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Examining the impacts of individual lot stormwater detention in a housing estate

Darrien Y.S. Mah[1,*], Johnny O.K. Ngu[2], P.D. Caroline[3] and M. A. Malek[3]

[1]Faculty of Engineering, Universiti Malaysia Sarawak, Sarawak, Malaysia
[2]Faculty of Civil Engineering, Universiti Teknologi MARA, Sarawak, Malaysia
[3]Institute of Sustainable Energy, Universiti Tenaga Nasional, Selangor, Malaysia
[*]Corresponding author: ysmah@unimas.my

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Abstract

This paper describes the Storm Water Management Model (SWMM) simulations of three individual lot stormwater detention systems under the car porches of houses. These three systems consist of ready-made modular units presumably fitted under 49 m^2 car porches of 204 double-story terrace houses. The 37,032 m^2 housing estate is calculated to have 75% of land covered with houses, 25% with roads and other infrastructures. The housing estate was subjected to 5-minute, 10-year Average Recurrent Interval (ARI) short-duration design rainfall. The model predicted that all three systems could reduce the peak runoff at outfall from 2.79 to 0.38 m^3/s. It indicated that any of the system could cause 86% reduction of the runoff for the whole housing estate. In order to differentiate the performance of the three systems, the housing lot was further investigated. When Type 1 system (1.15 m high with 49 m^3 per lot) was analysed by the SWMM model, only 8% of its storage volume was filled that highlights an over design. Type 2 system (0.3 m high with 6 m^3 per lot) modelled at 84% while Type 3 system (0.3 m high with 9 m^3 per lot), at 54%. The difference in heights between the systems explained the low percentage of filling for the Type 1 system. Comparing Type 2 and Type 3, concrete structure within Type 3 had only half of its volume filled. In this light, the Type 2 system made of polyethylene pieces was found the most efficient in lowering post-development peak runoff.

Keywords: Car porch, Drainage, Mekarsari, Modular, Sustainable development, Urban runoff

1. Introduction

Modifications to natural land cover cause changes to the flow mechanism of the local water cycle [1]. Forested land that is often a representation of pre-development condition could absorb runoff via the soil layers and plant roots. The resulted hydrograph in the presence of rooted plants has a low peak runoff and longer time to peak. Its baseflow is large due to the slow releases of water from the soils and plant roots [2,3]. Once the vegetations are replaced with buildings and roads, the built-up surfaces block water from infiltrating to the soils. Therefore, this so-called post-development condition causes a hike in both peak runoff and time to peak as well as a significant increase in the volume of runoff. Accumulated runoffs in the form of flash flooding come and go rapidly, a phenomenon often observed in the urban areas [4].

One of goals of urban stormwater management is to lower the post-development peak runoff to near the pre-development condition [5]. Stormwater detention is one of the practices to mimic the natural function of soils and plant roots [6]. In this paper, attention is paid to individual lots of stormwater detention systems. As the name suggests, this is a system installed within a private property's lot [7]. When portions of the stormwater runoff were captured at a lot scale, significant reduction in the discharge volume was achieved based on a case study in Western Australia [8]. Lot scaled devices were reported as locally efficient to reduce the flooding risks in another case study in China [9], reinstating the finding from the Western Australian study. However, in addition, appropriate locations to install the lot scaled devices were vital on reducing the impacts on a catchment's hydrographs [10]. This study is proposing the manipulation of common Malaysian house car