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Reliability analysis of rainwater tanks under different climatic and spatial conditions: A case study for Sydney

Monzur Alam Imteaz
Swinburne University of Technology, Australia

Abstract

A daily water balance model was developed using daily rainfall data, contributing roof area, leakage/evaporation loss factor, available storage volume, tank overflow and rainwater demand. In order to assess reliability of domestic rainwater tanks in augmenting partial household water demand in Sydney area, the developed water balance model was used for three different climatic conditions (i.e. dry, average and wet years). The traditional practice of rainwater harvesting volume/size design is based on historic annual average rainfall data. However, design of rainwater harvesting volume based on annual average rainfall data is not realistic. As a stormwater harvesting system designed considering average rainfall will not provide much benefit for a critical dry period. In several earlier studies, a single representative year was selected for each of the dry, average and wet years. Dry, average and wet years were defined for the years having an annual rainfall of 10 percentile, 50 percentile and 90 percentile values respectively. However, as a particular year may have an unusal rainfall pattern, this study considered five respective years for each of the dry, average and wet years. Model was used for selected five years and average outcomes were calculated. To assess the spatial variablity, the model was used for the performance analysis at four different regions of Sydney (Australia); North, Central, South-East and South-West. These four different regions of Sydney are characterised by notable different topography and rainfall characteristics. Reliability is defined as percentage of days in a year when rainwater tank is able to supply the intended partial demand for a particular condition. For the three climatic conditions, a number of reliability charts were produced for domestic rainwater tanks in relations to tank volume, roof area and number of people in a house (i.e. water demand). It is found that for a relatively small roof size (100m^2), 100% reliability cannot be achieved even with a very large tank (10,000L). Reliability becomes independent of tank size for tank sizes larger than 4,000~7,000L depending on the location. This is defined as threshold tank size, relationships with threshold tank sizes and annual rainfall amounts are then established for all the locations.

Biography

Monzur Imteaz is working as a Senior Lecturer within Civil Engineering group of Swinburne University of Technology at Melbourne, Australia. He has received his B.Sc. in Civil Engineering from Bangladesh University of Engineering & Technology and M.Eng. in Water Resources Engineering from Asian Institute of Technology (Thailand). He has completed his Ph.D. in 1997 on Lake Water Quality Modelling from Saitama University (Japan). After his PhD, he was working with Institute of Water Modelling (Bangladesh) in collaboration with Danish Hydraulic Institute (DHI). Later he has completed his post-doctoral research at University of Queensland, Brisbane. Before joining at Swinburne he has been involved with several Australian local and state government departments. At Swinburne, Dr Imteaz is teaching subjects ‘Sustainable Design’, ‘Urban Water Resources’ and ‘Integrated Water Design’. Also, he has been actively involved with various researches on sustainability, water recycling and modelling, developing decision support tools, rainfall forecasting using Artificial Neural Networks.