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ScienceDirect

Procedia Engineering 212 (2018) 752–759

Procedia Engineering

www.elsevier.com/locate/procedia

7th International Conference on Building Resilience; Using scientific knowledge to inform policy and practice in disaster risk reduction, ICBR2017, 27 – 29 November 2017, Bangkok, Thailand

Building resilience on water quality management through grey water footprint approach: a case study from Sri Lanka.

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Abstract

Waste disposal in to natural waterways is a critical environmental issue. Proper quantification of water pollution levels is mandatory in restoring the lost resilience of such polluted waterways. This study proposes development of calibration models to predict the Grey Water Footprints (GWF) of eight pollutant parameters *viz*. Biochemical Oxygen Demand (BOD_5), Total Ammonia, Nitrates, Nitrites, Total Phosphates, Total Suspended Solids (TSS), Total Dissolved Solids (TDS) and Chlorides. The study was conducted based on water quality and discharge data of the Mid Canal, the most polluted tributary of River Mahaweli, Sri Lanka. Calibration curves were developed for all parameters at average, minimum and maximum flow conditions and R^2 values of all calibration curves were above 0.9. For instance, the GWFs of any BOD_5 level of the canal, varying between a minimum of 12 mg/l and a maximum of 111 mg/l can be predicted using the calibration models $y = 0.003x - 0.002$ at the average flow rate of 0.26 m^3/s. The study also concludes that for any given pollutant concentration, higher flow rates result in higher GWF values. This study encourages further research on more tangible approaches for water pollution quantification rather than expressing pollution in terms of pollutant concentrations.

Peer-review under responsibility of the scientific committee of the 7th International Conference on Building Resilience.

Keywords: Grey water footprint; Water quality; Surface water pollution; Urban waterways; Mid-canal Sri Lanka.

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Peer-review under responsibility of the scientific committee of the 7th International Conference on Building Resilience
10.1016/j.proeng.2018.01.097

1. Introduction

Surface water pollution associated with rivers and streams is a serious environmental problem faced by the world today. Unregulated urbanization and rural-urban migration have evolved to become major causes of surface water degradation, especially in the cities of developing countries [1][2][3][4]. As a country with a growing trend for urbanization, unplanned urban population in Sri Lanka also has begun to exert pressures on the sectors of water supply, sewage disposal, waste management, and surface drainage in the cities [5]. Majority of natural streams that flow via densely populated and intensively urbanized cities have now been converted into artificial canals [6][7][8]. Since these waterways are subjected to severe human activities and subsequent pollution, these stream/canal systems are considered as effluent canals in many instances [6]. Mid canal, flowing through the Kandy city is an example of such a modified stream. It originates from the overflow sluice of the Kandy Lake located next to the Temple of Tooth Relic, runs through the densely populated city for nearly 6 km, and thereafter drains into the River Mahaweli at Gatambe [9].

Scheren et al. [10] points out in their study that policies for sustainable development, including restoration and preservation of catchment ecosystems, should also be directed towards improved land-use practices. Understanding the risk associated with the prevalent water quality impairment and environmental degradation in polluted water ways is important as this condition might escalate into a substantially disastrous situation, sooner or later as such polluted effluent canals have many adverse impacts on the health of nearby residents as well as the aesthetic value of the area [6]. Assessing the extent of water pollution using conventional methods of water pollution quantification has not yielded commendable results. Conventional methods usually quantify pollution in terms of a pollutant concentration whereas the grey water footprint (GWF) approach expresses water pollution in terms of a volume of water used up in waste assimilation [11][12]. This method is more convenient as it brings water availability, which is always expressed as a volume, and water pollution under the same denominator.

2. Materials and methods

2.1. Site selection

The study area, Mid Canal, located in the central hills of Sri Lanka, is considered the most polluted surface water body in the Kandy district [5][6]. It contributes significantly to the pollution of River Mahaweli. The length of the canal is nearly six kilometers and the width varies from 10 m to 15 m along its course. It begins from the Kandy lake sluice (on the top right hand corner of Figure 1), flows through the city and converges with the River Mahaweli at Gatambe (on the bottom left hand corner of Figure 1). Its headwater is confined to south-eastern foot hills of the Kandy Lake watershed and its seven tributaries originate from the Hanthana mountain range.

Figure 1: The route of Mid-canal (Meda ela) from Kandy lake-sluice to confluence with river Mahaweli at Gatambe (source: Google Earth, 2016)