# Assessment of Storm wind speed at the Shin-Kori nuclear power plant site using the WRF400 model in the SSP5-8.5 scenario

Dongchang Kim [a], Shinyoung Kwag [b], Hyoseung Son [c], Seunghyun Eem [c*],
[a] *Department of Convergence & Fusion System Engineering, Kyungpook National Univ., Daegu, 41566, Republic of Korea*
[b] *Department of Civil & Environmental Engineering, Hanbat National Univ., Daejeon, 34158 Republic of Korea*
[c] *Department of Smart plant Engineering, Kyungpook National Univ., Daegu, 41566, Republic of Korea*

[*] *Corresponding author: eemsh@knu.ac.kr*

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## 1. Introduction

Nuclear power plants must be safe from external disasters such as earthquakes, floods, and typhoons [1]. Design and safety assessments for these disasters have traditionally been conducted based on the assumption of normality based on past observations [2]. However, climate change is changing the intensity and frequency of external disasters such as heavy rain, wildfires, and extreme winds [2]. Therefore, there is a growing need to reexamine design criteria established solely on past observations to ensure sufficient safety margins under future conditions [2].

This study assessed future storm hazards, represented by extreme wind speeds, in the vicinity of the Shin-Kori Nuclear Power Plant while accounting for climate change. Wind speed data from the WRF400 regional climate model for East Asia were employed for this purpose. Using spatial downscaling, bias correction, temporal downscaling, and extreme value analysis, 100-year return-period storm wind speeds were estimated for the 2070–2100 period under the SSP5–8.5 scenario. The estimated storm wind speeds reflecting climate change were then compared with those derived from observational records.

## 2. Methods

This study estimated future storm wind speeds for the 2070–2100 period under the SSP5–8.5 scenario, using the Busan observation station, which is located closest to the Shin-Kori Nuclear Power Plant site, as the reference location. As illustrated in Fig. 1, the overall procedure consisted of acquiring observational and climate-model wind-speed data, spatial downscaling, bias correction, temporal downscaling, and estimating storm wind speeds through extreme-value analysis.

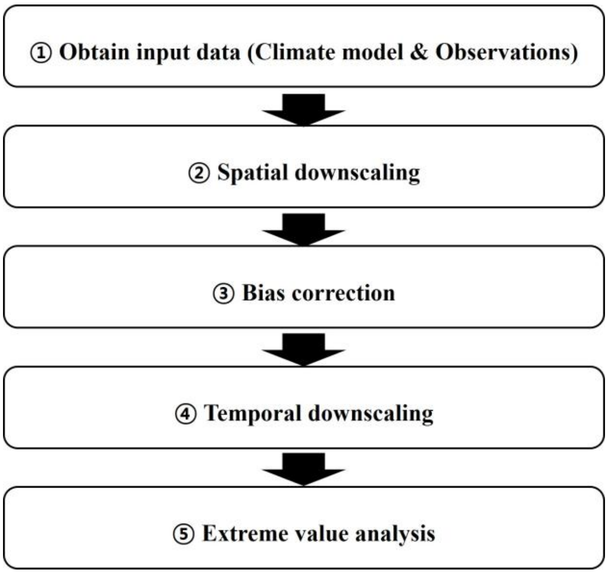


Fig. 1. Framework for estimating future storm under climate change

Observational data were obtained from records of the Automated Synoptic Observing System (ASOS) station located in Busan. For the climate model data, daily mean wind speed outputs from the WRF400 regional climate model over the East Asia domain were used. Because the RCM wind speed data were provided in a gridded format, spatial downscaling was performed based on the location of the Busan observation station. Subsequently, to improve consistency between the climate model data and observations, bias correction was performed using Quantile Delta Mapping as shown in Fig. 2, thereby producing site-specific wind speed data [3].

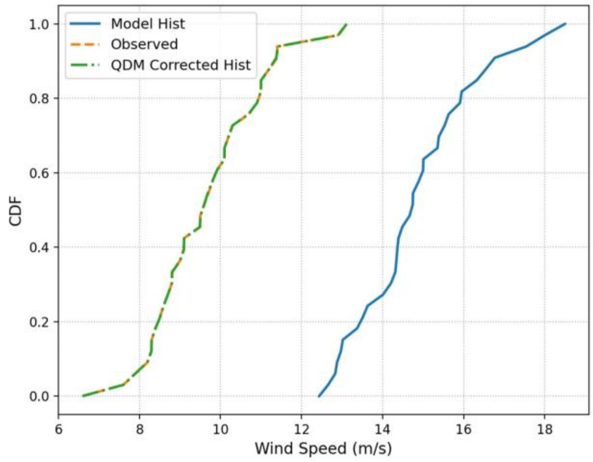


Fig. 2. Bias correction of climate model(WRF400) simulations for the historical period using observed data

In this study, wind speed data from the regional climate model (RCM) were provided as daily mean values. Therefore, to convert them into wind speed indices suitable for design evaluation, a gust-factor–based temporal scaling method was applied to estimate the 10-minute maximum wind speed(V10) and the 3-second maximum instantaneous wind speed (V3). The gust factor was derived from Busan observational data using empirical relationships among the daily mean wind speed (U), the 10-minute maximum wind speed, and the 3-second maximum instantaneous wind speed. An extreme value analysis was then performed using the Gumbel-Chow distribution.

## 3. Results

The 100-year return period wind speeds estimated at the Busan ASOS Observatory reference point for the SSP5-8.5 (2070–2100) period are presented in Table I along with observation-based results.

Table I: Observed vs RCM-based 100-year return-period wind speeds (SSP5-8.5, 2070–2100)

| | V10 | V3 |
|---|---|---|
| Observed | 37 m/s | 45.4 m/s |
| WRF400 | 23.36 m/s | 32.32 m/s |

The 100-year return-period storm wind speeds estimated under climate change conditions (SSP5–8.5, 2070–2100) were generally lower than the observation-based 100-year return-period wind speeds. This tendency is interpreted as resulting from the inclusion of severe storm events, such as typhoons, in the observational records. In contrast, the climate model does not adequately capture the extreme wind speeds associated with such events. Therefore, for the design evaluation of nuclear power plants, further assessment is needed to account for extreme wind speeds associated with typhoons under future climate conditions.

## 4. Conclusions

This study estimated future storm wind speeds at the Shin-Kori Nuclear Power Plant site for the 2070–2100 period under the SSP5–8.5 scenario using observational data from Busan and outputs from the WRF400 regional climate model. The results showed that the climate model–based 100-year return-period wind speeds were estimated to be lower than those derived from the observational data, which is interpreted as being related to the limitation of the regional climate model daily mean wind speed data in adequately reproducing short-duration extreme strong winds associated with typhoons.

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