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Evaluating Urban Runoff Reduction Effects of Low Impact Development Practices under Different Rainfall Characteristics: Case Study of Tianjin, China

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In the urban environment, urbanization has raised many negative effects, such as climate change, urban flood etc. A good method to study on the Low Impact Development (LID) and Sponge City project is needed for diminishing the impact of urbanization; it means improve hydrological cycle for urban areas, which was mainly embodied in improving infiltration and interception capabilities. It has become crucial to assess the effectiveness of LID for hydrological cycle. By applying LID, the runoff volume and peak value reduced, because of increasing infiltration and interception capacity.

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 including cistern system, bio retention facilities, wetlands, lateral ditch, infiltration trenches, grass swales, green buffer zone etc. There is little research to accurately determine the runoff control capability of LID such as porous pavement (PP), especially at large scales and under long-term condition when compared to the earlier studies mostly towards design storms in relatively small watersheds. Therefore, the need for research in this area is not timely, but also imperative.

The focus of the study area is the Tianjin Airport Economic Area, located in the Binhai New Area in Tianjin, the northern part of China as shown in Figure 1. Tianjin city is the largest coastal city in northern China. The Tianjin Airport Economic Area is a typical urbanized watershed with multi-functional land uses including industrial, commercial, and residential and recreation land uses occupying an area of 45km2.

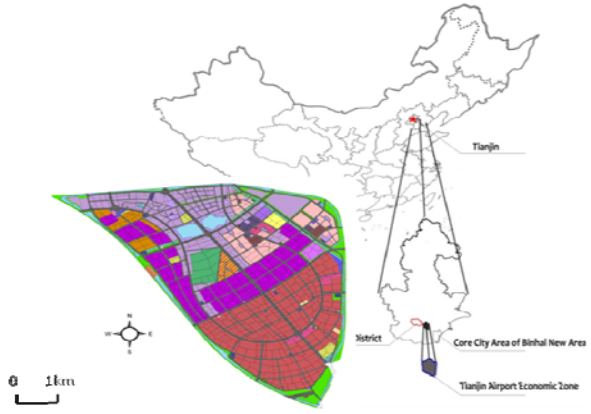

Figure 1 Location of the study domain

The average annual precipitation of Tianjin City is nearly 550 mm, however, due to monsoon climate influence, the rainfall is very unevenly distributed within a year as shown in Figure 2. About 78.5% of the annual precipitation falls in the summer from June to August, while about 58.6% of the total annual rainfall occurs in only one month, from the second half of July to the first half of August. This has substantially increased the risk of flooding dangers. Additionally, the rainfall is also unevenly distributed annually. There is a huge variation between dry year and wet year.

In the present study, 11 years' rainfall data (2002 to 2012) were employed to evaluate the LID performance in terms of runoff reduction and water balance restoration by using a numerical model, Storm Water Management Model version 5 (SWMM 5). SWMM5 models the hydrological and hydraulic processes occurring in each LID facility by dividing the facility into three layers: surface layer, soil or

pavement layer and storage layer. All three layers have different storages and they function differently.

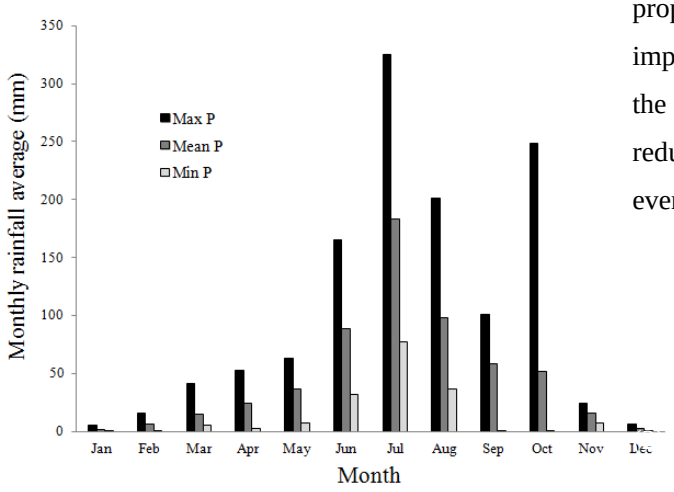

Figure 2 Monthly rainfall averages in Tianjin

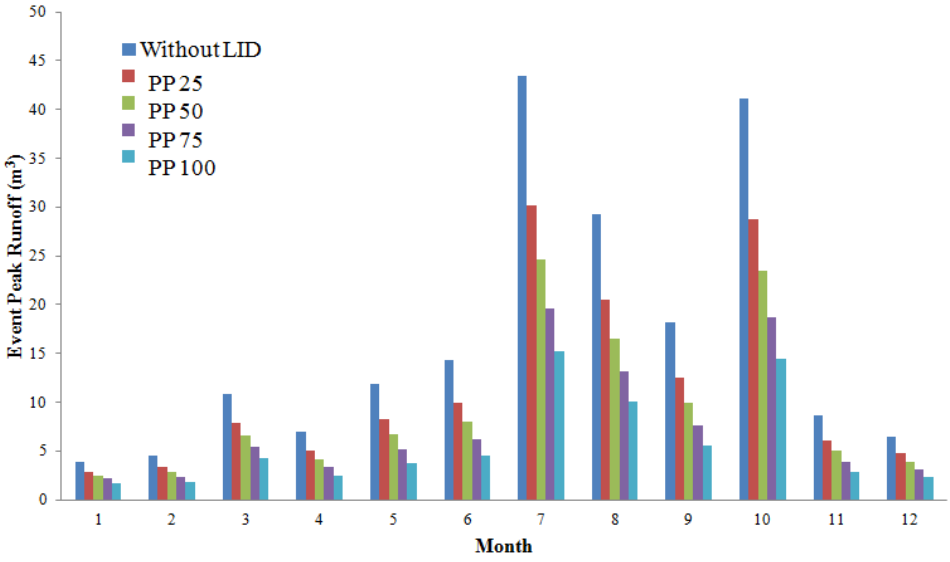

Figure 3 LID monthly performance

PP 25, PP50, PP 75, PP 100 means that porous pavement was implemented on 25, 50, 75, 100 % of all roads respectively. After simulation, Figure 3 indicates that porous pavement has impact differently due to the changing rainfall pattern and consequently increasing runoff volume and peak flow. The performance of LID is affected by their storage and properties such as the percentage of the target area implemented with LID. Further study shows that all the four LID series are more effective in runoff peak reduction during the heavier and shorter rainfall events.