Low Impact Urban Development For Climate Change and Natural Disaster Prevention

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Abstract: Increase of impervious areas due to expansion of housing area, commercial and business building of urban is resulting in property change of stormwater runoff. Also, rapid urbanization and heavy rain due to climate change lead to urban flood and debris flow damage. In 2010 and 2011, Seoul had experienced shocking flooding damages by heavy rain. All these have led to increased interest in applying LID and decentralized rainwater management as a means of urban hydrologic cycle restoration and Natural Disaster Prevention such as flooding and so on. Urban development is a cause of expansion of impervious area. It reduces infiltration of rain water and may increase runoff volume from storms. Low Impact Development (LID) methods is to mimic the predevelopment site hydrology by using site design techniques that store, infiltrate, evaporate, detain runoff, and reduction flooding. Use of these techniques helps to reduce off-site runoff and ensure adequate groundwater recharge. The contents of this paper include a hydrologic analysis on a site and an evaluation of flooding reduction effect of LID practice facilities planned on the site. The region of this Case study is LID Rainwater Management Demonstration District in A-new town and P-new town, Korea. LID Practice facilities were designed on the area of rainwater management demonstration district in new town. We performed analysis of reduction effect about flood discharge. SWMM5 has been developed as a model to analyze the hydrologic impacts of LID facilities. For this study, we used weather data for around 38 years from January 1973 to August 2014 collected from the new town City Observatory near the district. Using the weather data, we performed continuous simulation of urban runoff in order to analyze impacts on the Stream from the development of the district and the installation of LID facilities. This is a new approach to stormwater management system which is different from existing end-of-pipe type management system. We suggest that LID should be discussed as a efficient method of urban disasters and climate change control in future land use, sewer and stormwater management planning.

Keywords: Low Impact Development(LID), Climate change, Natural disaster prevention, Storm water management model5(SWMM5)

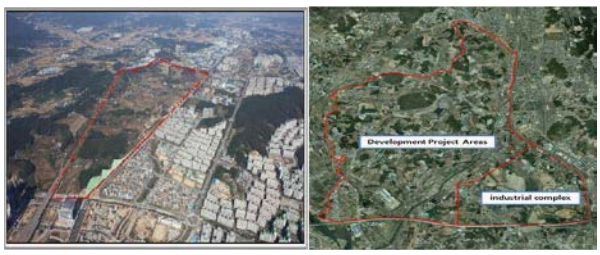
I. INTRODUCTION

Increase of impervious areas due to expansion of housing area, commercial and business building of urban is resulting in property change of stormwater runoff. Also, rapid urbanization and heavy rain due to climate change lead to urban flood damage. In 2010 and 2011, Seoul had experienced shocking flooding damages by heavy rain. All these have led to increased interest in applying LID and decentralized rainwater management as a means of urban hydrologic cycle restoration and natural disaster prevention such as flooding.

Low Impact Development(LID) methods is to mimic the pre-development site hydrology by using site design techniques that store, infiltrate, evaporate, detain runoff, and reduce flooding. Use of these techniques helps to reduce off-site runoff and ensure adequate groundwater recharge. The contents of this research include the LID technique selection and optimum size an estimation of LID practice facilities planned for the site. LID Practice facilities were designed in the area of Test-bed in New town city. This is a new approach to stormwater management system which is different from existing end-of-pipe type management system.

II. MATERIAL AND METHODS

LID district is new town of about 1.75million (m^2) and 4.0million (m^2) in A-New town and P-New town in city, Korea. [Figure 1] is the picture before development of the new town.



(a) A-New town (b) P-New town

Fig. 1. A view of predevelopment of the LID district

The A-New town area was divided into 15 sections. 60 urban type constructed wetlands, 463 lateral ditch type infiltration devices, 845 infiltration trenches, and 80 grass swales were allocated. Infiltration trenches and grass swales are applied in the park and green buffer zone, and the constructed wetlands are located in the planting belt of road. Lateral ditch type infiltration devices replace street inlets in the section with no green buffer zone or planting belt.

In the case of The P-New town, It was also applied LID technique and facility such as Fig. 2.

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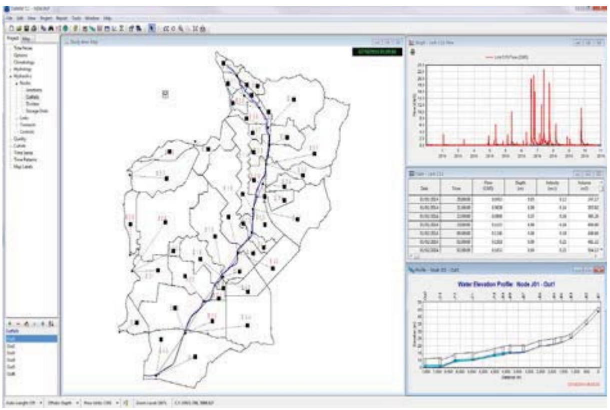
Fig. 2. Applicable LID in P-New town

SWMM5(Storm Water Management Model 5) applied in this study is a modified model of existing SWMM model to enable hydrologic impact analysis of LID stormwater management system. Existing SWMM model was modified by EPA in 2010 to enable simulation of LID systems such as rain garden, wetlands, infiltration trench, infiltration collecting well, grass swale and porous pavement.

(a) A-New town



(b) P-New town

Fig. 3. Screen of LID district using SWMM5(After development)

III. Results and Discussions

Continuous simulation on LID district was conducted using the weather data for about 38 years from January 1973 to August 2011 of the Cheon-an observatory. First, top 3 in the flood events were selected and the flood reduction effects of LID infiltration and retention system were analyzed. Bar graph in [Figure 4] displays the change in total runoff for each flood event. As a result of the simulation, runoff reduction effects in the LID design district were estimated to be approximately 55-66% (peak discharge), 25-121% (flow volume) in comparison with that before LID design.

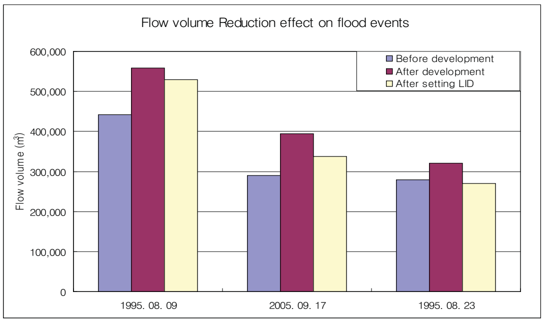


Fig. 4. Flow volume reduction effects of runoff simulation on flood events

IV. Conclusion

The analysis results of the effect of LID system installation on flood reduction effect and the change in flood volume using the SWMM5 model in the new town LID district are as follows.

First, we performed that LID technique selection and optimum size an estimation of LID practice facilities planned for the site(A, P-New Town).

Second, continuous simulations of urban runoff by installation of LID infiltration and retention system were conducted using the weather data for about 38 years. Top 3 flood events from the 38 years were selected and the flood reduction effects of LID infiltration and retention system were analyzed. For the top 3 flood event, installation of LID infiltration and retention system showed reduction effect of approximately 55~66% compared with the peak discharge increasing after the development.

These analysis results suggest that LID system and installation clearly demonstrate flood reduction effect in company with restoration of hydrologic cycle and control of non- point pollution. That is, these natural disaster management at the source is worth reviewing as an alternative to improve city security which is threatened by heavy rains following the climate change. There needs to be further studies on applying LID decentralized rainwater management system onto existing infrastructure to build safe city corresponding to future climate change.

References

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