# Development of Malaysia Integrated Windstorm Database

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***Abstract*** *- Windstorm frequently occur in Malaysia and had ability to cause various of damage and adverse effects. Thus, the mitigation measures are developed so that the impact can be avoided or at least minimized. There are three (3) mitigation measures of this disaster which are establishment of classification scheme (magnitude scale) that classified between intensity of the windstorm with its potential damage, development of early warning system and identification of risk area of the disaster. Unfortunately, in Malaysia, the existing classification scheme (magnitude scale) that been used is unsuitable, early warning systems still doubtful of its effectiveness and there is also no map of showing risk areas is produced until to date. Therefore, to overcome of this deficiency, integrated windstorm database is recommended to be developed, so that information regarding to the windstorm occurrence can be completely collected and stored. Later, it can be used as an input for development of mitigation measures in the future. Instead of discusses how the database is developed and operated, the article also suggested the information that should be collected and to be stored in the database.*

**Keywords** - *database, windstorm, Malaysia*

## I. INTRODUCTION

Windstorm is an atmospheric disturbance manifested in strong winds accompanied by rain, snow, or other precipitation and capable causing significant damages along its path.In Malaysia, windstorms can be expected each year, throughout the year and most of the districts had experienced of windstorm [1]. Reports from mass media of windstorm occurrences in Malaysia show that the disaster is not only damage either to building (house collapsed and roof blown off), properties (power pole brought down and canopy blown away) and vegetation (tree uprooted and tree trunk broken) but also could possible extend to secondary damages such as cause injury, claim life to the human and destroy vehicles. This is due to the fallen trees and flying objects. Besides, it also creates social problems such as trauma and homeless to the victims. The losses caused by a typical damage value reach from thousand to a million ringgit.

Due to various damages, several mitigation measures were developed, so that the impacts of this disaster can be avoided or at least minimized such as establishment classification schemewhich classified between intensity of the windstorm with its potential damage, development of early warning system which is to warn public the possibility of windstorm occurrence and identification of risk area which is prone of the disaster.

The well-known scale that related to windstorm were Beaufort scale, Fujita scale, TORRO Tornado Intensity scale and EF-scale. These descriptive scales adapt similar concept by distinguish various levels of damages according to the wind speed. The scales can be used as an input in assessing design practice, construction methods and building codes for constructing structurally sound housing and shelters [2, 3]. Therefore, minimum set of design specifications and/or regulations for resistance of the building and construction quality could be set up accordingly in order to comply the structures safety [4]. Since there are catastrophe damages in building construction even though within a short span of time, could result more dangerous in fatalities [5].This due that factors influenced damage to structures by windstorm which are wind hazard(i.e., risk) and the resistance(i.e., vulnerability) had been made known. Research over historical events has been successful in identifying features and construction details that are effective in reducing structure loss from high wind events [6].

Current severe weather criteria classified wind speed above 50 km/h is a severe stormby-product that could possibly create damages (blew off roofs). However, according to some reports showed that wind with speed below than 50 km/h also possibly creates the similar damages. Estimation of 80 damage cases related to the windstorm in Peninsular Malaysia, damages roofing system are caused by wind speed were in the range of 37 to 49 km/h [7]. This due to existing criterion adopted a criterion which is similar to Beaufort scale that been established not in the country. Even though, some existing classification schemes (scales) had similar concept which represents a range of wind speeds and its possible damages, however, the value of characteristics and category of specific damages were different.The different is due to the place and time where the

classification scheme is established. Experience in establishing enhanced Fujita scale shows that enhanced Fujita scale is not applicable to the European countries since differences in construction between countries and also its developed during 'dark age' period of windstorm research in Europe where recording and rating of windstorms was not consistently done on a routine basis. Apart from differences in construction, changes in development of construction technology and building practices are another reason [8, 9].

For the natural disaster, forecast weather for a few times ahead will help to issue early warning to the public to take early action. Even though early warning system not intended to prevent disaster but is still necessary because it could provide lead time for the public to save life and sometimes gives people enough time to safeguard property [10]. Warning should not only issue suggested time, areas at risk, intensity of occurrence, possible damages but also recommended protective behaviour for those at risk [11, 12]. The importance to equip early warning systems for forecast and issue the warning to the public of severe thunderstorms, thunderstorms with damaging wind gusts, large hail or tornadoes has proven since 28 of 33 European countries which represent 85 % had the system [13].

Malaysia Meteorological Department (MET) have been playing an active role in monitoring and issue severe weather warning to the public in the country. The department used severe weather criteria as a guideline of possibility threat caused by either heavy rain and thunderstorm in a warning. The warning also indicates locations and periods of threat which disseminated through department website, Facebook, and Twitter. It shown that MET had a systematically operation regarding to detect, forecast and issue warning of severe weather. However, remarks 'these conditions may cause strong winds' for some thunderstorm warnings has raised questions of the windstorm-producing thunderstorms issued warnings accuracy because term 'may' can mean either a tendency do occur or not do occur. On the other hand, it's shown that the existing mechanism of early warning system is still doubtful of its effectiveness to monitor windstorm-producing thunderstorm. In addition, there is no study has been conducted until to date in assessing the effectiveness and opinion of several authors which commented about lack of mechanism to predict windstorm-producing thunderstorms in the country reinforced the matter. Malaysia has made significant progress on technical aspects of monitoring and forecasting heavy rainfall during the Northeast monsoon but when deals with the windstorm especially on wind gust prediction, these aspects still lack capability and provision of timely and accurate early warning on strong winds to the users with sufficient lead time, its intensity and damages [14, 15, 16].

Identification of area that prone of windstorm occurrence is also important due it will lead to the use of appropriate technology which can reduce the damaging effects in that particular area. Moreover, appropriate insurance based on the windstorm risk of an area can be applied to the population in order to reduce the losses to be borne by the government through Department of Social Welfare if the windstorm occurs.

Number of studies showed that Malaysia is still lacking in aspects of the mitigation measures that been practiced in some countries such as classification scheme (magnitude scale), early warning system and risk area. Until to date, none of the parties has produced a holistic map that showing the risk locations of windstorm throughout the country. Due to this lack, it is feared that the impact of this disaster damage can't be avoided or minimized which continuously cause substantial losses in the future. Therefore, to overcome these shortcomings, collecting basic information related to windstorm-producing thunderstorms from many aspects is essential. This is because it is the first step if to understand about the disaster in-depth. Prediction and warning operations should start some fundamental work such as collecting report, maintaining reports and conducting research because without deeper understanding of the local severe storm environments, the skills of the forecasts may be limited [13]. Full understanding of the windstorm mechanisms drawn from historical records is a pre-requisite for accurate multi-annual predictions of future windstorm loss [17].

Therefore, integrated windstorm database is suggested to be developed, so that basic information related to windstorm in the country can be stored systematically, centralized and easy to access. Although the main purpose is to ensure the three (3) main mitigation measures can be developed effectively but actually it is also to ensure the stored information could be referred for other uses in dealing with this disaster and its impacts in the future. Although, there are a party that had a database related to windstorm like the Department of Social Welfare and local authorities, however, the stored information is not comprehensive and scientific to be used as an input to develop mitigation measures completely.As example, Department of Social Welfare store victim personal details and its properties damages as well, so loss compensation can be delivered to the victims.While, local authorities only need to store information of broken and uprooted trees and property under their supervision that damaged for purpose of assessment and records of repair funding to the contractors(out-sourcing). The reason integrated database that links to the existing database of some parties and comprehensive should be developed in the country. Many countries have developed their own database like Germany (TorDach database) and Czech Republic (Historical-

climatological database). The integrated windstorm database is a requirement supporting tool if this disaster needs to be handled effectively.

## II. MALAYSIA INTEGRATED WINDSTORM DATABASE

The article only discusses about the information or raw data that need to be stored in this database which later can be analyzed and then used for the specified purposes. It does not involve any discussion of the software that been used to develop this database and how it is integrated technically through a network of information technology.

### *A. Development*

The database was developed through studies on existing windstorm databases or others databases, proceedings, journals, articles, guidelines, books, websites and also from authors experience themself in gathering information on windstorm as well. All the information in the existing windstorm database were included together with some new additional information. These new information was added in propose to provide adequate information for the specified purposes. The main aim of the database is to ensure that information is integrated and adequate in understanding the phenomenon of windstorm in Malaysia and furthermore the information can be analyzed for mitigation and managing this disaster impacts in the country. There are four (4) focused thrusts in the database which are statistical of occurrences, details of the windstorm occurrence including its hydrometeorological. climatological and intensity, cost of repair and loss compensation due to damage and windstorm spatial map.

### *B. Modus Operandi*

The database will be monitored and organised by a research center that acts as the administrator. All the received information will be verified before been updated in the database. The reason is to ensure only valid and relevant information to be stored. On the other hand, the database actually is integrated database for various parties but liable to be incharge on a one party. There are some agencies that already have an existing database-related natural disasters which keep the confidential information. As an example, Department of Social Welfare, this department has its own database that stores information of the disaster victims such as personal details and damage to their homes intended for receiving loss compensation. If this information is not been controlled, particularly a victim personal details, it is not possible to be manipulated for the improper purpose in the future. In addition, monitoring can keep the received information from overlap and stored systematically since various parties involved in providing the information in this database. More over, to ensure only authorized parties are allow to use the information. Report is the end product for each template so that this hardcopy can be checked, verified and stored as a records.

Table I shows the details of the information that need to be stored in the database.Primary information is an information (raw data) that received originally from various parties. While secondary information is an information that has been modified and streamlined from primary information by the administrator. Secondary information is the only information that been allowed to be stored in the database.Table IIdescribes the functions of each related parties that integrated in the database.

**TABLE I: DETAILS INFORMATION TO BE STORED IN THE DATABASE AND ITS FLOW**

| Thrust | Primary data | | Secondary data |
|---|---|---|---|
| | Agency | Data | Administrator |
| Windstorm occurrence | Local authority | Damage to public properties, broken branches and fallen trees | All information received to be maintained except for the location which will be converted to be coordinate (longitude and latitude) and marked on the map |
| | Department of Social Welfare | Damage to residential houses | |
| | Public Works Department | Damage to road furniture | |
| | Tenaga NasionalBerhad | Damage to electricity transmission | |
| | Telco company | Damage to telco transmission | |
| | Water supply agencies | Damage to pipelines | |
| | Premise owner | Damage to premise | |
| | Public | Any damage | |
| Windstorm climatological, meteorological and intensity | Malaysia Meteorology Department | Satellite imageries, radar imageries, radiosonde data and meteorology station data | All information received to be maintained except for data from meteorological station which will be drawn as a graph |

**TABLE II (cont'd): DETAILS INFORMATION TO BE STORED IN THE DATABASE AND ITS FLOW**

| Thrust | Primary data | | Secondary data |
|---|---|---|---|
| | Agency | Data | Administrator |
| Repair and cost estimation | Construction Industry Development Board | Repair works methods for building and price for properties and construction materials | All information received to be maintained except for the location which will be converted to be coordinate (longitude and latitude) and marked on the map |
| | Advertising agency | Repair works methods for signage and its material price | |
| | Department of Agriculture | Treatment methods for vegetation and vegetation price | |
| | Plant nursery | Treatment methods for vegetation and vegetation price | |
| | Insurance company | Loss compensation to human and vehicle | |
| Windstorm spatial map | Department of Survey and Mapping Malaysia | Unrestricted digital topographic map | Digital map will be modified, while soil material series map to be maintained |
| | Department of Agriculture | Soil material series map | |

**TABLE IIII: DETAILS OF THE PARTIES RELATED TO THE DATABASE**

| Party | Details |
|---|---|
| Local authority | Government agency which is responsible for public health, waste removal and management, town planning, environmental protection and building control, social and economic development and general maintenance functions of urban infrastructure. |
| Department of Social Welfare | Government agency which its roles and functions to preventive and rehabilitative services in social issues and the development of the community. |
| Water supply agencies | Government agency which is responsible to provide technical advisory services to the ministry and other agencies in planning, designing, implementing and managing water supply programmes and ensure sufficient, quality and reliable water supply for the public and industry. |

**TABLE IIV (cont'd): DETAILS OF THE PARTIES RELATED TO THE DATABASE**

| Party | Details |
|---|---|
| Public Works Department | Government agency which is responsible for construction and maintenance of public infrastructure |
| Tenaga NasionalBerhad | Electric utility company which its core activities are in the generation, transmission and distribution of electricity. Other activities include repairing, testing and maintaining power plants, providing engineering, procurement and construction services for power plants related products, assembling and manufacturing high voltage switchgears, coal mining and trading. |
| Telco company | Company which is responsible to provide a variety of mobile communication services. These services include voice under their prepaid plans and post-paid plans, SMS, data plans and services, international roaming, international calling card and WAP services. |
| Premise owner | Government or private agency which own the building for business or services activities |
| Public | Population of individuals |
| Malaysia Meteorology Department | Government agency which is responsible to fulfil the needs of the people for meteorological, climatological and geophysical services for national security, societal well-being and sustainable socio-economic development. |
| Construction Industry Development Board | Statutory body under government agency which is responsible to coordinate all activities in the construction industry and increase its competitiveness. |
| Department of Agriculture | Government agency which is responsible to provide quality and efficient services to agricultural entrepreneurs through the application of advance technologies and agricultural regulatory services to boost production capability and ensure the safety of the country agriculture sector. |
| Plant nursery | Supplier of garden plants |
| Insurance company | Private agency which is received a license or authorization for the purpose of insurance. |
| Department of Survey and Mapping Malaysia | Government agency which is responsible to provide cadastral survey, geographic information in accordance with established standards. |

### C. Templates

Template is a form base where the data is filled and stored.

**a) *Main***

This template displays the statistics of windstorm occurrences for each states and regions (Fig. 1).The purpose is to identify which state or region is prone of windstorm occurrences, therefore the risk state and region will be given priority in the provision of loss compensation due to the damages and installation of early warning system.


**Fig. 1: Main template**

***b) District***

This template also displays statistics of windstorm occurrences similar as a main template but more specific on districts (Fig. 2). Had a similar purpose to identify which district is prone of windstorm occurrences whereby later, the information is for provision of loss compensation and early warning system. However, statistics of districts is more useable compared to states and regions since local authorities are by district. As a result, early planning and preparation to mitigate and manage this disaster can be done more efficiently. For the research, the study to find out why some areas are prone of windstorm occurrence can be done. Then, further study can be conducted to understand what the factors influence the susceptibility and also risk areas can be identified. In the future, insurance premium which is based on windstorm occurrence risk of the area can be applied to the population in order to reduce the burden of loss compensation to be paid by the government.


**Fig. 2: District template**

***c) Windstorm occurrence***

This template is to record the details of a windstorm occurrence (Fig. 3). These details can be analyzed for in-depth study of an occurrence as an input for the development of early warning systems and technology for reducing the damages of windstorm. Type of windstorm either downburst, tornado, tropical storm or typhoon also should be recorded. Even though the damage impacts are almost similar in the varies intensity, but the mechanism is different. General appearance of damage to a particular structure by wind is very similar if without reference to specific wind speeds whether it caused by tornado, typhoon, downburst or straight-line winds [18]. Therefore, in-depth study can be conducted for each type of windstorm. Photos for any damage also be placed, so that damage assessment can be done precisely and also to distinguish whether the damage is primary or secondary damage. It is very useful in understanding the details of the damage and besides, the repair cost and loss compensation can be estimated accurately.


**Fig. 3: Windstorm occurrence template**

***d) Damage map***

The map locates the location for each types of damages (Fig. 4). This is to describe the state of the affected areas more clearly. Information from the template is also for in-depth study.


**Fig. 4: Damage map template**

***e) Statistic***

Displays details statistics for windstorm occurrences by month for each districts, states and regions (Fig. 5). This statistic can show when the period of time for each districts, states and regions should be allocated a high loss compensation. In addition, period of risk also can be made known. So, early planning and preparation can be done.

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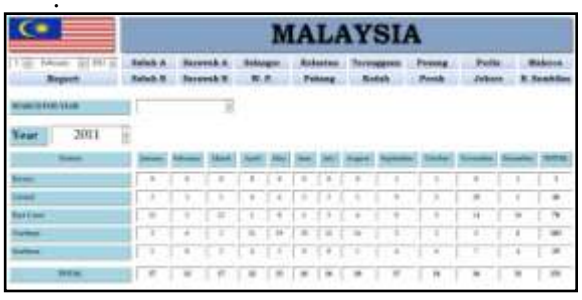


**Fig. 5: Statistic template**

***f) Windstorm hydrometeorological, climatological and intensity***

This template is to record hydrometeorological, climatological and intensity of a windstorm occurrences (Fig. 6). The purpose is similar as windstorm occurrence template. The information in this template should be combined with the information in the windstorm occurrence template if intended to study windstorm from various aspects. Windstorm damages from satellite, radar, radiosonde and meteorological station parameters showed encouraging finding, more robust information and provide more reliable automatic guidance to forecasters [19].

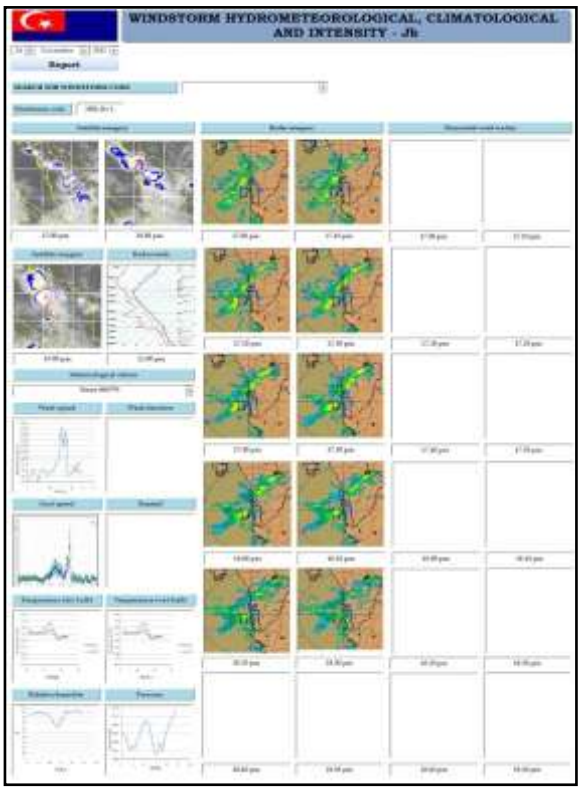


**Fig. 6: Windstorm hydrometeorological, climatological and intensity template**

***g) Windstorm spatial map***

This template placed a windstorm spatial map and soil material series map (Fig. 7). Windstorm spatial map provide coefficient of wind multiplier for each area in Malaysia. This map was developed based on the following equation with some modifications which is do not take into account$M_d$ factor:

$$V_{site} = V \times M_d \times M_z \times M_s \times M_t$$

where $V_{site}$ = maximum local (site) wind speed
V = wind speed
$M_d$ = directional multiplier
$M_z$ = terrain (roughness) multiplier
$M_s$ = shielding multiplier
$M_t$ = topographic (hill-shape) multiplier

It enables wind or gust speed can be accurately determined at any area in Malaysia since it considered factors such as topographic, geographic terrain and surface roughness. Thus, each damage can

be determined its intensity. The map can also be used as input in early warning system and roof building designation. Topographic, geographic terrain and surface roughness factors should be considered as multipliers severe wind gust risk assessment[20,21]. Three-dimensional topographic wind adjustments, exposure information at buildings level and appropriate vulnerability curves if adopted in the models will enable the models to assess the risk more accurately [21].

While, soil material series map is used to know which soil series that makes tree much easier to be uprooted than just a break when windstorm is occurred. It will make known when the windstorm occurred, a tree that be planted on a particular soil series either uprooted or broken branches. As an example, TORRO scale at T0 stated that trees will be broken at the wind speed 21.5 ± 3.5 m/s but on wet unstable soil, tree will be uprooted. This proved that the damaging effects by windstorm to the trees is influenced by soil series.

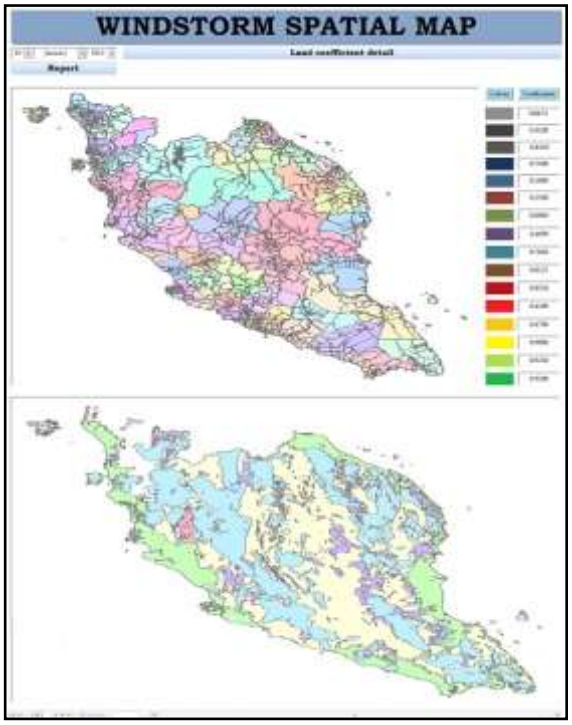


**Fig. 7: Windstorm spatial map template**

### *h) Repair and cost estimation*

There is numerous damage that could cause by windstorm either to building, properties, vegetation, vehicle or human. These can be seen by refer to the damages that listed in Beaufort, Fujita or Torro Scale. The recommendations of repair works are associated with the damage to the building, property and vegetation only. The estimation cost of repair works for each damage were also included (Fig. 8). This estimation cost is the standard guideline which can be referred by the victims to estimate the expenses that needed to repair the damage. The victim will know the actual compensation to be received and this would avoid from loses either to the victim or the government.


**Fig. 8: Repair and cost estimation template**

### *i) Loss compensation estimation*

This template lists the compensation for damage to the vehicle or injury and death to humans only (Fig. 9). It purposes to facilitate the compensation claims by victims or their heirs.

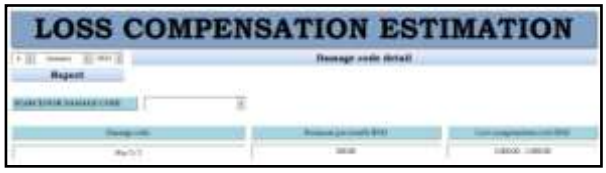


**Fig. 9: Lost compensation estimation template**

### *j) Contact estimation*

This template lists individuals or agencies that involved directly with windstorm in the country (Fig. 10). Make it easy to contact someone if there are any matter related to this disaster.


**Fig. 10: Contact template**

## III. CONCLUSIONS

Development of integrated windstorm database as supporting tools in the country is crucial because:

i. high frequency of windstorm occurrence in the country
ii. damage affected by windstorm causes a various adverse effect to humans, properties and economy
iii. none, not suitable and doubtful effectiveness of main mitigation measures of windstorm disaster in the country
iv. existing database only focus on the specific information and not comprehensive related to the windstorm
v. difficulty in accessing information on the windstorm in the country

It is known that the classification scheme (magnitude scale) is one of the main mitigation measures but also can be used an input for other main mitigation measures such as early warning system and identifying risk areas. Without complete and current information, it is likely that all of these is impossible to be achieved. Storing information of a windstorm systematically and continuously in integrated database is an extra-mile in handling this disaster. Existence of integrated information platform can provide a broader base for the addition of a new necessary information. The article only provides general guidelines or concept of how information of windstorm in the country should be stored in a systematically. However, on the top of that, it must be refined in advance if to ensure the systematically storage of the information and easy way to integrate with related parties.

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