon Si Thammarat Province Year 2020 and forecast of dengue cases Nakhon Si Thammarat Province, Year 2020.

Discussion :

The study found that the number of dengue fever cases Nakhon Si Thammarat Province in the year 2020, there will be a decrease in the number of cases until April. Then the number of cases gradually increased in July and decreased in the following month, which is consistent with forecast, but some cases the actual number of patients was less than the predicted number. This could be due to the 2020 coronavirus outbreak (COVID-19), causing a lockdown across Thailand. People meet is dwindling compared to 2019, and rain effect in the November. Until the floods throughout Nakhon Si Tham Province, which two factors resulted in the number of dengue fever cases decreased and did not meet the forecast number.

Conclusion :

From the study of the number of cases with dengue fever Nakhon Si Thammarat Province,Thailand since from 2015 to 2019, the forecasting method was Winters 'additive exponential smoothing and Winters' multiplicative exponential smoothing. The forecast accuracy was examined by MAD. Found that The forecasting method of Winters 'additive exponential smoothing is a better Winters' multiplicative exponential smoothing where MAD is 174.21107 and the forecast equation is as follows : $F_{t+m} = 214.9673221 + 1.893106655m + S_{t-L+m}$

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