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Simulation of Water Temperature in Small Pond using Parametric Statistical Models: Implications of Climate Warming

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Abstract: Changes in temperature and precipitation pattern due to global warming are likely to affect quantity and quality of water in different water bodies. Water temperature modelling techniques are usually employed to study the effect of global climate change on the streams and rivers ecosystems. Performance of two parametric statistical models, namely, simple linear regression (SLR) and four parameter nonlinear logistic regression (NLR) models were evaluated for a small aquatic pond located in semi-arid region of India. The developed models were field tested for mean, minimum, and maximum air-water temperatures on daily, weekly, and monthly time scales. The models parameters were estimated from the measured air-water temperatures time-series data using the least squares optimization method. Performance of the models were evaluated using three statistical indicators, namely, the index of agreement (d), Nash-Sutcliffe modelling efficiency (E), and root mean square error (RMSE). Performance of the SLR and NLR models were found to be comparable for all the three data series and time scales. However, the NLR model was found to perform relatively better as compared to the SLR model for all the three time scales. Results also revealed better correlations between the measured and simulated water temperatures on weekly and monthly time scales as compared to daily time scale. Application of the SLR model for projecting changes in attributes of a small aquatic pond in a semi-arid region of India under the changing climate scenarios, revealed 1.3 and 3.7 °C increase in pond water temperature with increase in air temperature from 1.5 to 4.3 °C by the end of 2080. This increase in water temperature resulted in an increase in water evaporation rate by 8.3 – 30.3 %, and reductions in hydro-period and saturated dissolved oxygen by 3 - 26 days and 2.2 – 6.5 %, respectively.

Key words: Pond; Water-temperature; Simple Linear Regression, Nonlinear Logistic Regression; Climate change.