PREDICTION OF DISSOLVED OXYGEN IN HARBOURS USING ARTIFICIAL NEURAL NETWORKS: AN APPLICATION TO THE PORT OF **COLOMBO**

By

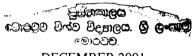
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THIS THESIS WAS SUBMITTED TO THE DEPARTMENT OF CIVIL ENGINEERING OF THE UNIVERSITY OF MORATUWA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ENGINEERING.



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DECEMBER 2001.

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DECLARATION

I hereby declare that the work included in the thesis in part or whole has not been submitted in any form for any other academic qualification of any institution.

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ABSTRACT

Maintenance of high dissolved oxygen (DO) level in harbours is highly important as it could give rise to catastrophic effects if it is depleted affecting day- to- day port functions such as dredging activities and other maintenance work. The depletion of DO results not only in toxic gases such as methane and hydrogen sulfide but also in accumulation of wastes. Frequent monitoring of DO is therefore imperative, but makes practical difficulties due to ship movements and other activities. Hence, prediction of DO with an empirical model using Artificial Neural Networks (ANNs) was done with success with an application to the Port of Colombo (PoC). This model aims to lessen the frequency of monitoring DO and to foresee the responses of the system due to environmental changes. The performances of ANNs were compared with Multiple Linear Regression (MLR). Monthly values of 4 water quality parameters at several depths for the period of four years from 1997 to year 2000 were collected. Sometvalues of weather parameters of rainfall and wind velocity for the corresponding period were also collected. The neural network possessing 7 inputs and 45 hidden neurons, performed well giving rise to correlation coefficient (R) as 0.87 and 0.67 for calibration and verification respectively. The inputs are temperature, depth and five rainfall intensities (including values on four immediate previous days). A sensitivity analysis was carried out to assess the potentials of small changes in each input on the neural network output. MLR model with 7 input variables indicated R to be 0.45 for calibration after several transformations. The temperature was the most influential variable among the ANN inputs affecting the output. In conclusion, it could be inferred that the ANN model is capable of predicting DO in PoC considerably well compared with MLR.

ACKNOWLEDGEMENT

First, I would like to render my cordial thanks to my supervisor, Dr. Mahesh Jayaweera for advising and guiding me in all aspects. My gratitude should also go to Professor (Mrs.) N. Rathnayake, Director of Postgraduate Studies, for supporting me in numerous ways.

Further, I would like to extend my gratitude to the Asian Development Bank (ADB) for the provision of financial aids. Special thanks hereby go to the Japan Port Consultant (Pvt.) Ltd. for giving me the necessary water quality data of the inner harbour of the Port of Colombo. I am also grateful to the Meteorological Department for providing me with meteorological data.

It is with grateful appreciation that I acknowledge the contribution of the Environmental Engineering Laboratory-staff in the University of Moratuwa, Electronic Theses & Dissertations namely Ms. Privanka Dissanayake, Mrs. Nilanthi Gunathilake and Mr. Justin Silva. At last, but not least my sincere thanks go to all the others who helped me in numerous ways to make this a success.



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LIST OF SYMBOLS

		<u>Name</u>
		Momentum
		Learning parameter
		Change in Y for a unit change in X_2 keeping X_1
		constant
-		Effect of X_1^* on Y_1^* keeping X_2^* constant.
		Change in Y for a unit change in X_2 keeping X_1
		constant
		Effect of X_2^{\bullet} on Y_2^{\bullet} keeping X_1^{\bullet} constant
	** .	Number of pairs.
		versity of Moratuwa, Sri Lanka.
		tronic Theses & Dissertations Determination coefficient Will mrt ac lk
		Correlation of X_I with Y
		Correlation of X_2 with Y
		Correlation of X_1 with X_2
		Partial correlation of X_2 and Y with X_I Controlled.
		The Slope between low summary point and the
		middle of the curve.
		The Slope between middle summary point and the
		high summary point
		Standard deviation of X_L
		Standard deviation of X_2
		Standard deviation of Y data.
		. 6 6 6

sd_{X_1}	Standard deviation of X_I data.
sd_{y} .	Standard deviation of Y^* data.
$sd_{X_1^*}$	Standard deviation of X_1^* data.
X_I	Dependent variable.
X_2	Dependent variable.
$X^{^{*}}$	Standardized version of X.
X_H	X coordinate of the high summary point
X_L	X coordinate of the low summary point
X_M	X coordinate of the middle summary point
\overline{X}	Sample mean
Y	Independent variable
Y^{*}	Standardized version of Y
\overline{Y}	University Lanka.
Y_H	Electronical flates of the high summary point
Y_L	www.lib.mrt.ac.lk Y coordinate of the low summary point.
Y_{M}	Y axis value of middle summary point.

LIST OF ABBREVIATIONS

<u>Abbreviation</u>

Name

Ammonium-N Ammonium Nitrogen

ANN Artificial Neural Network

ANN-16 ANN model with 16 inputs

ANN-9 ANN model with 9 inputs

ANN-7 ANN model with 7 inputs

BPN Backpropagation Technique

BQ Bandaranayake Quay

CH₄ Methane

COD Chemical Oxygen Demand

DO Dissolved Oxygen

H₂S UnivHydrogen Sdlptridewa, Sri Lanka.

JCT Electronic Theses Terminas ertations

M www.lib.mrt.ac.lk

MLR Multiple Linear Regression

MLR-16 MLR model with 16 inputs

MLR-9 MLR model with 9 inputs

MLR-7 MLR model with 7 inputs

Nitrate-N Nitrate Nitrogen

Nitrite-N Nitrite Nitrogen

Organic-N Organic Nitrogen

ORP Oxygen Reduction Potential

PoC Port of Colombo

PVQ Prince Vijaya Quay

QEQ Queen Elisabeth Quay

Rain-1 Rainfall intensity on the 1st day

Rain-1 Rainfall intensity on the 2nd immediate previous

day

Rain-1 Rainfall intensity on the 3rd immediate previous

day

Rain-1 Rainfall intensity on the 4th immediate previous

day

Rain-1 Rainfall intensity on the 5th immediate previous

day

RMS Root Mean Square

SLPA Sri Lanka Ports Authority

SD Standard Deviation

SS Suspended Solids

Total-N Total Nitrogen

Total-P Total Phosphorous

WinNN Windows Neural network

