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THE EFFECT OF FLOOD REDUCTION AND WATER CONSERVATION OF DECENTRALIZED RAINWATER MANAGEMENT SYSTEM

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Climate change and increase of surface runoff by urbanization caused the urban flooding. Therefore, a sustainable new paradigm is required to recover sound water circulation and overcome the limitations of the existing water management system vulnerable to flooding. Recently Rainwater management is widely known and its legal obligation is strengthened to improve the control capacity for flooding reduction and water conservation in urban areas. Multipurpose DRMS(Decentralized Rainwater Management System) is a new paradigm proposed and recommended by NEMA(National Emergency Management Agency) for both flood control and water conservation. In this study, a flood prone area in Suwon of South Korea is selected and analysis of DRMS has been made using XP-SWMM for different scenarios of RT installation with same total rainwater tank volume and location. In addition, the effects of water resources secure were analyzed in accordance with using stored rainwater in tank. As a result, installing one rainwater tank of 3,000 m$^3$ can reduce the peak flow rate by 15.5%. Installing six rainwater tanks of 500 m$^3$ volume in the area can reduce the peak flow rate by 28%. Three tanks concentrated in the middle region can reduce peak rate more than evenly distributed tanks. In case of the same tank volume, the more the number of rainwater storage tanks installed, the more the better water quality was guaranteed.

Introduction

In recent years, the frequency of heavy precipitation caused by climate change due to urbanization and the increase in impervious surfaces bring about excess of the design capacity of the sewer flooding low-lying areas, such as the cause of the damage. National Emergency Management Agency recently and Suwon city in KOREA is offering multi-purpose decentralized rainwater management as a new deal for overcoming the limits of the existing storm drain system. Decentralized rainwater management (DRMS) is to manage rainwater in various locations within the watershed to install small-scale rainwater storage tank away from the existing system such as the centralized rainwater management. Fig. 1 is shows the conceptual differences of conventional centralized management and decentralized management of rainwater
Centralized management of existing rainwater which sole purpose is to prevent flooding, whereas the decentralized rainwater management and flood prevention, as well as away from some domestic water, emergency water, fire water, landscape irrigation can be used for multi-purpose use.

In this study, using a Windows-based XP-SWMM, in areas prone to floods of M town in Suwon city as a research area to study 1) the impact on the peak runoff reduction for the number of rainwater storage tank installation, and 2) the effect on improvement in peak runoff reduction distributed for rainwater storage tank, or the installation location of the deployment types.

Materials and Methods

The capacity of rainwater storage tank installed in the study area (Rainwater Tank, RT) was calculated by considering the building area, Eq. (1) were calculated by the method (Ministry of Land, Transport and Maritime Affairs, 2009).

\[ V_r = A_r \times K \]  

\( V_r \): Storage tank capacity [\( m^3 \)]  
\( A_r \): Architectural roof area (or the area of impervious area) [\( m^2 \)]  
\( K \): Factor of reservoir capacity (0.05 ~ 0.1) [\( m^3/m^2 \)]

Target area of the entire roof in the M town is about 0.029 \( km^2 \). Here, capacity factor of storage tank 0.1 (\( m^3/m^2 \)) and multiply by 2,850 \( m^2 \) storage tank has a capacity of approximately calculated. In this study, the number of storage tank specific, location-specific simulated at each catchment capacity of the storage tank so that the distribution can be easily assumed reservoir
capacity of 3,000 m³. Land cover using the ArcGIS program, such as sewage pipe network is required for simulation input data from GIS data was extracted. Then, based on the building materials were used hydrologic simulation has XP-SWMM. As M town is a combined sewer area, Water flow capacity of the pipe network were investigated in order to characterize the effluent.

In order to study the effects of decentralized rainwater storage tank according to the number, the capacity of peak flow reduction was analyzed. A total capacity of 3,000 m³ of rainwater storage tank is same as the single rainwater storage facilities. Table 1 shows the installation number and capacity of rainwater storage tank. The decentralized system as shown in toward Case a to Case f is became. The arrangement of rainwater storage tank by each case is shown in Fig. 2.

Table 1. Volume and number of rainwater tanks in each case

<table>
<thead>
<tr>
<th>Case</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tank volume (m³/EA)</td>
<td>0</td>
<td>3,000</td>
<td>1,500</td>
<td>1,000</td>
<td>750</td>
<td>600</td>
</tr>
<tr>
<td>No. of tanks (EA)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

In addition, rain water storage tank for each condition of flooding large areas in the existing drainage system and was firstly placed.

Figure 2. Cases for simulation of decentralized rainwater tank installation

The effect of peak runoff reduction was simulated according to rainwater storage tank deployment type (location). To this end, M town upstream, midstream, downstream and were
divided into three town, the total number of rainwater storage tank in watershed was fixed at three.

Results and discussion

Using the actual rainfall in 2000, the results of peak runoff reduction for several alternatives of rainwater storage tank installation is the same as Fig.3.

Figure 3. Discharge at outfall with different number of RT under the same total volume

If 3,000 ㎥ of a rainwater storage tank volume in downstream basin was installed, 1.42 ㎥, the volume of peak runoff was decreased (about 15.5%) . Therefore, when you install rainwater storage tank was able to reduce peak runoff, the decentralized rainwater storage tank to be able to further reduce peak runoff could be confirmed as the tendency. As a case of M towns, when each three of 1,000 ㎥ of rainwater storage tank was installed in the middle area, the most effect of peak runoff reduction was shown. This means that the installation of rainwater storage tank by the change of location affect runoff in downstream of watershed. Considering the characteristics of the banks, the rainwater storage tank capacity to put the distribution of the weighted peak flux reducing effect to the case where it can be seen that further increase.

Conclusions

As a result, installing one rainwater tank of 3,000 ㎥ can reduce the peak flow rate by 15.5%. Installing six rainwater tanks of 500 ㎥ volume in the area can reduce the peak flow rate by 28%. Three tanks concentrated in the middle region can reduce peak rate more than evenly distributed tanks. In case of the same tank volume, the more the number of rainwater storage
tanks installed, the more the better water quality was guaranteed. Method and results obtained in this study are within the downtown more safe and sustainable anti-flooding and that design facilities can be used to predict the effect.

Acknowledgments
This research was supported by a grant (12-TI-C01) from Advanced Water Management Research Program funded by Ministry of Land, Infrastructure, and Transport of Korean government.

REFERENCES