COMBINING WATER AND ENVIRONMENTAL FOOTPRINT METHODS FOR LIFE CYCLE ASSESSMENT OF RUN OF THE RIVER TYPE MINI/MICRO HYDROPOWER GENERATION

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Hydropower is popular as one of the most environmentally friendly renewable energy sources. However, with the expansion of knowledge about footprint methods, it has been identified that there are considerable carbon, water and ecological footprints in hydropower schemes that are not adequately recognized based on commonly available tools and methods for overall impact assessment. Among these tools which assess the environmental impact quantitatively, the water footprint methods assess the water consumption (alias water loss) per unit of power produced at a hydropower plant.

There are three methods of assessing the water footprint of hydropower plants namely, Gross Evaporation Method (WF1), Net Evaporation Method (WF2) and Net Water Balance Method (WF3). All three methods have been developed and used for hydropower plants connected to major reservoirs but have not been used for run-of-river (ROR) type mini/micro hydropower plants. Identifying this research gap, along with the fact that the Ceylon Electricity Board has planned to increase the mini/micro hydropower production in their Long-Term Generation Plan, this study has investigated the ability to apply the existing water footprint methods to ROR type mini/micro hydropower plants. Furthermore, their ability to relate to the Sri Lankan context as a viable tool in mini/micro hydropower plant designing phase is also investigated.

The existing WF methods were applied to three selected mini hydropower plants in Seethawaka Ganga Sub-basin in the Kelani River Basin. To conduct the application, the daily streamflows at the weir locations were derived using a calibrated HEC-HMS model and available meteorological data. Then a correlation was synthesized between the daily streamflow at the weir and daily energy production of the mini hydropower plants based on the characteristics of the installed turbine and generator capacities. Simultaneously, the water losses were estimated using meteorological data and plant specific data which were extracted from project documents and using GIS tools. With the derived energy generation and estimated water losses, the daily, monthly, and annual WFs were calculated and their ability to reflect the ROR nature, the scale of the plant (i.e., mini/micro scale) and the Sri Lankan context were investigated.

Based on the findings of the detailed analysis, it was concluded that the most appropriate water footprint method that reflects above-mentioned characteristics is the Mean Monthly Water Footprint of Gross Evaporation Method. Furthermore, a quantitative as well as a qualitative sensitivity analysis was carried out to identify all possible variations that may affect the outcome and the ability to integrate water footprint into ecological footprint evaluation is discussed. The study findings will be useful in the proper evaluation of overall impacts and for decision making in the implementation of future mini/micro hydropower generation plans.

Keywords: ecological footprint; Kelani River Basin; water footprint

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