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# Estimation of Flood Discharge According to Variability of Rai Nfall Distribution Using Gis-Based Method in a Basin

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# ESTIMATION OF FLOOD DISCHARGE ACCORDING TO VARIABILITY OF RAI NFALL DISTRIBUTION USING GIS-BASED METHOD IN A BASIN

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***Abstract:*** *These days, the distributed model is becoming popular because it can utilize the spatial information of watershed from remote sensing, radar, and satellite technologies. Unlike the popularity of distributed model, we are using mean areal precipitation as the input data of the model. However, in reality, precipitation has uncertain spatial distribution by variability of its movement and direction and so it is difficult to assure the mean areal precipitation of the basin is really a representative mean value of the basin. Therefore, in this paper, we selected radar rainfall data from 12 Jul 2009 to 15 Jul 2009 for consideration of spatial distribution of rainfall and a semi□distributed model for consideration of spatial distribution of the basin characteristics in SumJin river basin, Korea. We simulated the flood discharge by considering radar rainfall movement and direction using a grid- based ModClark model in HEC-GeoHMS which is a semi-distributed model. As the results, we investigated the variability of peak flow according to variability of radar rainfall movement and distribution and knew that the direction of rainfall movement affected peak flow and time of peak flow. In conclusion, we have known that it may be important to consider the rainfall movement and direction for the investigation of flood discharge characteristics such as peak flow and peak time.*

***Keywords:*** *radar rainfall, distributed model, ModClark, flood discharge.*

## INTRODUCTION

In recent decades, the extreme weather events due to the climate change are frequently occurred over the world. Korean peninsular has also suffered from natural disaster by localized extreme events and the damage tends to be rapidly increasing. Therefore, the estimation and forecasting of flood discharge in real time could be a very important issue for the flood damage prevention and reduction. To do the flood discharge estimation, we need rainfall data as the input of a rainfall-runoff model.
The mean areal rainfall obtained from the point rainfall data are usually used as the input data. However, the point rainfall may have its limitations for representing spatial variability of rainf all and so we used radar rainfall for its spatial variability. Also this study used a semi-

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distributed model called ModClark which can consider the spatial distribution of the basin cha
racteristics such as the runoff curve number, time of concentration, and so on. Then we simula
ted flood discharge by considering rainfall movement and direction to investigate the effect of
rainfall movement. We estimated flood discharges by considering four directions of radar rai
nfall and the movement directions of radar rainfall are determined by wind directions. Then w
e investigated how peak flow and peak time are changing according to the rainfall movement.

**Modified Clark Method**

Modified Clark or ModClark model in HEC□GeoHMS is incorporated with radar rainfall da
ta which can consider spatial variability of rainfall. The grid based ModClark model uses DE
M cells for the distribution of radar rainfall and the CN value and time of concentration in a b
asin will be determined by GIS tool. Then the flood discharge is simulated with the parameter
s of time of concentration $T_c$ and storage constant K.(HEC, 1996)

**Study area and radar rainfall**

The study area is Sumjin river which is located in the southern part of Korean peninsular. Th
e basin area is 4,911.89 □, basin length is 223.86 km, and mean width of basin is 21.94km. T
he 65.8% of the basin is mountain area
This study uses the radar rainfall recorded in the period of 22:00 July 12, 2009 to 08:00 July
15, 2009. The basin is divided into the cell size of 1Km× 1Kim which is the same size with ra
dar rainfall grid and the CN is extracted from the soil map and land cover map. The time of c
oncentration, $T_c$ and the storage constant K are estimated based on the grid□sized basin of 3
0m × 30m in HEC-GeoHMS.

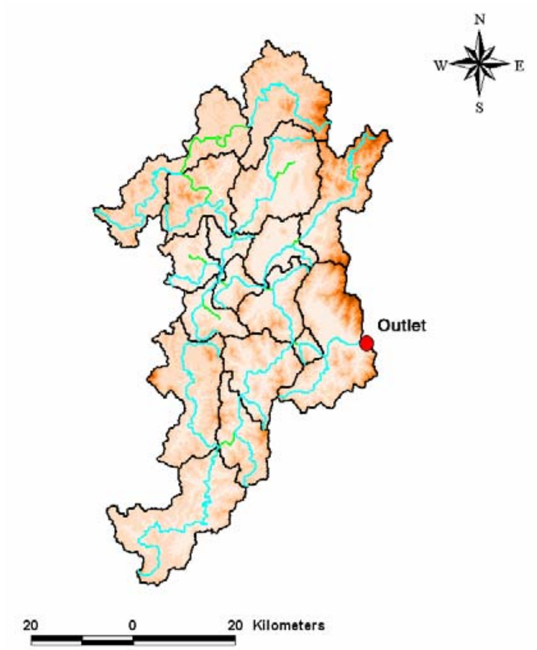


**Fig. 1. Sub-basin of Sumjin river Basin**


**Fig. 2. Model configuration of HEC□GeoHMS**

## Analysis of Rainfall Variability

We collected wind related data from six meteorological stations near to the Sumjin river basi n.Wind in the south□western direction observed as the highest velocity in the period of 12 J uly 2009 to 15 July 2009. We also considered three more wind directions which are perpendi cular to the south□western direction. The flood discharges were simulated at the basin outlet by considering radar rainfall movement in four wind directions. These directions are : South □Western(SW), North□Western(NW), North□Eastern(NE), and South□Northern(SN) dir ections for the radar rainfall movement. The rainfall is spatially distributed into four direction s based on the centroid of the basin. Rainfall movement had following characteristics : NW a nd NE rainfall are moved and distributed from upstream to downstream of the river. SE rainfa ll from downstream to upstream of the river. SW rainfall from upstream to downstream(Figs 3 ~ 6).

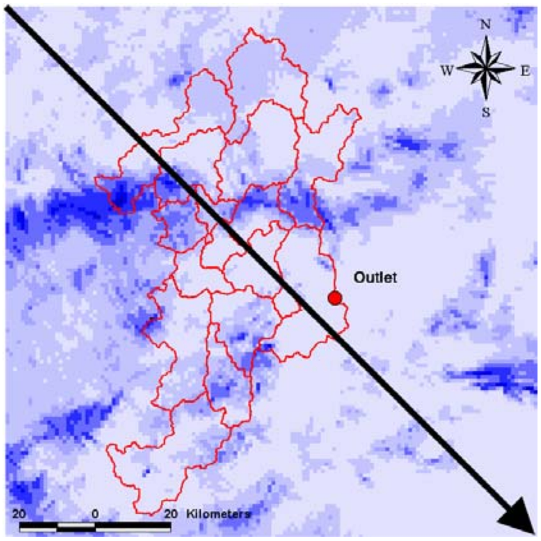


**Fig. 3. NW radar rainfall distribution**

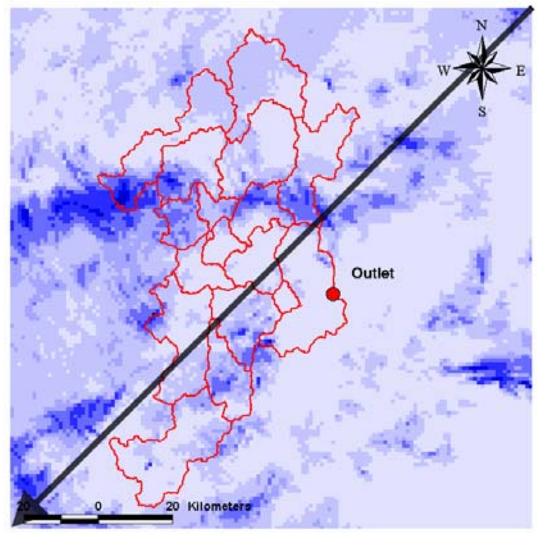


**Fig. 4. NE radar rainfall distribution**

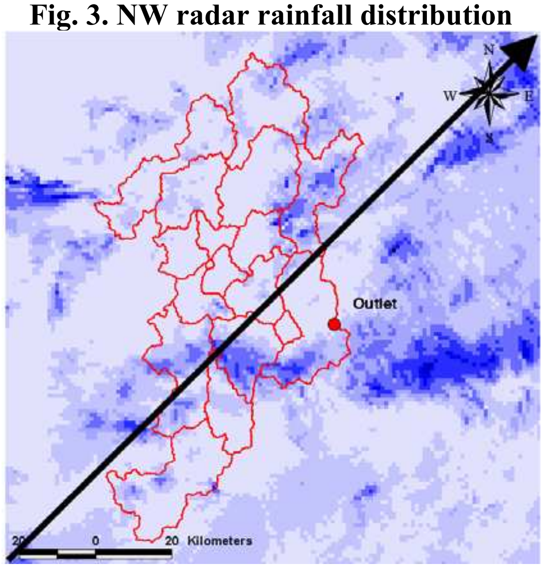


**Fig. 5. SW radar rainfall distribution**

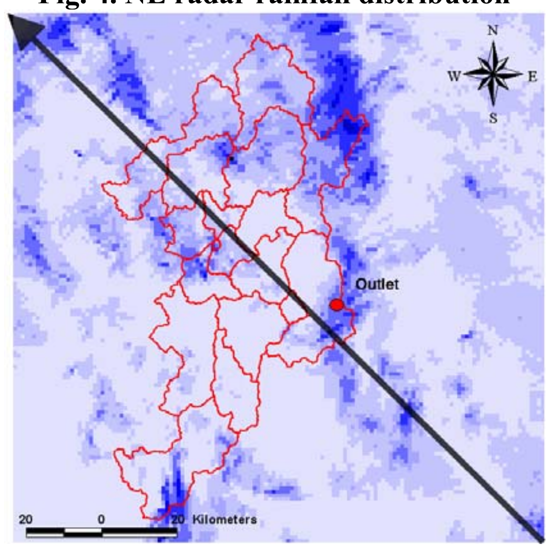


**Fig. 6. SE radar rainfall distribution**

**Estimation of Flood Discharge**

This study estimated optimal parameters from runoff simulation using SW radar rainfall and from the calibration of simulated runoff with the observed discharge in Songjung station located in the outlet. Then the runoff or flood discharge simulations were performed and compared for four directional radar rainfall movements (Fig. 7).

There is nothing little to choose between the total volume. But, there's Peak flow difference between the four directions. NW and NE rainfalls moved to the same directions with the river flow and inflow to the channel was becoming greater than outflow in the basin. Therefore, the peak flow was large and runoff was delayed in the stream. SE and SW rainfalls influenced on the runoff at the outlet and peak flows were relatively less than NW and NE rainfalls. SE rainfall showed more larger peak flow than SW rainfall.

**Table 1. Peak flow and Peak Time at Songjung water level station**

| Radar Rainfall movement | Peak flow (hr) | Interval between Peak flow on the basis of SW (hr) | Total Volume (□) | Interval between Total Volume on the basis of SW (hr) |
|---|---|---|---|---|
| **NW** | 308.31 | 48.20 | 22,467.26 | -33.04 |
| **NE** | 338.88 | 78.77 | 22,486.54 | -13.76 |
| **SE** | 242.89 | -17.22 | 22,503.13 | 2.83 |
| **SW** | 260.11 | - | 22,500.30 | - |

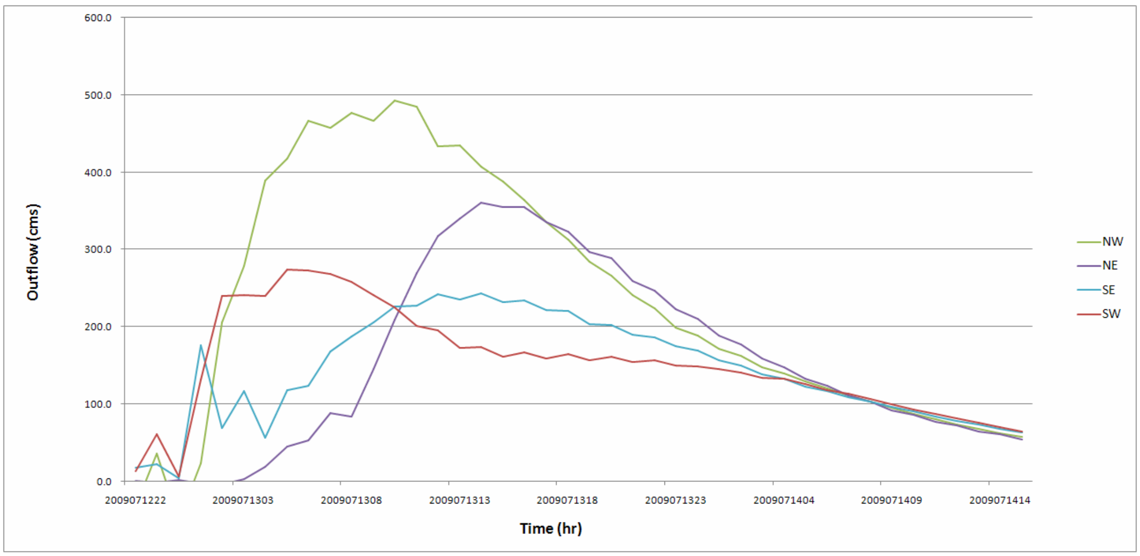


**Fig. 7. Outflow hydrograph at Songjung water level station**

## CONCLUSIONS

We considered rainfall movement and direction for the investigation of runoff or flood discharge variability and for this, we used radar rainfall which can consider its spatial variability. This study have also used a semi□distributed model which can consider spatial distribution of the basin characteristics for the runoff simulation.

Especially we investigated the variability of peak flow and peak time according to variability of radar rainfall movement and distribution and knew that the direction of rainfall movement affected peak flow and time of peak flow. In conclusion, we have known that it may be important to consider the rainfall movement and direction for the investigation of flood discharge characteristics such as peak flow and peak time

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