

Doctoral Dissertation

Study on Environmental Mitigation Function of the
Rain Gardens in Japan

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ABSTRACT

Rain gardens have recently gained popularity in Japan for the management of urban storm runoff. However, due to limited expertise regarding the environmental mitigation function of such facilities, the level of their optimality in urban development remains unclear. To help elucidate the environmental effects of the rain garden in Japan, this study combined field monitoring and model simulation methods to evaluate the environmental mitigation function of rain gardens at different spatial scales of Japan. The research of the storage/infiltration function and flood mitigation function was conducted at a campus scale (Kyoto Gakuen University, Kyoto, Japan). After confirming the feasibility of the rain gardens in Kyoto City, the SWMM model was used to evaluate the hydrologic and water quality effects at an urban catchment scale (Nakagyo Ward, Kyoto, Japan).

The results showed that the rain gardens at Kyoto Gakuen University had a functional storage capacity, with a 109.54 m³ of soil water storage capacity for a rain garden at a catchment area of 409.25 m² and an average of 0.227 cm/s saturated hydraulic conductivity; a proper flood mitigation function with almost 2 hours of the peak flow delay time under 100 mm/h rainfall intensity and more than 60 % of the runoff control rate. And the rain gardens at Nakagyo Ward, Kyoto, showed an apparent total runoff reduction of 13.78 % under an average 28.18 mm/h of the rainfall intensity; a sufficient flood mitigation function for one minute peak delay time under six different rainfall return periods; a reasonable contaminant reduction rate, in particular at three years return period (TSS 15.50 %, COD 16.17%, TN 17.34%, TP 19.07%).

The environmental mitigation functions of the rain gardens at different spatial scales and under different rainfall return periods were well performed. As such facilities offer flexibility in terms of size and location, their application in other urban areas of Japan and Asian monsoon climate area may be advisable.