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Application of Benefit Assessment to Infiltration Facilities demonstrated in Seoul Metropolitan, Korea

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Abstract. Seoul metropolitan has established a vision as 'Healthy water-cycle city' to resolve urban water-environmental deterioration. Therefore, various infiltrative Low Impact Development (LID) facilities are constructed and operated, however, benefit analytic plans for systematic valuation are insufficient. In this study, to analyze various benefits of these kinds of infiltration facilities, contents for benefit analysis were selected and categorized. As a result of quantification and valuation, the facilities showed the total benefit as 0.99 dollar/y·m^2 for infiltration storage tank and 1.10 dollar/y·m^2 for infiltration storage tank. Characteristics of benefit distribution were various reflecting characteristics of each infiltration facility (Water saving: 88~90%, Energy: 4%, Air quality improvement: <1%, Climate change adoption: 5~7%, Respiratory health care: <1%). As further studies, the synergy effects by integrated LID systems would be evaluated such as prevention of heat island based on suggested benefit assessment plans for each LID facility.

Keywords: Low Impact Development (LID), Benefit assessment, Categorization for benefit assessment, Quantification and valuation, Infiltration system

1 Introduction

Low Impact Development (LID) means the decentralized network for rainwater management such as green roof, infiltration storage and permeable pavement. These kinds of LID facilities have roles for reduction of surface run-off and improvement of water environment [1]. And they also show positive effects such as not only reduction of non-point pollutants but also energy saving, air quality improvement, carbon reduction and real-estate value increasing [2].

Recently, it is analyzed that the economic values of LID facilities are high, but the various researches also are needed for improvement of assessment to LID facilities. For example, USEPA compared and suggested the construction costs of LID facilities to residential complex, however the study did not deal with functional characteristics of the LID facilities [3]. And although the other researches also displayed the beneficial assessment of LID facilities, the results were such as a fragmentary benefit

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of unit LID facility and the various considerations are insufficient to estimate accumulated benefits of LID facilities [4]. In this study, two-step framework were applied to infiltrative LID facilities including infiltration storage and permeable pavement located in Seoul Metropolitan in Korea and the beneficial values were analyzed by quantification and valuation.

2 Methodology

This study utilized two-step framework to estimate economic, environmental and social benefits and analyze the benefits. The two-step framework developed by Center for Neighborhood Technology (CNT) and was applied to Chicago city in USA [2]. The framework is designed to assess accumulated benefits of infiltration facilities considering various benefit categories including water and energy saving, air quality improvement, climate change adoption and respiratory health care.

The first step of framework is to define the units of benefit contents and quantify them. And the second step is to determine beneficial values based on quantification at the first step. Additionally, the indirect benefits were also considered through two-step framework which were caused by direct benefits in the other categories [5].

3 Results and Conclusion

3.1 Structure of basic units for benefit assessment

For the analysis of categorized benefits for infiltration facilities, the necessary information were arranged (Table 1) and they were used for the assessment. Unit cost for wastewater treatment and annual precipitation during 10 years are needed for the estimation of benefit with respect to water saving, and the related information such as unit costs for electricity are specified for Seoul Metropolitan in Korea [6].

For the estimation of benefit by air quality improvement, NO_2 and SO_2 reduction by an infiltration facility and its unit cost data were applied [7] [8]. And social benefits by carbon reduction was also analyzed based on the data such as carbon reduction load and its unit cost. With respect to respiratory health care, estimated benefit data for reduction of respiratory diseases caused by NO_2 and SO_2 were used [9]. Additionally, indirect benefits by water and energy saving were estimated using related quantification data.

Table 1. Basic unit information for annual estimated benefit through infiltration facilities

Category	Benefit Content	Estimation	Unit	Ref.
Water saving	Unit cost for wastewater treatment	0.64	dollar/m^3	[6]
	Annual precipitation during 10 years	1,511.5	Mm	[6]
Energy saving	Unit cost for electricity energy	0.09	dollar/kWh	[6]
	Decreased energy for wastewater treatment for unit volume	0.314	kWh/m^3	[6]
Air quality improvement	Estimated benefit for unit reduction of NO_2	7.36	dollar/kg	[6]
	NO_2 reduction coefficient by energy saving	0.000879	kg/kWh	[6]
	Estimated benefit for unit reduction of SO_2	4.54	dollar/kg	[7]
	SO_2 reduction coefficient by energy saving	0.002385	kg/kWh	[8]
Climate change adoption	Estimated benefit for unit reduction of carbon	0.19	dollar/kg C	[6]
	Carbon reduction coefficient by energy saving	0.89	kg C/kWh	[6]
Respiratory health care	Estimated benefit for reduction of respiratory diseases caused by NO_2	0.91	dollar/kg	[9]
	Estimated benefit for reduction of respiratory diseases caused by SO_2	1.67	dollar/kg	[9]

3.2 Characteristics of benefit variation of infiltration facilities

Fig. 1 is displaying categorized annual benefit assessment for infiltration storage tank and permeable pavement. As results of benefit assessment, the facilities showed the total benefit as 0.99 dollar/y·m^2 for infiltration storage tank and 1.10 dollar/y·m^2 for infiltration storage tank. Characteristics of benefit distribution were various reflecting characteristics of each infiltration facility (Water saving: 88~90%, Energy: 4%, Air quality improvement: <1%, Climate change adoption: 5~7%, Respiratory health care: <1%). As further studies, the synergy effects by integrated LID systems would be evaluated such as prevention of heat island based on suggested benefit assessment plans for each LID facility.

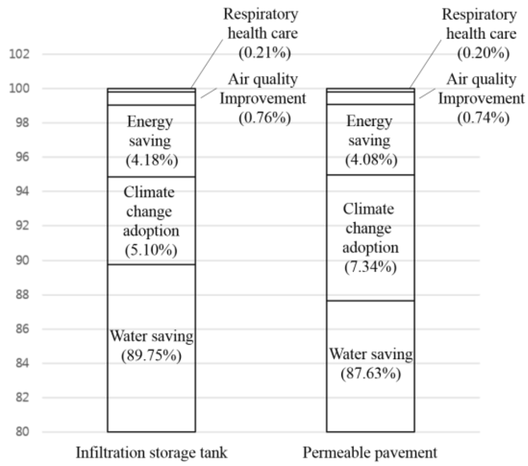

Fig. 1. Categorized annual benefit assessment for infiltration facilities

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