External Flood Risk Analysis at NPP Site Considering Climate Change

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1. Introduction

In recent years, the flooding risk of national major facilities has increased significantly due to heavy rainfall events. These facilities should consider and evaluate the external and internal flooding risk such as flash flood from rainfall, watershed flooding, river flooding and coastal flooding.

This study estimate the flood resulting from extreme rainfall with LIP(Local Intensive Precipitation). The impact of buildings, road, and curb at the NPP site are analyzed, and the roughness coefficient according to the landuse condition is estimated. For external flooding hazard analysis, 2D analysis is carried out by applying the analysis of the tidal levels as external boundary conditions. Based on the results of the 2D analysis, hazard curves for the inundation depth with frequency and duration are developed at specific area of NPP.

A new flood hazard curve are presented by the relationship among rainfall, flood depth and annual exceedance probability. The result of this study in expected to be a basis for the waterproof design, the flood prevention function design and the advancement of flood prevention measures .

2. Research Method

Probable Maximum Precipitation(PMP) considering the climate change scenarios of RCP4.5 and RCP8.5 are computed and compared with the probability flood by frequency analysis to estimate the LIP. In order to evaluate the external flooding risk on these structures, two dimensional hydraulic analysis is performed and the frequency hazard curve is developed using the results of flood depth and velocity.

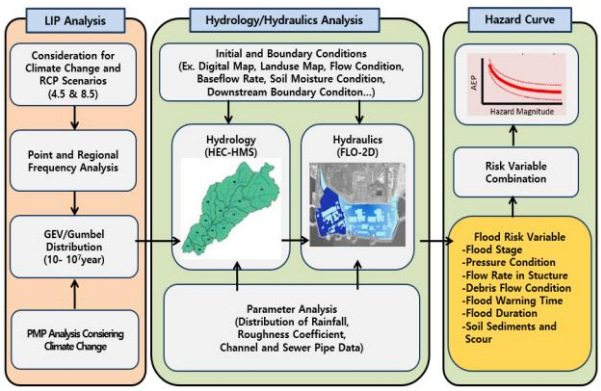

Fig. 1. Flow Chart of the Study

2.1. Detail of Topographic

The detailed topographic data for the refinement of the external flooding analysis is constructed and DEM data with high resolutions for the NPP site are generated.

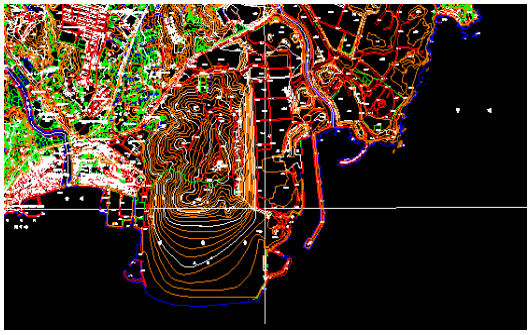

Fig. 2. Digital Topographic Maps of Study Area

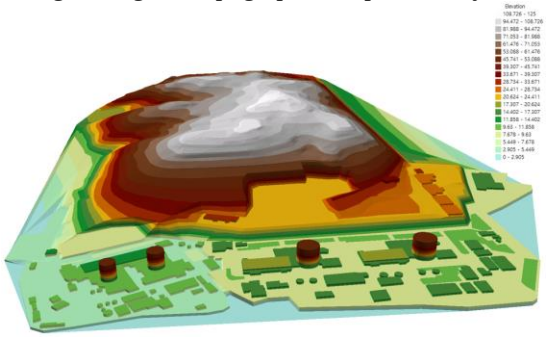

Fig. 3. TIN of NPP Site

2.2. 2D Simulation and Hazard Analysis

Based on the topographic data generated, 45 scenarios were constructed combining nine return periods from 100year to $1x10^7$ years and rainfall duration conditions from 1 hour to 3 hours.

A two-dimensional analysis comprised a grid size of 3m x 3m and total simulation time was 12 hr. (Fig. 4)

Fig. 4. Modeling of 2D Inundation Analysis

Fig. 5 shows the precipitation-nonexceedance probability relationships for the rainfall duration conditions from 10mm to 6 hours.

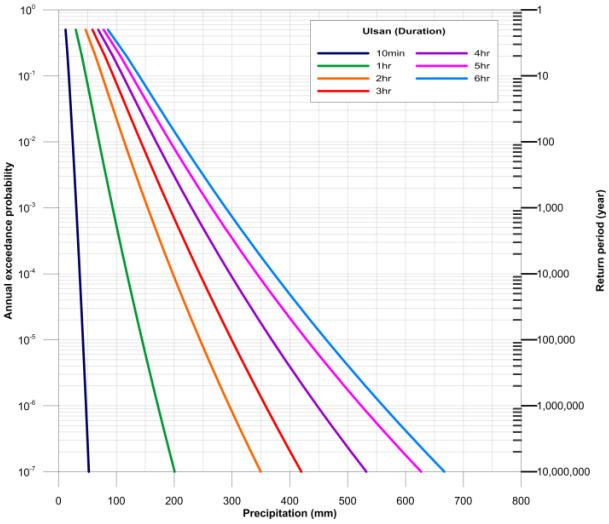

Fig. 5. Precipitation-Frequency Relationship

Two-dimensional analysis determined the inundation depth at each time step, and the typical results were presented as follows (Fig. 6).

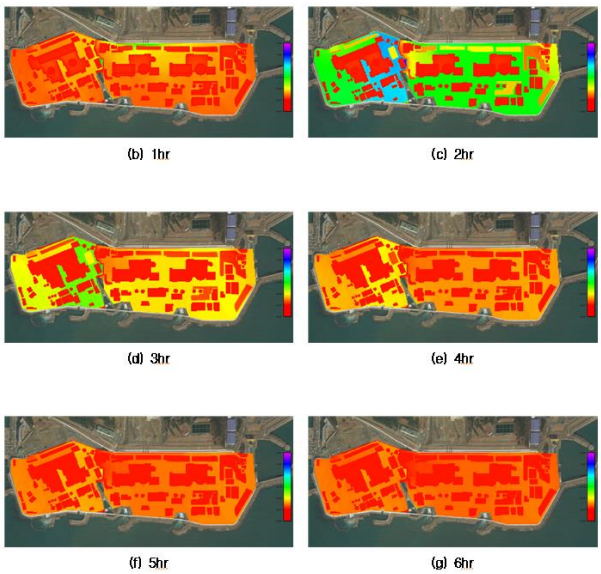

Fig. 6. Inundation Depth
(Rainfall Duration = 2hr, Return Period = 10^6y)

Based on the results of the two-dimensional analysis, flood hazard curves for the inundation depth with the various frequency and duration conditions are developed at specific area of major facilities. The internal flooding within structure, system and components caused by external flood inundation in the major facilities was also evaluated.

3. Conclusions

As the results of this study, the basic data for the probabilistic risk assessment of external floods that could occur at the site of the NPP from the extreme flood conditions due to river flood, watershed flood, and coastal flood were established. The probabilistic flood risk assessment method would be able to assess the risk associated with vulnerability at the site of the NPP site, and it can be used as a technical basis for comprehensive and detailed quantitative risk assessment, as well as for establishing structural/non-structural measures and for various regulation tools against severe flooding at NPP site.

4. Acknowledgments

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