

# Modelling the association of air pollution and climate variables with cardiovascular diseases hospital admissions in Kuching, Sarawak



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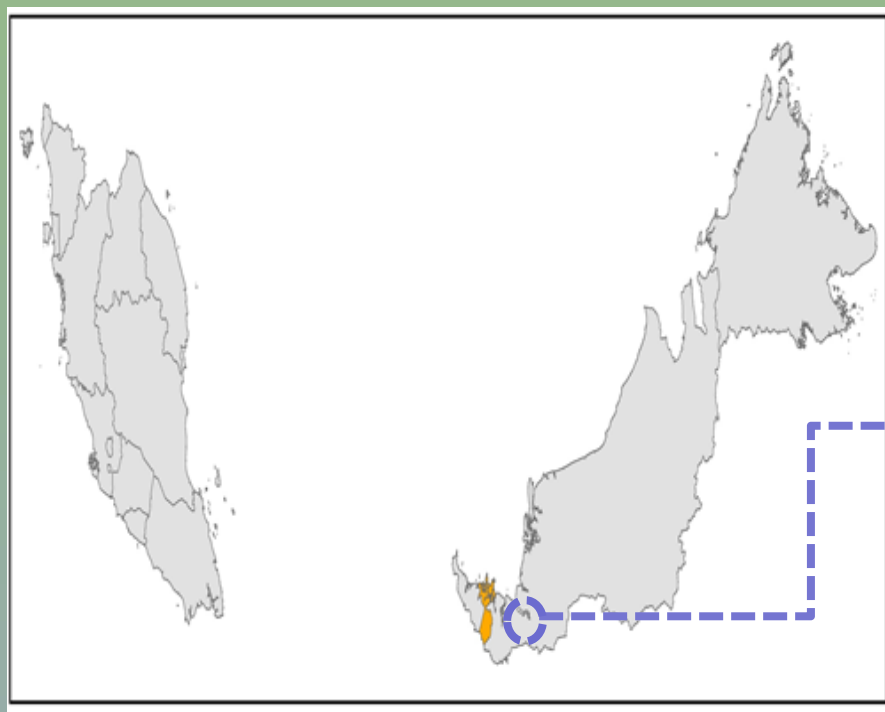
Much evidence suggested the association between environmental air pollutants with CVD (Brunekeef 2010, Mills et al., 2007; Miller et al., 2007; Dominic et al., 2006; Autrup, 2010).

Climatic parameters (temperature, rainfall and relative humidity) also showed an adverse consequences with health outcomes (Kim et al., 2016; Liu et al., 2014)

Study in Kuala Lumpur, Malaysia showed significant effects of ambient air quality level and air related health condition of residents (Ling et al., 2010).

Comprehensive effort should be done to reduce air pollution that will result in health benefits for the people.

## KUCHING, SARAWAK



Land area of 1,498 km<sup>2</sup>



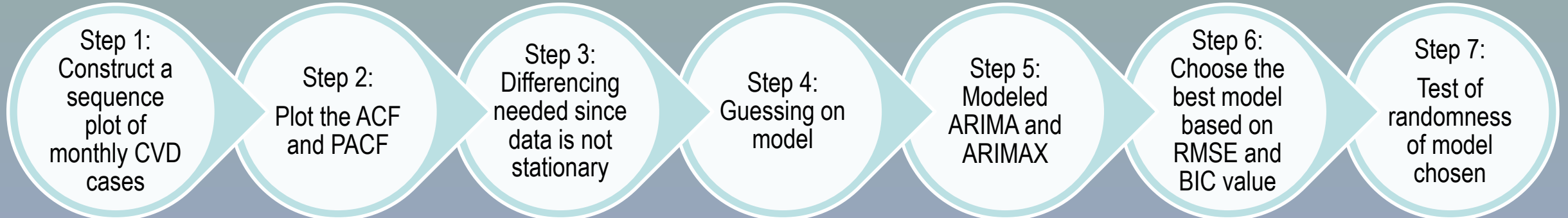
Total population of 684, 900 (DOSM, 2016)



Hot and humid weather.  
2 monsoon & 2 inter-monsoon seasons.  
Rainfall occurs throughout the year.  
Heavier precipitation during north-east monsoon in November-March & south-west monsoon in June-September.



### ARIMA and ARIMAX : Model development



### Model structure

Model	Exogenous variables							
	Air pollutants					Climate		
	PM <sub>10</sub> Avg	CO Avg	SO <sub>2</sub> Avg	O <sub>3</sub> Max	NO <sub>2</sub> Avg	Temperature Max	Relative humidity	Rainfall
Model 1								
Model 2	•							
Model 3		•						
Model 4			•					
Model 5				•				
Model 6					•			
Model 7						•		
Model 8							•	
Model 9								•
Model 10	•	•	•	•	•			
Model 11						•	•	•
Model 12	•	•	•	•	•	•	•	•

### Descriptive statistics

Variable	Range	Mean (sd)
Monthly CVD cases	84-476	224.5833 (58.6055)
<b>Air pollution data (monthly average)</b>		
PM <sub>10</sub> Average	20.33-139.43	39.4718 (15.8162)
CO Average	0.2391-1.2233	0.4775 (0.1729)
SO <sub>2</sub> Average	0.0007-0.0039	0.0019 (0.0008)
O <sub>3</sub> Maximum	0.0155-0.9747	0.0296 (0.0669)
NO <sub>2</sub> Average	0.0015-0.0153	0.0063 (0.0022)
<b>Climate data (monthly average)</b>		
Temperature Average	25.10-28.42	26.5103 (0.6011)
Temperature Maximum	28.26-34.49	31.7630 (1.0890)
Relative humidity	76.42-90.34	84.5940 (2.6121)
Rainfall	2.80-43.59	11.9279 (6.9624)

### Acknowledgement

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Monthly counts of CVD admissions was plotted and do not appear to have a strong annual trend.

PM<sub>10</sub> concentrations had a number of noticeable peaks over the study period (1999 to 2015)

**BEST FITTED MODEL**  
ARIMA (0, 1, 1)(1, 0, 0)<sub>12</sub> with PM<sub>10</sub> using Ljung-Box shows at first 16 lag autocorrelation among the residuals are zero (p-value=0.325 > α=0.05).

