# Distribution of Maximum Wind Potential Damage by the Typhoon Maemi in Gyeongnam Province, Korea


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## Introduction

- Recently extreme weather events due to climate change has led to frequent typhoons and localized torrential rainfalls and a steady increase in droughts and the desertification phenomenon, etc. around the globe, and the scale of damages are also gradually escalating.
- Also torrential rainfalls exceeding the maximum rainfall records of the past is continually occurring in South Korea and the scale of damages due to meteorological disasters have reached several trillion Korean won since the 2000s.
- Since types of disaster occurrences and the mode of the progression of the damage are diverse, it is essential to understand the areas of preparation, response and recovery and mitigation.
- However, currently within Korea, research regarding disaster response measures conducted from this perspective is almost absent.

### The Object

**The present research seeks to utilize the risk assessment model employed in preceding researches within Korea and abroad to calculate the 3-second gust in Busan and the Gyeongnam Province region for the 2003 typhoon Maemi, and apply this data to identify the distribution characteristics of the maximum wind potential damage for houses according to detailed units at the level of the city as well as the gun and gu districts.**

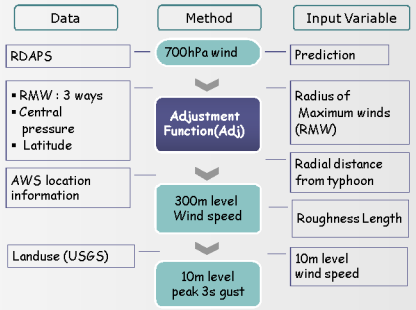
## Data and Methods

### Data

- Period
  : Typhoon Maemi(September 12-13, 2003)
- Regional Data Assimilation Prediction System (RDAPS) 10km resolution data
  : 700hPa wind speed
- RSMC Tokyo-Typhoon Center
  : Best track - Latitude, Central pressure
- United States Geological Survey (USGS)
  : Roughness length, land use
- Florida Department of Financial services
  : damage probability, rate of restoration
- FPHLM : rate of restoration cost , damage probability data
- National Statistical Office
  : number of household

### Methods

- 3s gust wind




- Amount of damage
  - The damage state is obtained based on the calculated 3-second gust (Park, 2009), and at this point the rate of restoration for the structural components of the houses are obtained to calculate the scale of maximum wind potential damage.
  - The rate of restoration cost must be individually tapped in .

Table 1. Example of damage vulnerability matrix.

| 3-second gust (mph) | Roof cover | | | Roof Sheathing | | |
|---|---|---|---|---|---|---|
| | DS1 (0-25%) | DS2 (25-50%) | DS3 (50-100%) | DS1 (0-25%) | DS2 (25-50%) | DS3 (50-100%) |
| 35 | 0.27574 | 0 | 0 | 0.14778 | 0 | 0 |
| 40 | 0.33153 | 0 | 0 | 0.19617 | 0 | 0 |
| 45 | 0.3458 | 0 | 0 | 0.24545 | 0 | 0 |
| 80 | 0.45979 | 0 | 0 | 0.43452 | 0 | 0 |
| 85 | 0.46966 | 0.00005 | 0 | 0.90602 | 0 | 0 |
| 95 | 0.47621 | 0.00376 | 0 | 0.4665 | 0 | 0 |
| 100 | 0.46856 | 0.01376 | 0.00001 | 0.94554 | 0.00024 | 0 |
| 105 | 0.45261 | 0.03299 | 0.00013 | 0.47451 | 0.00173 | 0 |
| 115 | 0.38344 | 0.10012 | 0.00589 | 0.89047 | 0.02644 | 0.00001 |

## Results and Discussions

### 3s gust wind

- Storm area : The 3-second gust exceeds 25m/s

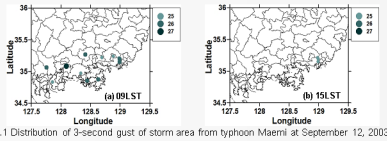



Fig.1 Distribution of 3-second gust of storm area from typhoon Maemi at September 12, 2003.

- Strong-wind area : The 3-second gust is 15m/s or higher but below 25m/s

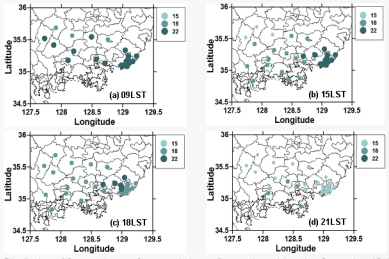



Fig.2 Distribution of 3-second gust of strong wind area from typhoon Maemi at September 12, 2003.

### Maximum Wind damage potential

- Due to the absence of representative prices established for each component of the houses, the price of the house calculated consisted of the scale of damage wrought by the 3-second gust on the price of the entirety of a single house (50 million Korean won).

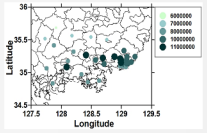



Fig.3 Distribution of maximum wind damage potential of a detached house in Busan-Gyeonam district.

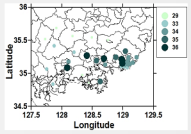



Fig.4. Distribution of mean 3-second gust during period from 0900 LST September 12, 2009 to 1500 LST September 13, 2003.

- The areas with the highest amount of damage consisted of Buk-gu, Gangseo-gu and Sasang-gu in Busan, where the damage was 12,980,265 won.
- The reason high amounts of damage incurred in these regions is the 3 second gust which is an input variable in the calculation of the amount of damage was higher compared to other areas.
- Based on the results shown above, it is demonstrated that the 3-second gust for a particular region exercise a great impact on the amount of damage calculated for a single house.

### 3-second gust wind and roughness length

- To determine the degree of impact exercised by an area's roughness length on the calculation of the 3-second gust , the data for 9 A.M. on September 12th was examined as a case study (Table 2).

Table 2. Distribution of wind speed on 300m level and 3-second gust on the surface at 0900 LST September 12, 2003.

| Regional | Wind speed on 300m level | 3-second gust | Regional | Wind speed on 300m level | 3-second gust |
|---|---|---|---|---|---|
| CGP | 32.14 | 23.85 | HIN | 32.04 | 24.68 |
| SOP | 32.14 | 23.85 | CHE | 31.98 | 24.64 |
| TDG | 31.24 | 23.2 | TYG | 34.63 | 26.61 |
| YDO | 32.14 | 23.85 | SAC | 32.81 | 27.31 |
| PSJ | 31.24 | 23.2 | KHE | 30.69 | 25.16 |
| TNE | 30.9 | 22.96 | NRY | 28.11 | 21.74 |
| NAM | 30.9 | 22.96 | KJE | 34.82 | 26.76 |
| PUK | 31.24 | 26.03 | YAS | 29.51 | 24.21 |
| HUD | 30.9 | 23.83 | URG | 30.5 | 23.53 |
| SHA | 32.14 | 23.85 | HMN | 31.45 | 26.2 |
| GJG | 30.02 | 23.17 | CYG | 28.53 | 22.06 |
| KSP | 30.38 | 25.33 | KSG | 33.75 | 25.96 |
| YJE | 30.9 | 22.96 | NHE | 33.41 | 25.7 |
| SYG | 30.9 | 22.96 | HDG | 32.05 | 26.69 |
| SAS | 31.24 | 26.03 | SCG | 29.06 | 24.25 |
| KJG | 29.65 | 22.09 | HYG | 28.14 | 23.5 |
| CWN | 31.17 | 25.97 | KCG | 26.72 | 20.69 |
| MSN | 32.14 | 24.76 | HCN | 28.44 | 21.99 |

- When calculating the 3-second gust based on the wind velocity at the 300m altitude, the variable of the roughness length can be considered to result in the greatest differences in value.

### Total amount of damage

- Examining the total amount of damage in each specific area of Busan and Gyeongnam (Fig.9), Jinju City was found to have the highest amount of damages, reaching 121,447,705,000 won.
- However, the 3-second gust, a factor which had been confirmed to exercise a large impact on amount of damage, was at the average level in Jinju and was not higher compared to other areas.
- Nonetheless the reason of high amount of damage in Jinju city was that this area contains the highest number of households within Busan and the Gyeongnam Province.

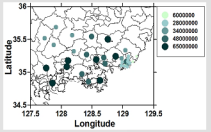



Fig.9 Distribution of the total maximum wind damage potential for all detached house in the City, Gun, Gu of Busan-Gyeongnam district.

- Although the amount of damage for a specific region is influenced by its 3-second gust, the number of households in representative houses within the region can be considered to be the factor which exercises a greater impact.

Table4 . The number of a detached house in the City, Gun, Gu of Busan-Gyeongnam district.

| Regional | Number | Regional | Number |
|---|---|---|---|
| CGP | 565 | HIN | 12,226 |
| SOP | 2,890 | CHE | 4,500 |
| TDG | 2,443 | TYG | 6,255 |
| YDO | 2,820 | SAC | 8,332 |
| PSJ | 5,238 | KHE | 7,595 |
| TNE | 2,963 | NRY | 10,519 |
| NAM | 4,155 | KJE | 7,637 |
| PUK | 1,077 | YAS | 3,518 |
| HUD | 1,880 | URG | 3,575 |
| SHA | 2,556 | HMN | 5,020 |
| GJG | 2,586 | CYG | 6,590 |
| KSP | 3,081 | KSG | 6,069 |
| YJE | 2,604 | NHE | 6,998 |
| SYG | 2,539 | HDG | 6,210 |
| SAS | 1,824 | SCG | 4,022 |
| KJG | 2,455 | HYG | 4,812 |
| CWN | 4,079 | KCG | 5,070 |
| MSN | 8,827 | HCN | 5,327 |

## Conclusions

- This research has focused on the amount of typhoon damage experienced by Busan and Gyeongnam Province.
- When the price of the representative house is assumed to be 50 million won, the amount of damage for a single house is greatly impacted by the 3-second gust experienced in that area, and the 3-second gust is largely influenced by the roughness length within the area.
- Urban areas in which the roughness length is large tend to have lower 3-second gusts compared to farming areas where the roughness length is smaller, but because these urban areas have more buildings compared to farming areas, they concomitantly have more buildings damaged compared to the farming areas and hence it is possible for urban areas to exhibit high levels of total damage amounts.
- The 3-second gust and the number of households are the two representative variables influencing the total amount of damage in a particular area.
- However, currently the number of households is comprised of detached houses for the particular area, and hence the amount of damage determined above cannot be considered the amount of damage applicable to all houses and apartments within the region. The number of houses may change upon improvements implemented to the database, and the amount of damage may accordingly change.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