Wind Engineering Joint Usage/Research Center
FY2018 Research Result Report

Research Field: General
Research Year: FY2018
Research Number: 183003
Research Theme: Wind Hazard Mitigation

Representative Researcher: Noram Irwan bin Ramli

Budget [FY2018]: 150,000 Yen

*There is no limitation of the number of pages of this report.
*Figures can be included to the report and they can also be colored.
*Submitted reports will be uploaded to the JURC Homepage.

1. Research Aim

The aim of the study is to develop a wind hazard map for Peninsular Malaysia. The wind hazard map is established by considering the V_{site} into the spatial area. V_{site} is determined by an equation that comprises the effect of Land Use Land Cover (LULC) and topography condition. The potential of wind hazard for a specific location is identified through spatial analyst technique. The main interest is focused on the performance of this method in establishing a wind hazard map that considers the effect of LULC and topographic condition. The wind hazard map will be evaluated based on past recorded wind damage data using statistical analysis.

2. Research Method

The following objectives of this research are:

1. To produce a database of Wind-Related Damage in Peninsular Malaysia.
2. To construct the Geo-database consist of all the related parameter for Wind Hazard Coefficient.
3. To developed the spatial integrated wind hazard map for Peninsular Malaysia

Peninsular Malaysia is selected as the study area for this research (Figure 3.1). This is due to several factors that significantly been discussed in the literature review. Several factors that have been taken into consideration for the selection of Peninsular Malaysia as study are, there are listed as follows: -.

1. The size of the Peninsular Malaysia 130,590 kilometre square which is in the recommended range for conducting hazard assessment at the national scale as per recommended by Van Westen (2013).
2. The location of Peninsular Malaysia is near to the equator which given more advantages with the constant climate throughout the year. (Ramli et al., 2015).
3. The damage due to a windstorm in Malaysia is only involved by localised effect

Peninsular Malaysia also was known as Malaya which is located at West Malaysia. It is the part of Malaysia which consist of Peninsular Malaysia and surrounding islands such as Penang, Langkawi, etc. The total area is 130,590 square kilometres (50,420 sq mi), on the north it shares a land border with Thailand. On the other side, the south part is the island of Singapore. Strait of Malacca lies on the west of Peninsular Malaysia which across the Sumatra Island, Indonesia. On the east side, the coastal area lies on the South China Sea.

Peninsular Malaysia accounts for the majority (roughly 81.3%) of Malaysia's population and the economy as of 2017, its population is roughly 26 million. Peninsular Malaysia is composed of 11 states and two federal territories. East coast and West Coast are frequently used in Peninsular Malaysia. The term East Coast is particularly used in Malaysia to describe the following states in Peninsular Malaysia facing the South China Sea, which consists Kelantan, Terengganu and Pahang. The term West Coast refers to a groups of state in Peninsular positioned towards the western coast. In general, all the group of states are facing the Strait of Malacca which is part of the Indian Ocean. West Coast is partitioned further into three regions. Even though Johor state has a coastline that is facing the South China Sea on the Pacific Ocean, it is not generally group as an East Coast region. This is because that the main coastline of the state is located on the Straits of Johor. The four main regions of Peninsular Malaysia are listed as below:

1. Northern Region: Perlis, Kedah, Penang, Perak
2. East Coast Region: Kelantan, Terengganu, Pahang
3. Central Region: Selangor, federal territories of Kuala Lumpur and Putrajaya
4. Southern Region: Negeri Sembilan, Melaka, Johor

Pre – Processing	**Processing**		**Post Processing**
Explore and Collecting data	Data conversion process Organization of the digital files into a GIS database	Perform the Spatial Modelling	Explore and Collecting data
Phase 1	**Phase 2**	**Phase 3**	**Phase 4**
Quantitative approach	**Identify Criteria**	**Formulate the Wind Risk Map**	**Validate with windstorm Damage**
Reviewing Historical damage data Analysis Data	Generate Wind Speed Multiplier Map Analysis of Hierarchy Process for AI	Develop Wind Hazard Map Wind Hazard Map - Site Wind Speed Wind Susceptibility Map using AHP	Validate windstorm Damage Statistical Analysis
Result & Discussion			
Conclusion & Recommendation			

Figure 1: An overview of the research process

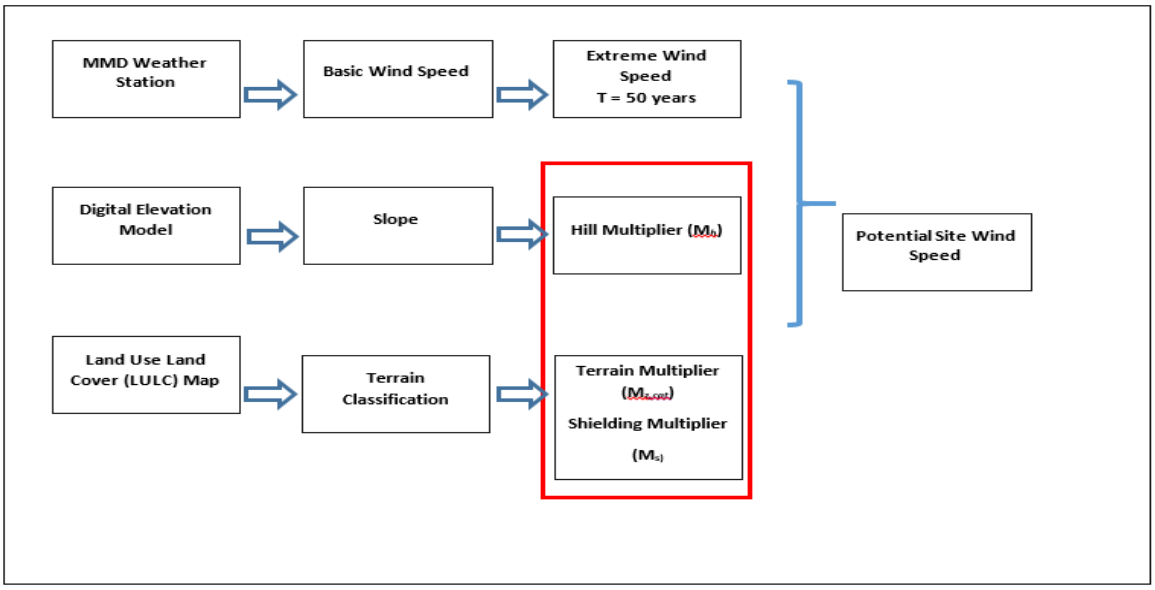


Figure 2 : Methodology for the development of Wind Hazard Map

Table 1: The class weight, factors weights and consistency ratio of the data layers used by using AHP Factor

Factor	Class	Class Weight	Factor Weight
	Wind Speed		
Wind (50 Years)	Beufort 9	0.05	0.64
	Beufort 10	0.12	
	Beufort 11	0.26	
	Beufort 12	0.58	
	Terrain Classification		
Terrain	class 1- Water, Bare Soil	0.46	0.28
	class 2 Open	0.25	
	class 3 – Mix (class 2&4	0.14	
	class 4 – Sub Urban	0.08	
	class 5 – Mix Class 4&%	0.04	
	class 6 - Dense	0.03	
	Slope Degree		
Slope	< 2.86	0.03	0.07
	2.86-5.71	0.04	
	5.71-18	0.08	
	18-30	0.15	
	30-40	0.25	
	>40	0.45	

3. Research Result

Base on the result shown in Table 2. The mean wind speed of damage cases base on V_{site} is higher compared to the V_s. The median and the skewness of Vs are also shown higher value compared to the V_s. The skewness is given information related to the inclination of data distribution. The higher the value shown that the probability increase due to data increase. In this case, it represents the percentage of damage and the wind speed. The maximum wind speed potential has been recognized base on damage location recorded 38.431 m/s compared to V_s which only identify at 31.599 m/s. This also can be shown in Figure 5, and 6 show that the 98% wind speed of V_s equal to 31.66 m/s while for V_{site} is given the value of 35 m/s. The min wind speed also found to be different where V_{site} still giving higher value when compared to V_s. This shows that V_s has described and predicted an area with low wind risk even though the true potential of the wind in a region favourably higher.

Table 2 : Histogram Analysis – Windstorm Damage in Peninsular Malaysia

Variable	Count	Mean	StDev	Min	Q1	Median	Q3	Max	Skewness
V site	294	29.334	2.66	24.033	27.126	28.956	30.787	38.431	0.59
Vs	294	28.062	1.75	24.501	26.801	28.226	29.373	31.599	0.07
V Sub-Dis	294	28.326	1.786	25.285	27.109	27.895	29.16	32.621	0.61
V district	294	27.763	1.541	24.592	26.783	27.838	28.473	30.844	0.34

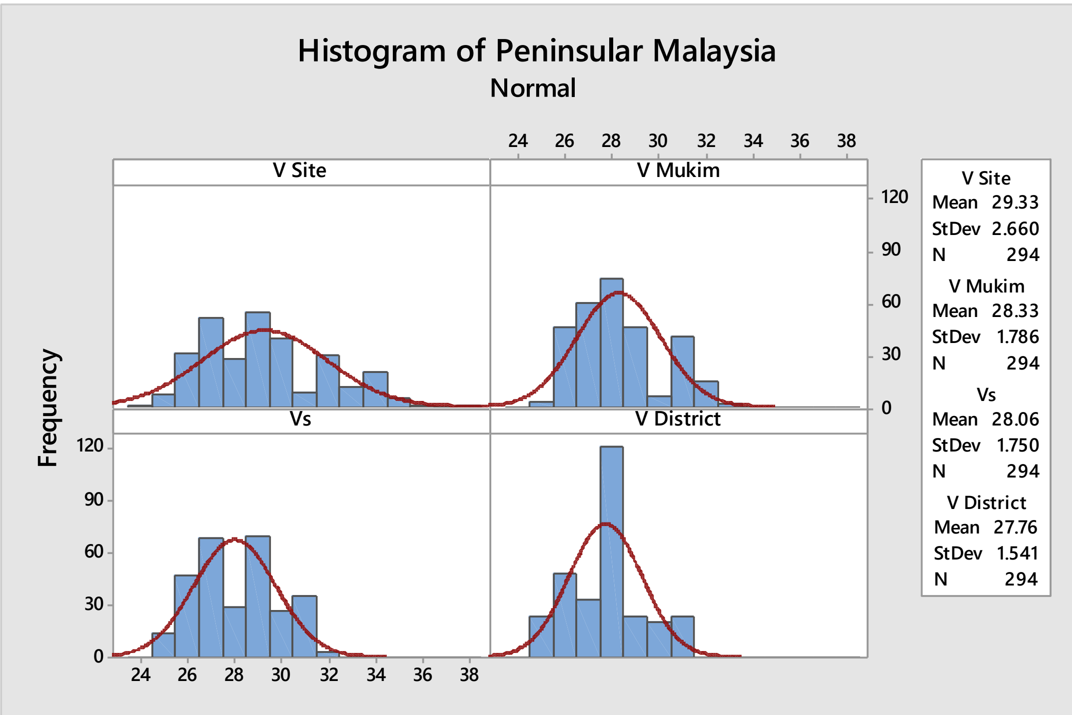


Figure 3 : Histogram Analysis for Peninsular Malaysia

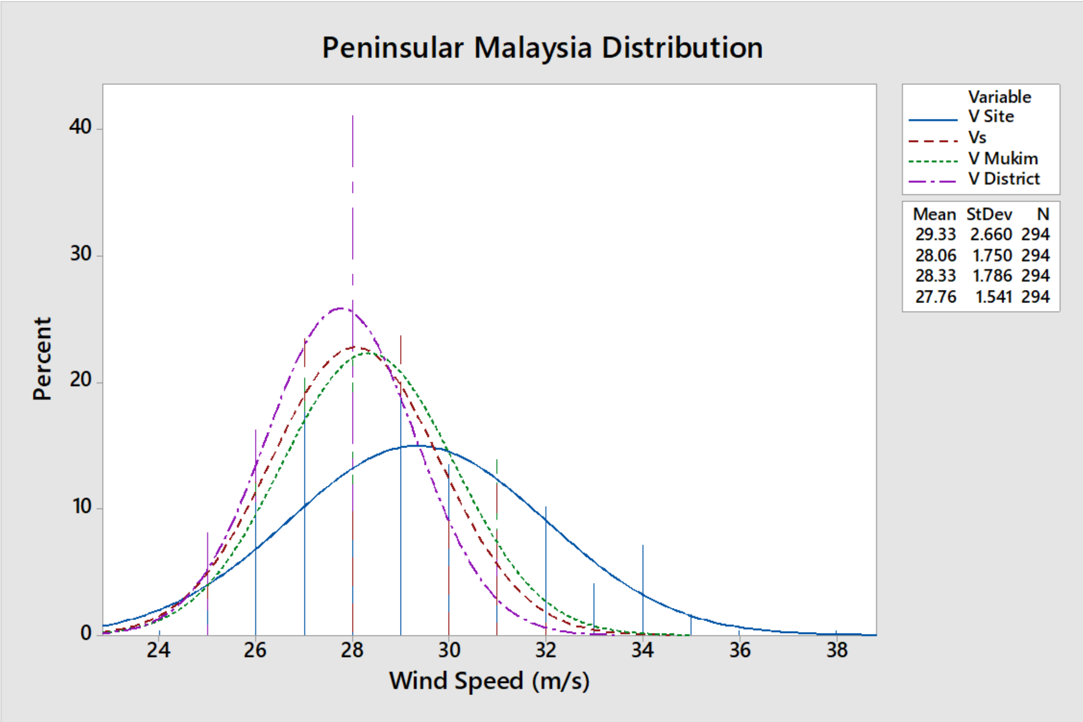


Figure 4 : Normal Distribution Plot Windstorm Damage Peninsular Malaysia

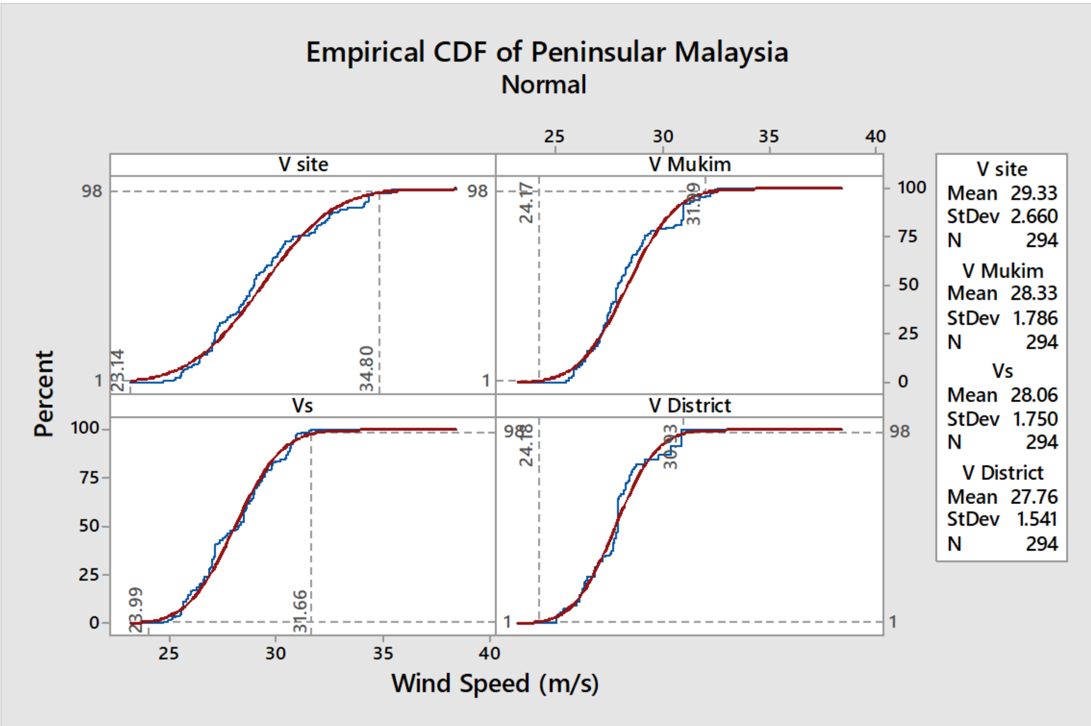


Figure 5 : CDF Analysis for Peninsular Malaysia

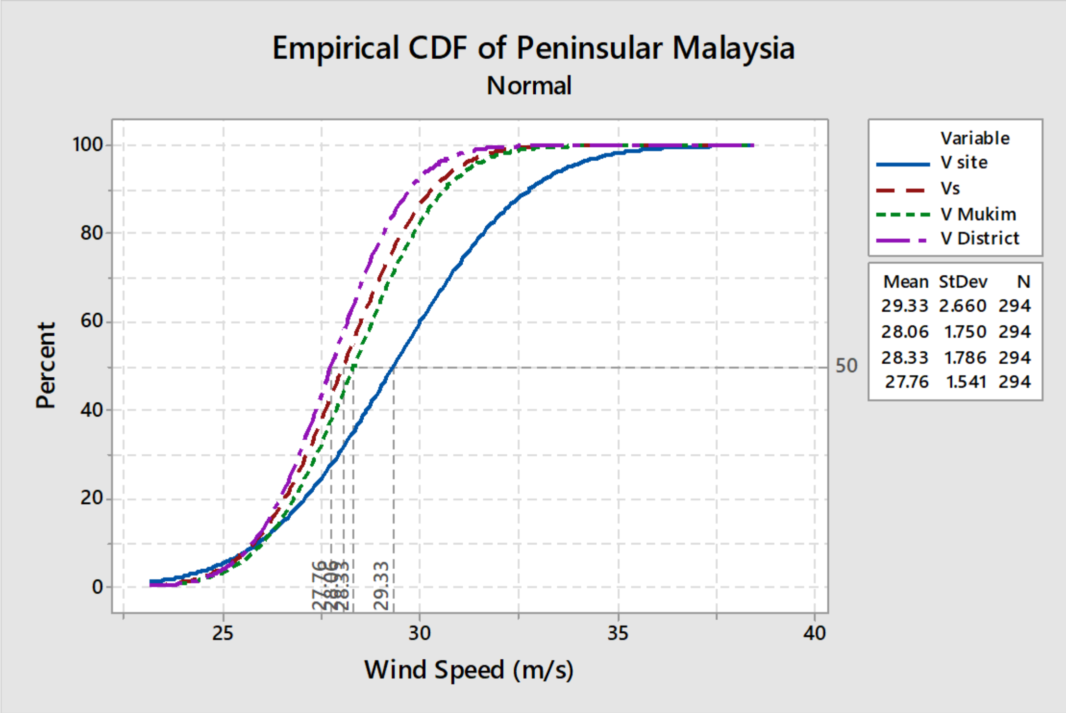


Figure 6 : CDF Comparison for Windstorm Damage Peninsular Malaysia

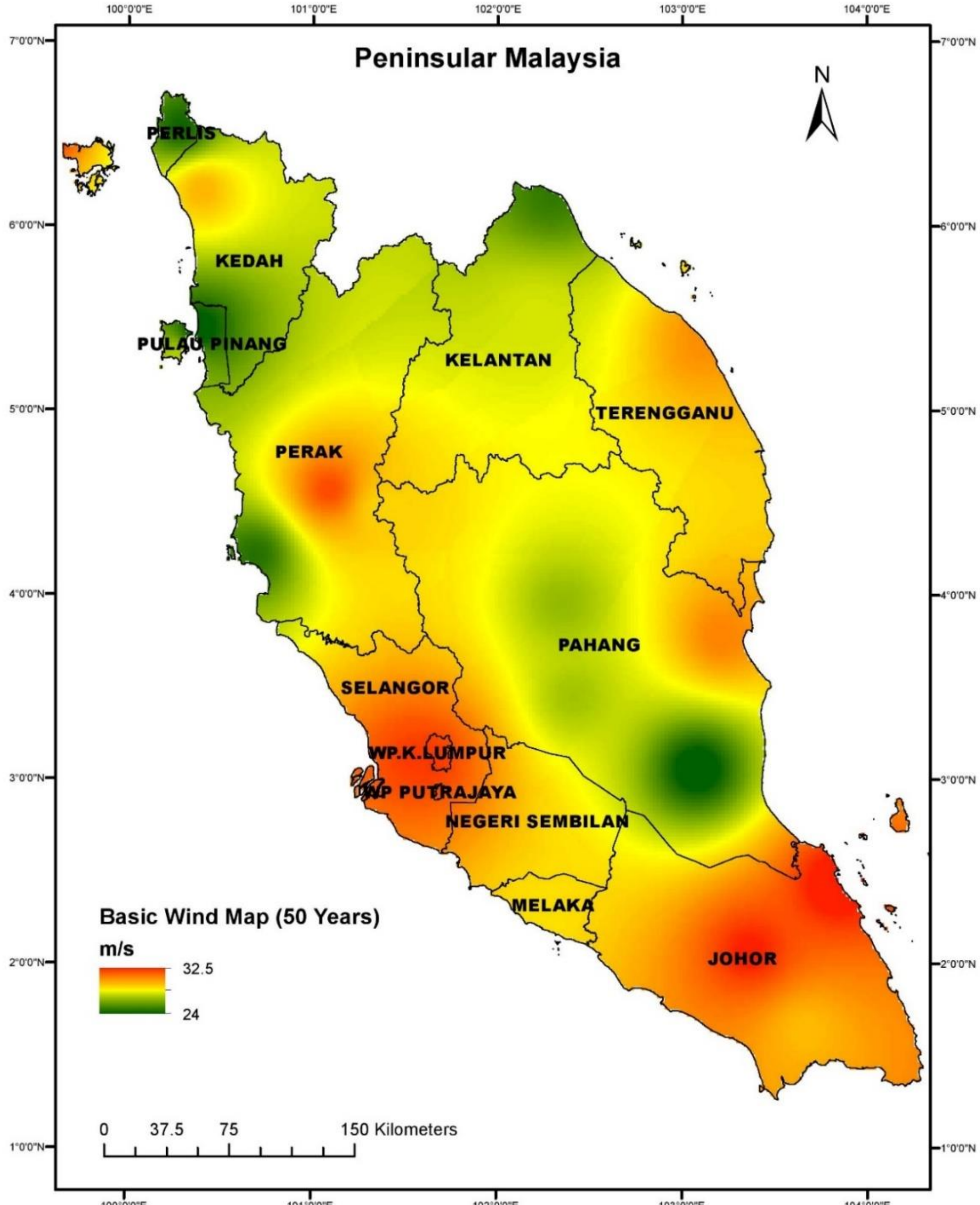


Figure 7 : Basic Wind Speed (V_s) Peninsular Malaysia

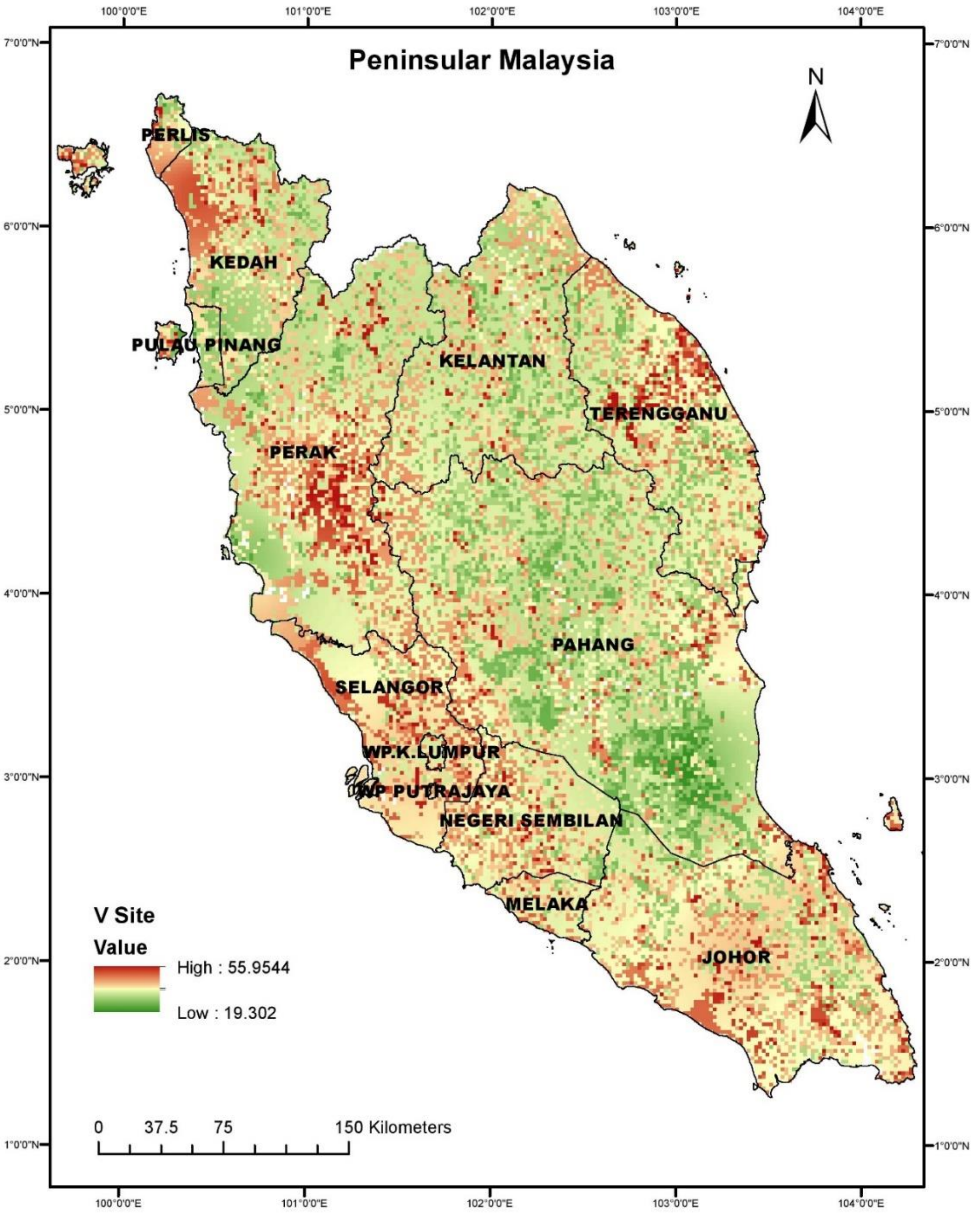


Figure 8 : V_{site} for Peninsular Malaysia

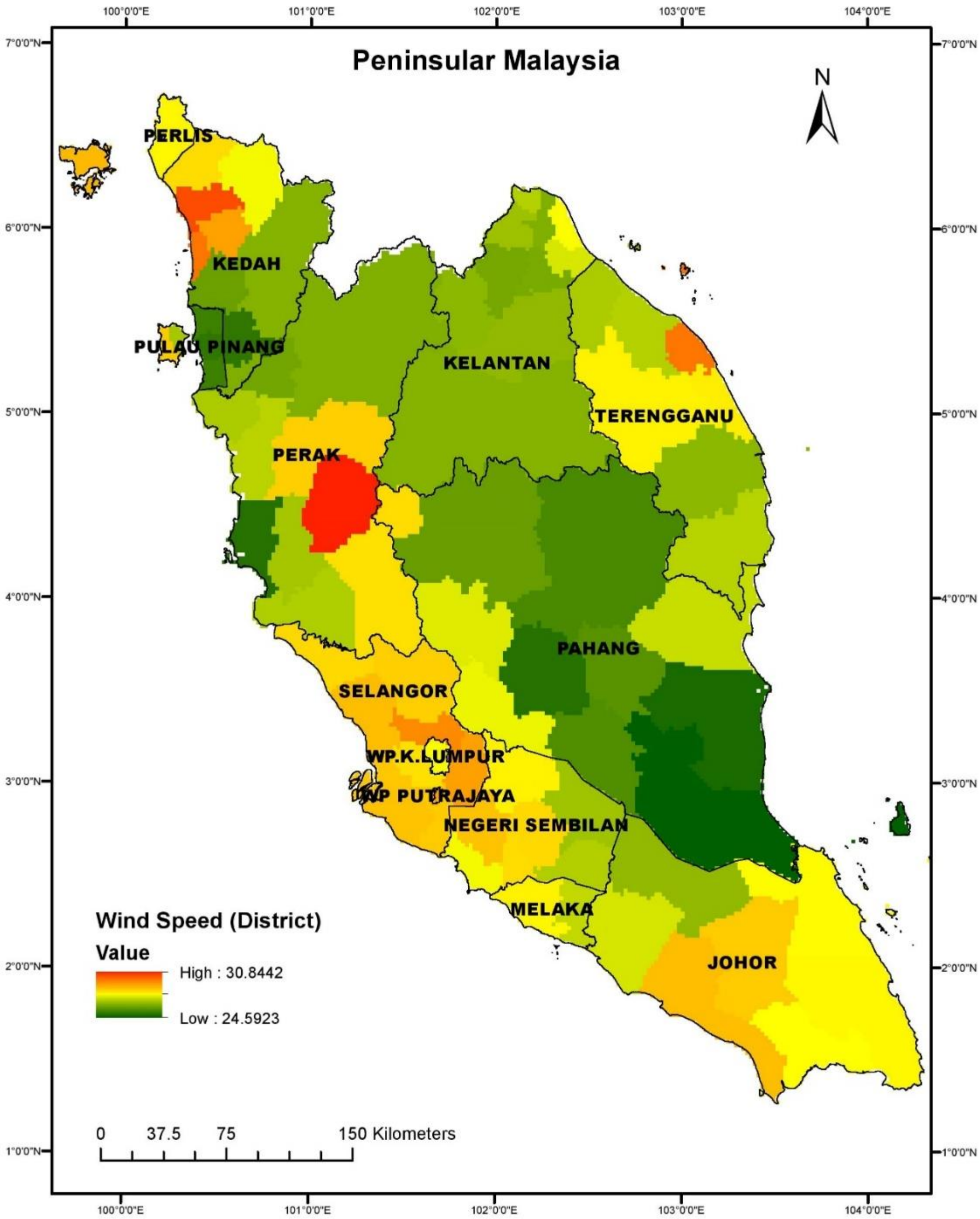


Figure 9 : Average V_{site} According to District in Peninsular Malaysia

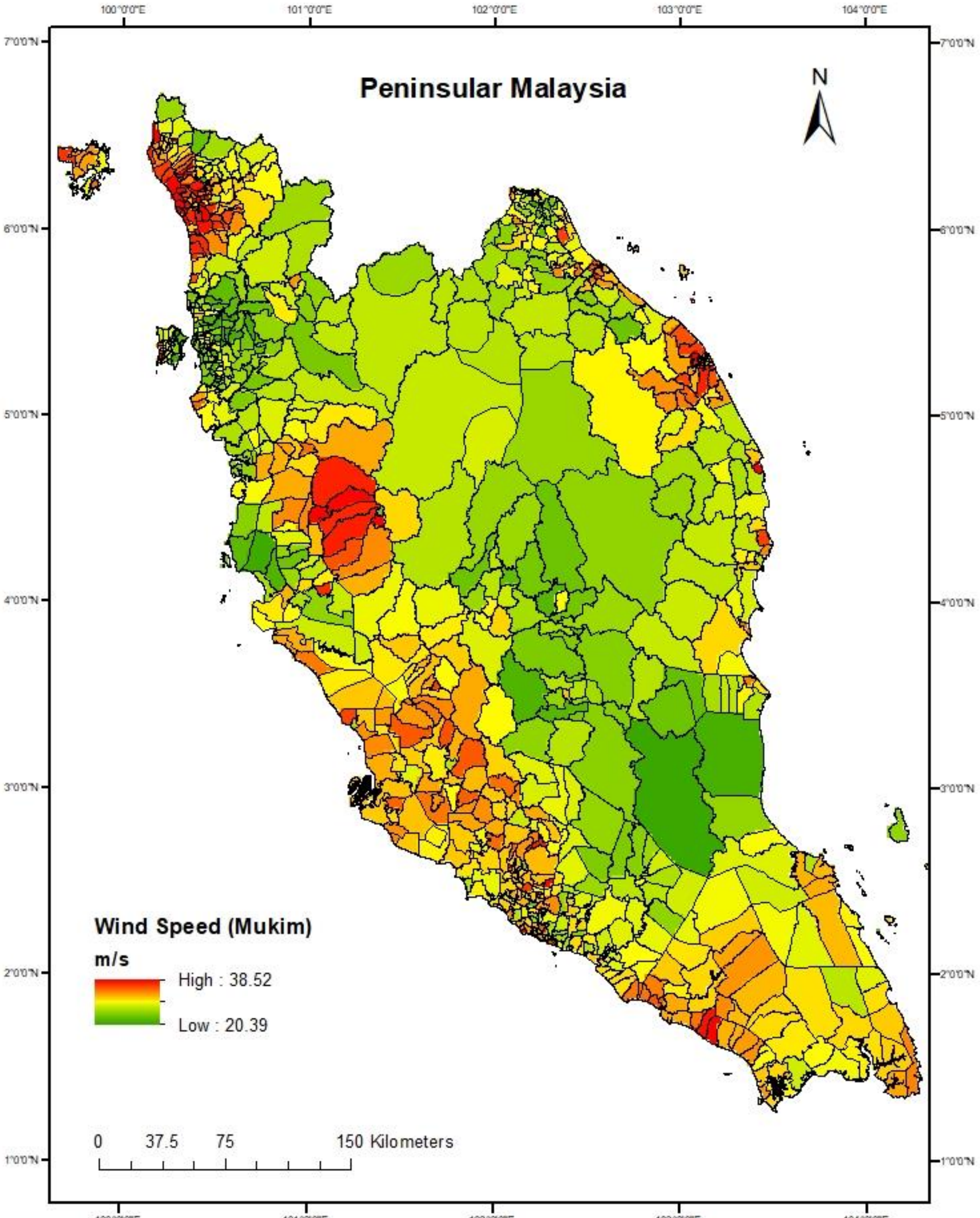


Figure 10 : Average V_{site} According to Sub District (Mukim) Peninsular Malaysia

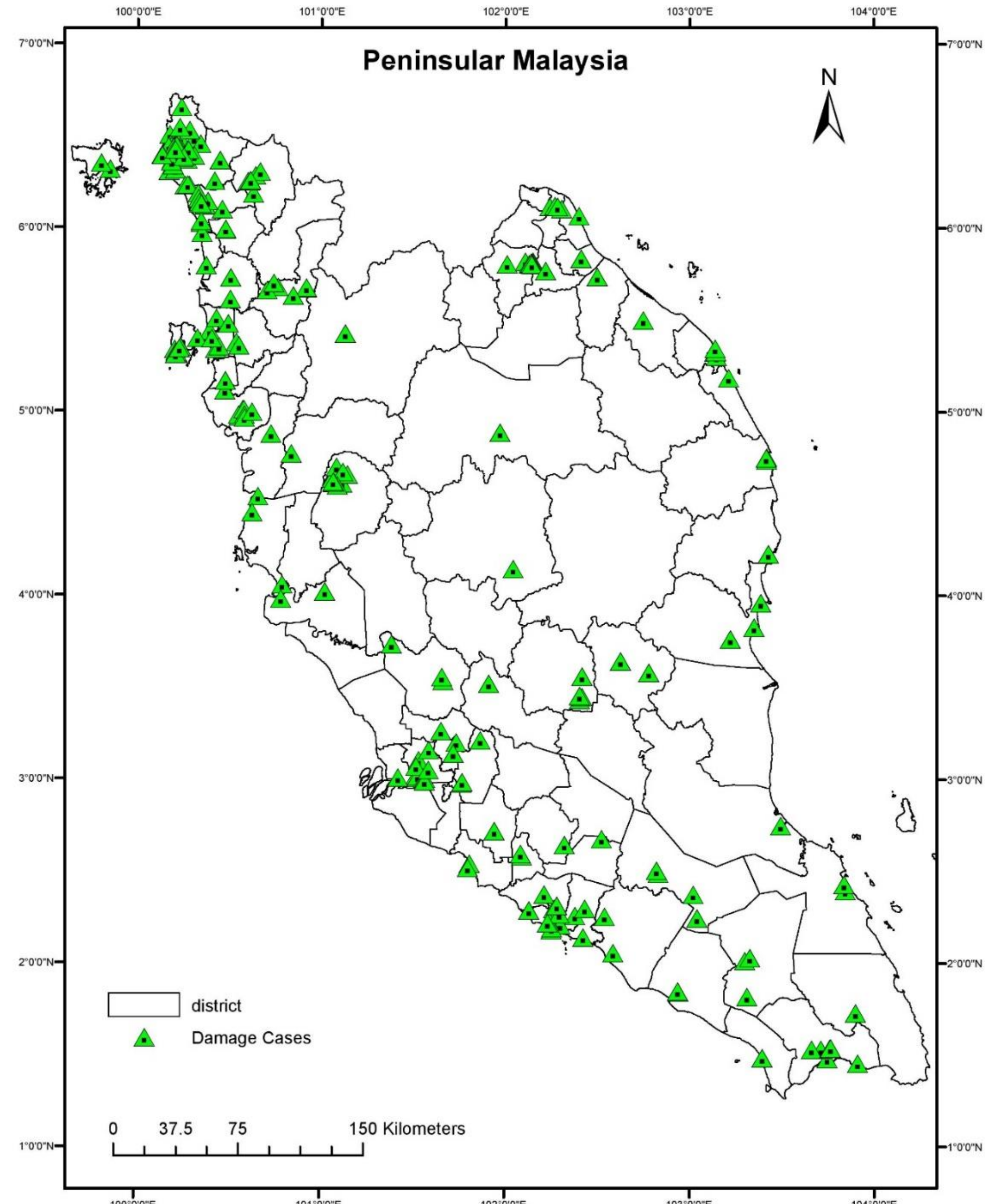


Figure 11 : Damage Cases Windstorm from the year 2009-2016 for Peninsular Malaysia

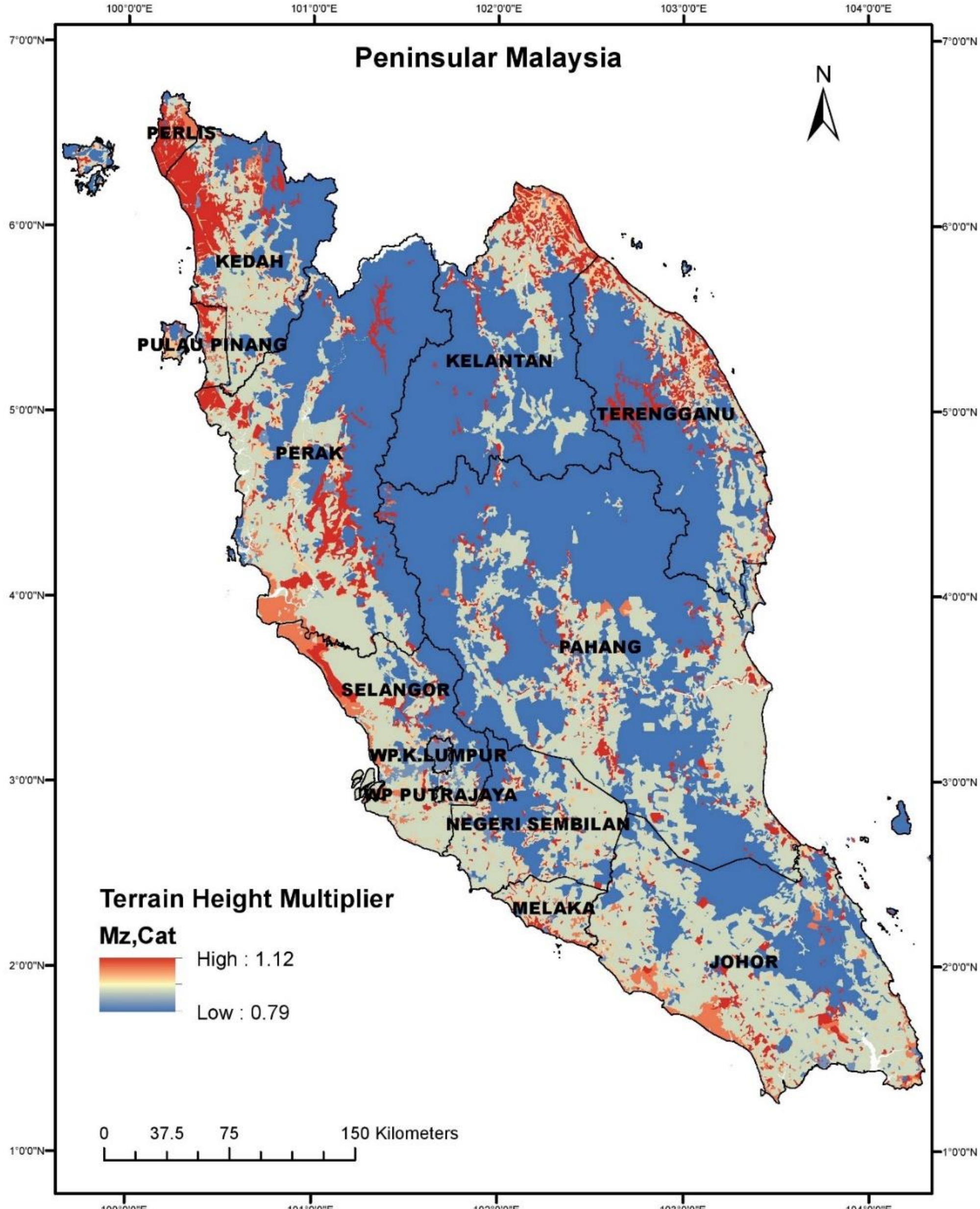


Figure 12 : Terrain Height Multiplier for Peninsular Malaysia

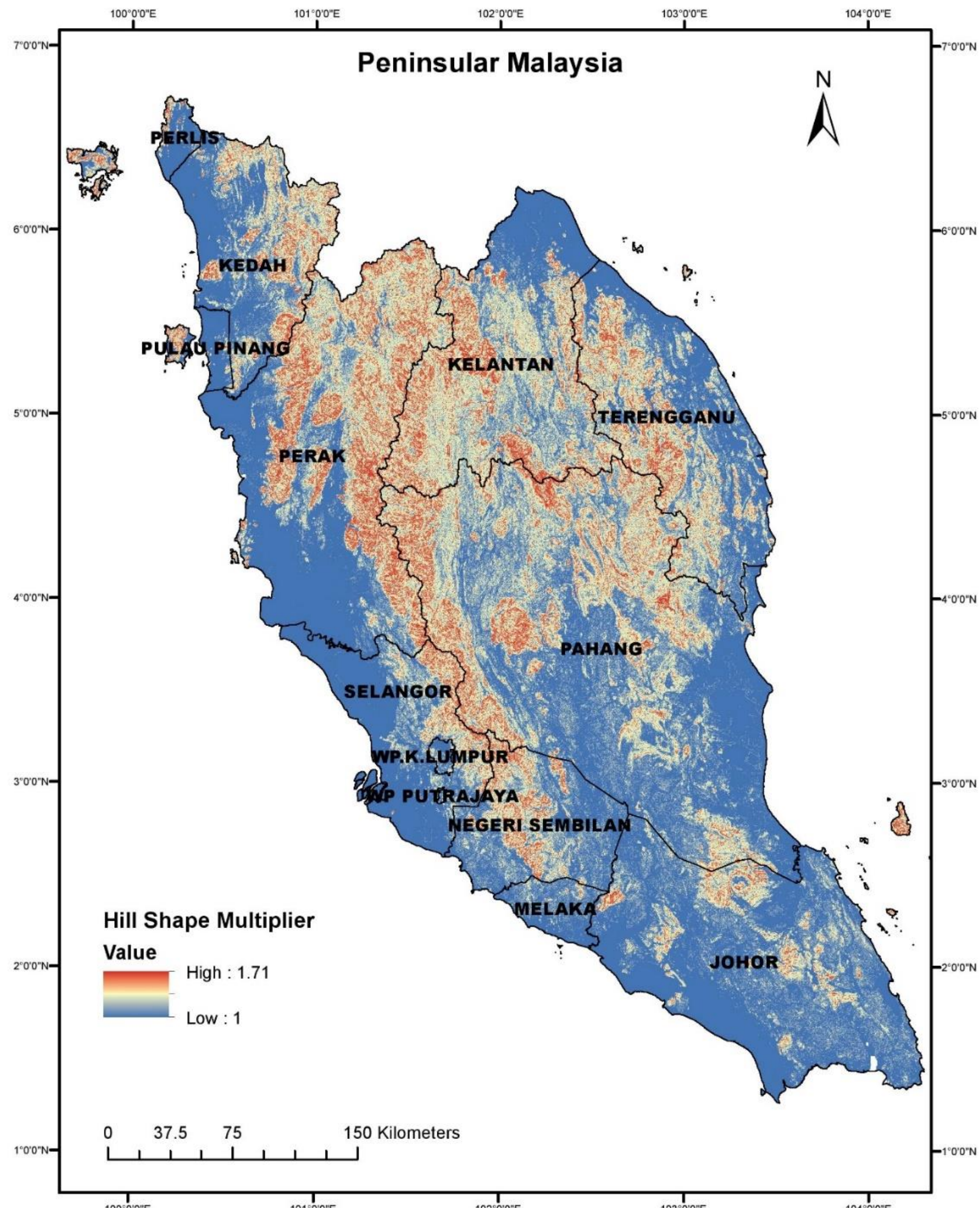
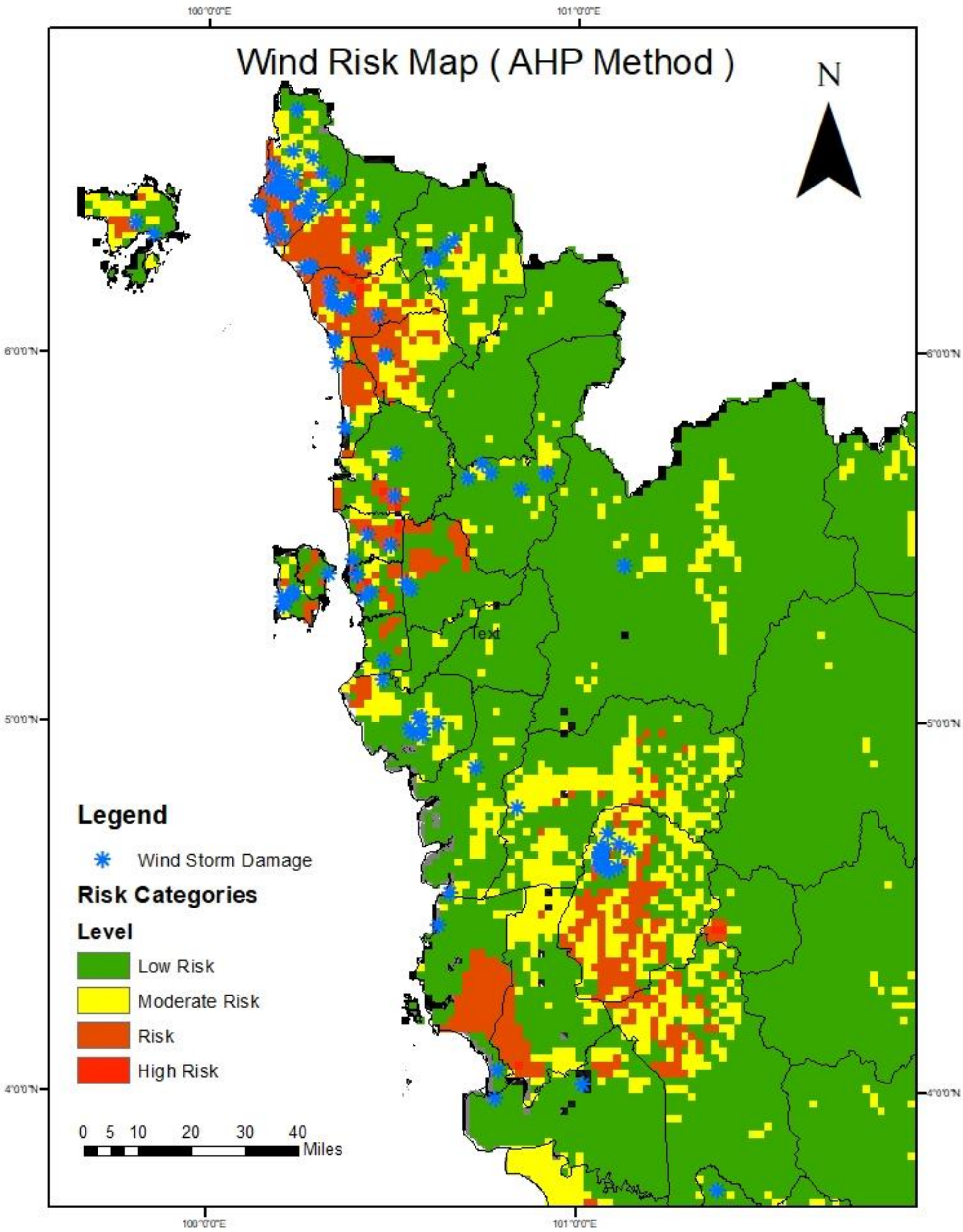


Figure 13 : Hill Shape Multiplier for Peninsular Malaysia



. Figure 14 : Wind Risk Map Using AHP Method for Northern Region

4. Published Paper etc.

1. Evaluation of wind hazard over Peninsular Malaysia using geospatial modeling (International Workshop on Wind Effects on Buildings and Urban Environment 2019) March 10 ~ 12, 2019, Atsugi Campus Tokyo Polytechnic University
2. Wind Risk mapping using GIS-based statistical models (In Press National Conference Wind & Earthquake 2019) 12 - 13 July 2019, Impiana KLCC, Kuala Lumpur, Malaysia

[Presentations at academic societies]

1. International Workshop on Wind Effects on Buildings and Urban Environment Presentation: Evaluation of wind hazard over Peninsular Malaysia using geospatial modeling

[Published books]

1. none

[Other]

Intellectual property rights, Homepage etc.

5. Research Group

1. Representative Researcher
   Noram Irwan bin Ramli
2. Collaborate Researchers
1. Taksiah A. Majid
2. Mohamad Idris Ali
3. Akihito Yoshida
4. Yukio Tamura

6. Abstract (half page)

Research Theme: Wind Hazard Mitigation
Noram Irwan Ramli (Universiti Malaysia Pahang)
Summary・Figures

This study presents the outcomes of the GIS-based statistical models for the development of wind risk susceptibility mapping using the geographic information system. The practice of GIS methods in risk assessment has regularly to be used. In this study, three factors including wind speed, slope and roughness condition are considered. The development of wind hazard over Peninsular Malaysia is performed with geospatial modelling. In assessing the wind speed hazard over the spatial area, the information of wind speed has been generally referred. Wind speed is predicted by using the probabilistic approximation of the previously recorded wind speed data. In the field of wind engineering, the potential of wind speed data at a specific site location is influenced by geographical factors such as surfaces roughness condition and topographic condition. Therefore, the surfaces roughness model and the topographical effect model are used to consider the site wind speed at specific sites. In order to integrate all the related information in a large spatial area such as an at Peninsular Malaysia, Geographical Information System have to be used. Previously some early studies have adopted this method, but then no confirmation has been made for this method. In advanced, the Analytical Hierarchy Process (AHP) was used to analyze the performance and identified the risk area. Wind hazard map by using AHP method are produced. From this study, the hazardous area was identified. Past damage record caused by windstorms is used to validate the wind hazard maps produced. Statistical analysis shows that the performance of this wind hazard map integrating the geographical factors with a combination of using the AHP method is prospective to use.