# CLIMATE CHANGE AND DESIGN CRITERIA OF STRUCTURAL MEASURES FOR NATURAL DISASTERS

Hung Soo KIM
*Vice President, Korean Water Resources Association*
*Professor, Dept of Civil Eng, Inha Univ., Korea. Email: sookim@inha.ac.kr*

## ABSTRACT

*The natural disasters such as floods and droughts have been severely occurred in Korea. So, this study tried to suggest the procedure for frequency analysis of the future rainfall, snowfall depth, and wind speed. The design criteria were estimated based on the frequency analysis for each hazard under the climate change. We compared the current design value and the future value then investigated the design criteria of structural measures for the future. Based on the climate change analysis, we have shown that the future rainfall and wind speed will be increasing but the snowfall depth will be decreasing.*

## INTRODUCTION

In recent decade, the natural disasters such as flood and drought have been severely occurred in Korea and this may be due to the climate change by global warming. So, Korean government tried to develop new design criteria for structural measures considering climate change effect that will both reduce and prevent the impacts of natural disasters for public security. The objective of this study is to suggest the design criteria of structural measures based on the frequency analysis for rainfall, snowfall, and wind speed under the climate change.

## METHODOLOGY

To quantify the impact of climate change on rainfall and snowfall, we use a GCM model of CNCM3 developed by Centre National de Recherches Meteorologiques, France and A1B, A2, B1 climate scenarios for the simulation of each meteorological data are used. The reason that CNCM3 GCM model is used here is based on the work of Kyoung (2010) who tested 24 GCM models provided by IPCC AR4 for the selection of a proper model which can be used in the Korean peninsula. However, the different models are used for the estimation of wind speed. This work uses the spatial and temporal downscaling techniques for obtaining the needed data for the frequency analysis in the study area. Point and regional frequency analysis are conducted for rainfall and snowfall. Overall diagram for the methodology is shown in the Figure 1.

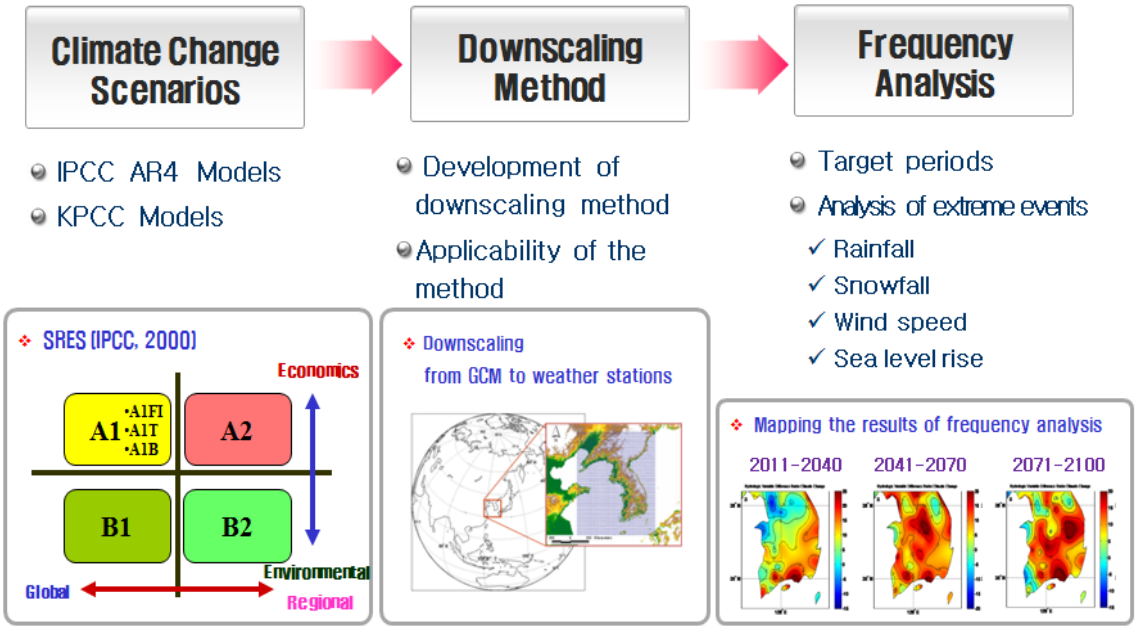



***Figure 1.*** *Schematic diagram for the assessment of the impact of climate change*

## APPLICATION OF FUTURE DESIGN CRITERIA UNDER CLIMATE CHANGE

The design criteria are estimated based on the frequency analysis for rainfall, snowfall, and wind speed under climate change then are applied to the disaster prevention or control facilities such as sewer system, vinyl house, a building, and so on. If we consider climate change, the design criteria will be higher than current one. As an example of a sewer system, we assume that the current design criterion is 20-year frequency for the rainfall but the future criteria under climate change could be 30-year frequency. In this case, do we apply the future criteria for the design of this sewer system? To apply the future criteria we may need careful investigation and so the guideline for application of future design criteria under climate change is shown in Figure 2.

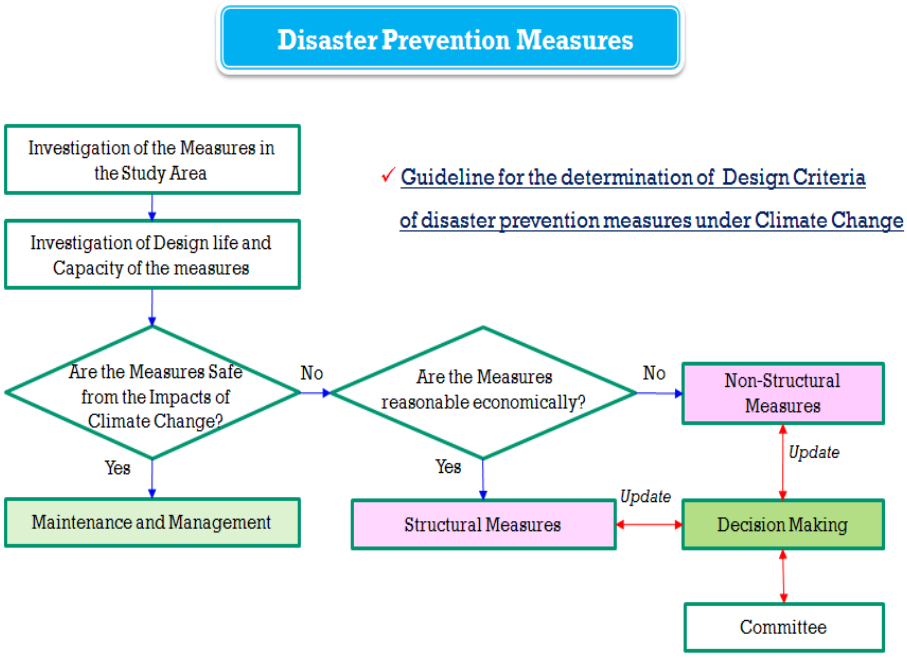


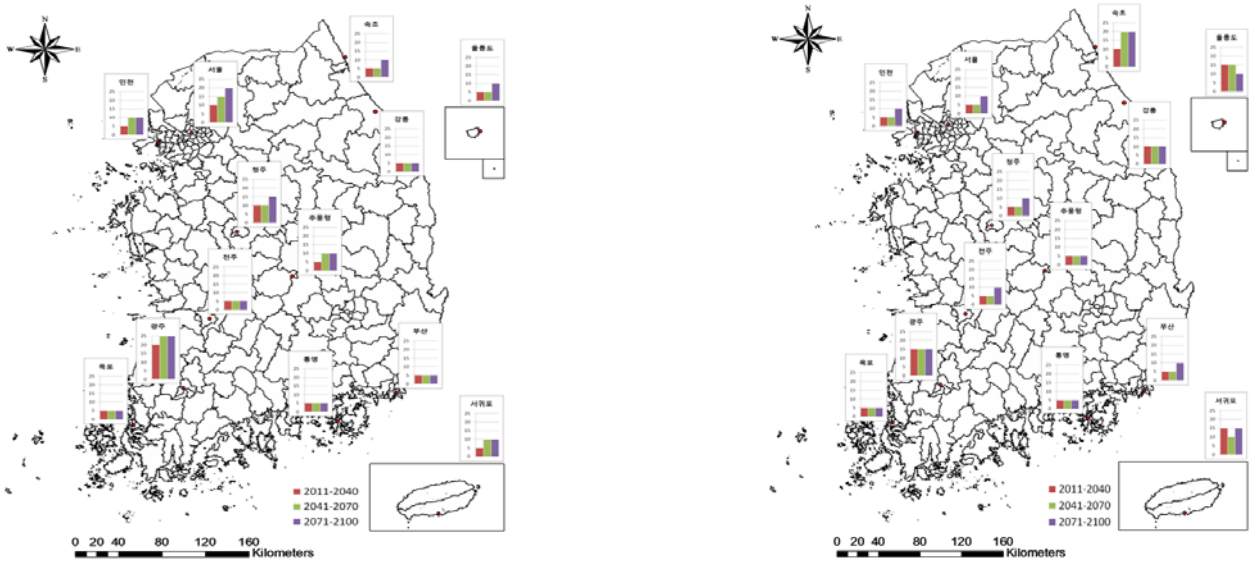

***Figure 2.*** *Decision making procedure for the application of future design criteria under the climate change*

## APPLICATION AND RESULTS

In this study, rainfall, snowfall, and wind speed are considered as the impact hazards or factors. The impact of climate change on these factors is analyzed and applied for estimating the design criteria of structural measures for disaster prevention. The results are described in the following sections for each hazard.

### Rainfall

We estimate the increasing or decreasing rate of frequency based rainfall in the future of 2100 for 59 stations in Korean peninsula and also estimate the rate for 13 regions. From the point and regional frequency analysis, we have known that the rainfall by point frequency analysis will increase up to 7-9% in the future. And the rainfall in the future will also increase up to 8-11% in 13 regions in the future. So, we can suggest new design criteria for structural measures for disaster prevention based on the analysis results.




*(a) Regional analysis* *(b) Point analysis*

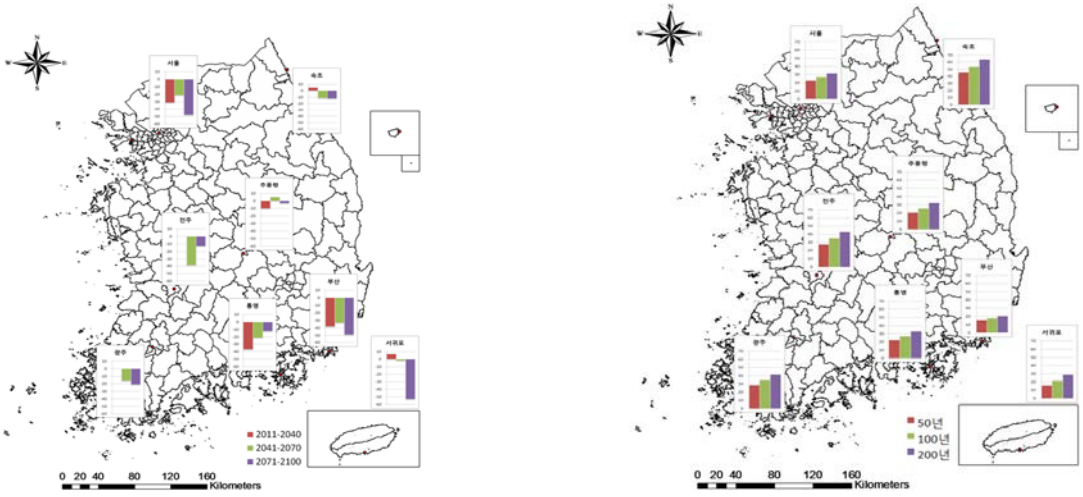
***Figure 3.*** *The increasing rate of the future rainfall under the climate change (%)*

### Snowfall

We estimate snowfall depth by frequency analysis for 59 weather stations in Korean peninsula. From the point frequency analysis, we have known that the snowfall depth by point frequency analysis will decrease up to 12-31% in the future. However, from the analysis of observations, we found that the extreme value will increase.

### Wind speed

In case of the wind speed, the future wind speed is simulated for 59 weather stations in Korean peninsula. The daily wind speed and 10 minutes average wind speed are estimated and then analyzed. As a result, we found that the wind speed of inland area will increase in the future. And so, we may need the increase of design criteria of wind speed in the northern part of inland area from 25m/s to 30m/s and the one in the southern part from 25m/s to 35m/s in the future.




*(a) Decreasing rate (%) for each period* *(b) Snowfall for 50, 100, 200-yr frequency*

***Figure 4.*** *The snowfall estimated by regional frequency analysis under climate change*

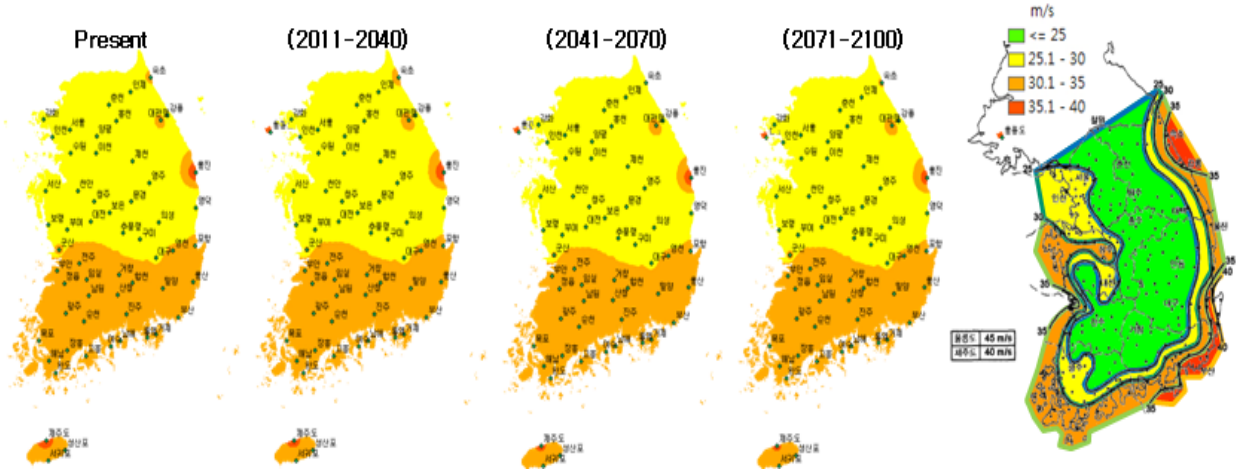



***Figure 5.*** *The wind speed estimated by frequency analysis under climate change*

## SUMMARY

**Table 1. Design Criteria of Disaster Prevention Measures Considering Climate Change**

| Items | Target Periods | | | | | | Remarks |
|---|---|---|---|---|---|---|---|
| | 2011-2040 | | 2041-2070 | | 2071-2100 | | |
| | AR4 | AR5 | AR4 | AR5 | AR4 | AR5 | |
| Frequency Based Rainfall Depth | +10 % | +15 % | +10 % | +15% | +15 % | +20 % | Daily Data |
| | +15 % | - | +15 % | - | +20 % | - | Hourly Data(1hr) |
| Frequency Based Snowfall Depth | -10 % | +5 % | -20 % | -30 % | -30 % | -40 % | Daily Data |
| Frequency Based Wind velocity | +5 m/s | - | +5 m/s | - | +5 m/s | - | Northern inland regions |
| | +10 m/s | +5 m/s | +10 m/s | +5 m/s | +10 m/s | -5 m/s | Southern inland regions |

## CONCLUSIONS

This study tried to suggest the procedure for frequency analysis of the future rainfall, snowfall depth, and wind speed. The future values were estimated from climate change analysis using a proper climate model and scenarios. We compared the current value and the future value then investigated the design criteria of structural measures for the future.

The suggested procedure and results could be used for the future long term plan related to rainfall, snowfall depth, or wind speed and also for the design of important facilities.

## REFERENCES

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