IDENTIFICATION OF SUITABLE LOCATIONS FOR RUN-OF-THE-RIVER HYDROPOWER GENERATION USING GIS AND ABCD MODEL IN UPPER KELANI RIVER BASIN IN SRI LANKA

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgment of any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in text.

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The above candidate has carried out research for the Master's thesis under my supervision.

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2019.09.25

Dr. R. L. H. L. Rajapakse Date

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ABSTRACT

Identification of Suitable Locations for Run-of-the-River Hydropower Generation using GIS and ABCD Model in Upper Kelani River Basin in Sri Lanka

The recent crisis in the energy sector has raised the need of exploration of additional renewable energy sources. Run-of-the-River (RoR) hydropower systems that harvest the energy from flowing water to generate electricity in the absence of a large dam and reservoir required in conventional impoundment hydroelectric facilities are gaining interest due to their minimum impact to the environment. Identifying suitable locations with significant potential of RoR hydropower capacity by using conventional methods is hindered in remote hilly inaccessible areas. The GIS tools and ABCD hydrologic model are used in the present study to remotely define and identify the feasible geographical features and estimate streamflow generation which governs the available hydropower capacity of potential sites in the project area.

The Upper Kelani Basin was selected as the overall project study area and two uppermost sub-catchments, namely Norwood and Holombuwa, were selected to optimize the ABCD model parameters for simulating streamflows with the selected rain gauge stations in each watershed. The ABCD daily hydrological model was calibrated using 5 years of data from 2008~2013 and validated based on four years of data from 2013~2017. The Shuttle Radar Topography Mission (SRTM) 90 m and 30 m Digital Elevation Model (DEM) terrain data was used in catchment delineation and available hydraulic head calculation along the river channel. The ABCD model parameters identified based on the two sub-catchments were progressively transferred to the downstream sub-catchments at locations where the feasible heads were available to establish potential RoR hydropower stations.

The identified *a*, *b*, *c* and *d* hydrologic parameters for Norwood and Holombuwa sub-catchments were (0.963, 398, 0.465 and 0.00001) and (0.995, 300, 0.542 and 0.0001), respectively. The Pearson's correlation coefficient (*r*) and coefficient of determination (R^2) were used as objective functions and the study found the values of ((0.825, 0.68), (0.59,0.35)) and ((0.87,0.75), (0.61,0.37)) for both calibration and validation model runs, respectively. The algorithm developed with Visual Basic for Application (VBA) Programming using extracted head from GIS tools in ArcGIS (v 10.3) platform to detect feasible sites based on river gradient coupled with flow estimates from the ABCD hydrologic model was found to be capable of remotely identifying potential locations for RoR hydropower generation. The study successfully established 36 suitable locations for RoR hydropower in the selected sub-basins.

The study shows that the proposed approach has vast advantages over the slow, cumbersome, uneconomical, conventional survey-based methods used for identification of potential RoR sites and further studies are recommended to recognize the sensitivity to terrain variations and incorporate alternatives for overall system optimization.

Keywords: Automated algorithm, Hydrological modelling, Model sensitivity and optimization

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