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Restoring Groundwater Surface-Water Interactions at Urban Drains

Impervious areas from urbanization minimizes infiltration in a catchment, resulting in an increase of peak flows during storms. To efficiently divert stormwater away from developed areas, Singapore has built a network of waterways consisting of 7,000 km of concrete lined canals and drains, and has successfully alleviated flooding in many flood-prone areas. Unfortunately, it has also tremendously degraded many riverine habitats and removed the natural groundwater-surface water interactions and the riparian zones. River restoration is multi-disciplinary and multi-faceted. This study particularly examines the possibility of rehabilitating the urban drains in Singapore by restoring the groundwater-surface water interactions without significantly comprising their conveyance capabilities. It first compares and contrasts the groundwater-surface water interactions at two catchments, one urbanized and one in a relatively undisturbed forest. The urbanized catchment consists of concrete-lined drains with weep holes allowing groundwater seepage. The undisturbed catchment consists of small forest streams with natural banks allowing free groundwater-surface water interchanges. The infiltration capacity of the area around the drain/stream and the discharge through the drain/stream are measured at both catchments. The seepage out of the weep holes and that along the stream bed is also characterized. This study further numerically simulates the groundwater-surface water interactions of the urban drains and the natural streams using the data collected. The numerical models also incorporate various bank designs for the urban drains in order to provide the most ecohydrologically efficient storm water conveyance system. For example, the concrete-lined banks are modified with semi-pervious lining, such as grass embedded concrete structures, which allows natural establishment of riparian areas around the drains and benefits the succession of riverine habitats. Overall, this study develops our understanding of the natural groundwater-surface water interactions in Singapore, which can be used as a design target in drain rehabilitation. It is also beneficial to the river rehabilitation in other cities by providing generic insights regarding the possibility of restoring groundwater-surface water interactions along urban drains.