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Optimal Design of Low Impact Development in the Urban Stormwater Drainage System Using Life-Cycle Cost Analysis

Yu Li (1), Kenji Tanaka (2), Maochuan Hu (2), Jeanne Huang (3), and Shigenobu Tanaka (2)

(1) Graduate School of Engineering, Kyoto University, Kyoto, Japan, (2) Disaster Prevention Research Institute, Kyoto University, Kyoto, Japan, (3) College of Environmental Science and Engineering, Nankai University, Tianjin, China

Urbanization has been proved to have substantial impacts on flood control and water balance. For areas that are urbanized rapidly, the practice of sponge city program provided by China and low impact development (LID) which is an integrated design approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible has gained an important place in water management and urban planning. The performances of LID alternatives can vary substantially due to different climate conditions and different rainfall characteristics. The effects of LIDs on hydrological cycle are of great interest for planners, designers and decision makers in considering the sustainability of urbanization. Despite a number of studies have investigated their potential of retention capacities in order to evaluate the performance of the various LIDs for planning and engineering design, less research has been done to integrate the performance of LID with life cycle cost, especially at large scales and under long-term condition.

In China, Tianjin airport economic area which is currently the one of the best-known large-scale sustainable new town development project located in Hai River basin is selected as the study area in this research. In this study, LID effects on the hydrological cycle were presented by SWMM simulation. The model was employed to run 11 years of meteorological hourly data (2002-2012) with various combinations provided by the LID alternatives including bio-retention pits, porous pavements and rain harvest systems. Findings include total runoff volume, peak flows, infiltration, evaporation, etc. The life-cycle cost analysis (LCCA) was used to analyze each LID alternative and combination of LIDs. The goal of this analysis is to produce an optimal design of LID facilities combination, further developing a more efficient and robust method and framework for the LID design.