USING GIS-BASED MULTI CRITERIA DECISION ANALYSIS FOR PRIORATIZING DRINKING WATER SUPPLY NEEDS: AN APPLICATION TO SOUTHERN REGION IN SRI LANKA

Anushka Sapumal Hewapathirana

169159 V

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Department of Civil Engineering

University of Moratuwa

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I declare that this is my own work and this thesis 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. Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

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Abstract

Using GIS-based Multi-Criteria Decision Analysis for Prioritizing Drinking Water Supply Needs: An Application to Southern Region in Sri Lanka

GIS-based Multi-Criteria Decision Analysis (MCDA) was carried out to prioritize drinking water supply need in the Southern Region, Sri Lanka. The degree of water demand is attributed to population density, water resources availability (Relative Water Balance), water quality (Equivalent Water Quality Index) and new development (Population Pressure) of the region. Spatial distribution of density of Grama Niladhari Division-wise (GND) population was obtained from census data of 2,131 GNDs; assigned to the spatial distribution domestic units available with Survey Department. Water resources availability of each GND was figured out by plotting relative water balance with the aid of average annual rainfall data from the Meteorological Department, Mean evaporation rate and inflow of rivers into the designated research area. Water quality of relevant GNDs was calculated and represented as Water Quality Index (WQI) with the aid of geochemical atlas produced by Dissanayake et al. (1985) and NWSDB treated water quality data. Moreover, the new development of the research area was symbolized with the development corridor stipulated under National Physical Plan for 2050. Four raster files were prepared. To weight criteria, Analytic hierarchy process (AHP) was adopted. To identify the prioritized patches, the weighted linear combination of raster shapefiles was derived as a method of compensatory aggregation. It was understood that a combination of water quality and population density was dominant in the prioritization of water supply needs. The model identified the values as 0.47, 0.39, 0.07 and 0.07 for the main criteria, respectively for relative water balance, equivalent Water Quality Index, population density and population pressure owing to new development. The output of the research was the preparation of an automated GIS tool for prioritization of water supply needs through the GIS model builder facility.

Keywords: Analytic hierarchy process, compensatory aggregation, GIS, MCDA, Spatial distribution, model builder, prioritization, Water Quality Index, weighted linear combination

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List of Abbreviation

AHP	Analytical Hierarchy Process
AWQI	American Water Quality Index
CCME	Canadian Council of Ministers of the Environment
EC	Electrical Conductivity
EWR	Environmental Water Requirement
GIS	Geographic Information System
GND	Grama Niladhari Division
HDI	Human Development Index
JICA	Japan International Corporation Agency
MADM	Multi Attribute Decision Modeling
MAR	Mean Annual Runoff
MCDA	Multi Criteria Decision Analysis
MCM	Million Cubic Meters
MD	Meteorological Department
NASA	National Aeronautics and Space Administration
NSF WQI	National Sanitation Foundation Water Quality Index
NWSDB	National Water Supply and Drainage Board
OWQI	Oregon Water Quality Index
RWB	Relative Water Balance
SD	Survey Department
SEBAL	Surface Energy Balance Algorithm
SLS	Sri Lanka Standards
SMCE	Spatial Multi-Criteria Evaluation
SWSI	Social Water Scarcity Index
TDS	Total Dissolved Solids
UN	United Nations
UNDP	United Nations Development Programme
WLC	Weighted Linear Combination
WQI	Water Quality Index

WSI	Water Stress Indicator
WSS	Water Supply Scheme
WTP	Water Treatment Plant
WWAP	World Water Assessment Programme