Determination of flood-inducing rainfall and runoff for highly urbanized area based on high-resolution radar-gauge composite rainfall data and flooded area GIS Data

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Abstract

This study derived the Flood-Inducing-Rainfall (FIR) and the Flood-Inducing-Runoff (FIRO) from the radar-gage composite data to be used as the basis of the flood warning initiation for the urban area of Seoul. For this, we derived the rainfall depth-duration relationship for the 261 flood events at 239 watersheds during the years 2010 and 2011 based on the 10-minute 1km-1km radar-gauge composite rainfall field. The relationship was further refined by the discrete ranges of the proportion of the flooded area in the watershed (FP) and the coefficient variation of the rainfall time series (CV). Then, the slope of the straight line that contains all data points in the depth-duration relationship plot was determined as the FIR for the specified range of the FP and the CV. Similar methodology was applied to derive the FIRO, which used the runoff depths that were estimated using the NRCS Curve Number method. We found that FIR and FIRO vary at the range of 37mm/hr-63mm/hr and the range of 10mm/hr-42mm/hr, respectively. The large variability was well explained by the FP and the CV: As the FP increases, FIR and FIRO increased too, suggesting that the greater rainfall causes larger flooded area; as the rainfall CV increases, FIR and FIRO decreased, which suggests that the temporally concentrated rainfall requires less total of rainfall to cause the flood in the area. We verified our result against the 21 flood events that occurred for the period of 2012 through 2015 for the same study area. When the 5 percent of the flooded area was tolerated, the ratio of hit-and-miss of the warning system based on the rainfall was 44.2 percent and 9.5 percent, respectively. The ratio of hit-and-miss of the warning system based on the runoff was 67 percent and 4.7 percent, respectively. Lastly, we showed the importance of considering the radar-gauge composite rainfall data as well as rainfall and runoff temporal variability in flood warning system by comparing our results to the ones based on the gauge-only or radar-only rainfall data and to the one that does not account for the temporal variability.

Keywords : Urban flood warning, Conditional merging, Rainfall threshold

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