METHODOLOGY FOR SPATIAL DISTRIBUTION OF DEMANDS IN RURAL REGIONS WITH LIMITED DATA AVAILABILITY FOR WATER DISTRIBUTION NETWORK MODELLING

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Master of Science in Environmental Engineering and Management

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Thesis/Dissertation submitted in partial fulfilment of the requirements for the degree

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DECLARATION

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

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The above candidate has carried out research for the PhD/MPhil/Masters thesis/dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor: Professor J.M.A. Manatunge

Signature of the Supervisor: Date:

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ABSTRACT

Demand allocation can be identified as one of the most important steps in modelling of water distribution networks (WDN). Often this is done by distributing the overall demand of a WDN across the nodes of the hydraulic model. In areas where properly geo-referenced demand points or consumer meters are unavailable, this becomes a tedious and a labour-intensive task that takes a considerable amount of time. This study addresses this challenge of spatially distributing the demands for hydraulic modelling of WDNs by introducing an innovative methodology has the capability of overcoming the scarcity of geo-referenced demand data or consumer meters. It focuses on distributing the overall demand of the WDN across the building points in the area proportionately to the sizes of building footprints. The proposed methodology is validated by applying the methodology to a real world WDN in Malimbada area of Matara District, Southern Province, Sri Lanka. Modelling was carried out using the Bentley WaterGEMS® software with the aid of ArcGIS platform, complemented by the applications such as QGIS and Google Earth Pro. Demand data needed for the modelling were obtained from the bulk flow meters of the supply reservoir of the WDN while building details were obtained from newly published Google Open Buildings dataset utilizing QGIS. Simulated results of the computed model were compared with the actual field data at selected locations obtained through digital pressure loggers. Comparison of observed and simulated pressures at different time steps and selected locations demonstrated a high degree of correlation. Linear correlation coefficients (R^2) affirmed the accuracy of the model across the entire network. Despite limitations, such as data availability challenges and the study's single-case focus, the methodology showcases promising results in replicating real-world scenarios. However, the study emphasizes the need for further research to assess its adaptability across diverse scenarios and network types. The study contributes to the field of WDN modelling by providing a convenient methodology to model WDNs in environments where the demand data availability is low.

Keywords: Water Distribution Networks, Hydraulic Modelling, WaterGEMS®, Demand Allocation, Demand Distribution

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ABBREVIATIONS

ADD	Average Daily Demand
AHF	Average Hourly Flow
AHFR	Average Hourly Flow Rate
DEM	Digital Elevation Model
DI	Ductile Iron
dia.	Diameter
EPS	Extended Period Simulation
GIS	Geographic Information Systems
HDPE	High Density Polyethylene
MSL	Mean Sea Level
N	North
NRW	Non-Revenue Water
NWSDB	National Water Supply & Drainage Board
PVC	Polyvinyl Chloride
WDN	Water Distribution Network