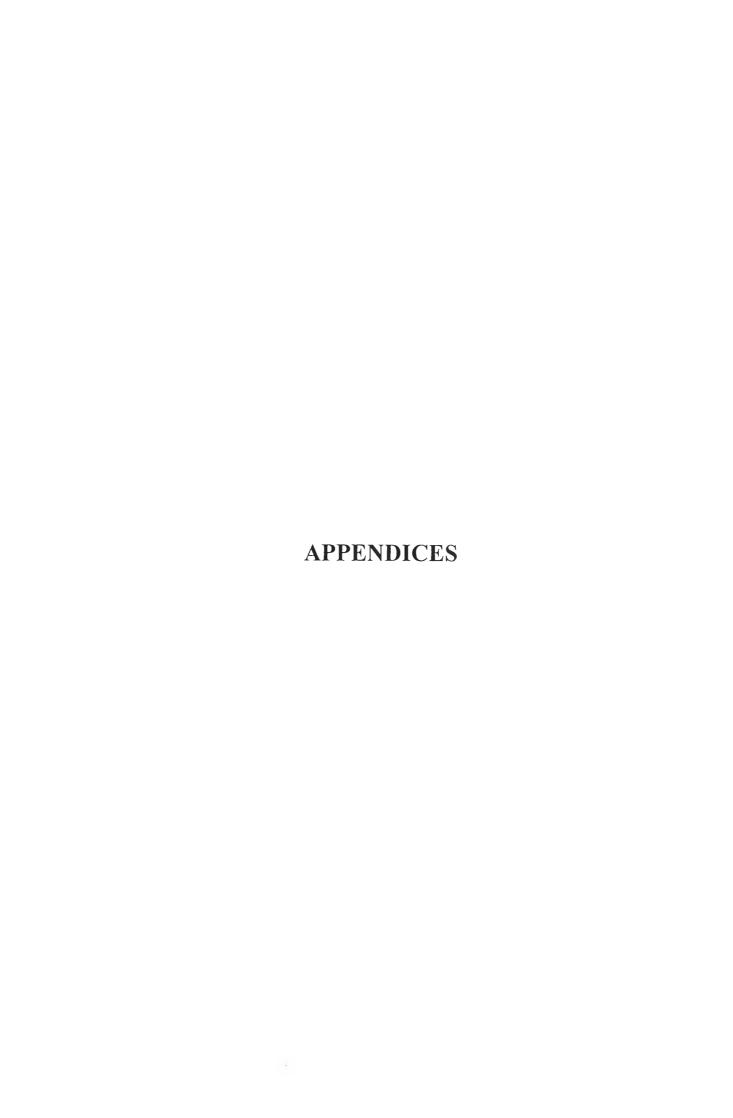# REFERENCES

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APPENDICES

APPENDIX A

INSTRUCTION MANUAL OF WATER DEMAND
FORECASTING USING NEURAL NETWORK
TOOLBOX

This section provides the instruction to forecast Water Demand with MATLAB and Neural Network Toolbox.

Requirements

Hardware: Pentium or AMD Athlon based Personal Computer with 64 MB RAM minimum.

Software: Microsoft Windows, MATLAB with Neural Network Toolbox, Microsoft Excel, Internet Explorer and Adobe Acrobat Reader.

Data: Data sets required as described in Chapter 4. All data should be accurately prepared and saved as MATLAB's file (.m).

Procedure

The procedures to forecast Water Demand with Neural Network Toolbox are as follows.

1. At desktop, double click MATLAB's icon to start MATLAB.

2. At the command prompt of MATLAB, run the prepared data file.

3. At the command prompt of MATLAB, type "nntool" and press "Enter" to start Neural Network Toolbox. The Network/Data Manager's window will now run and there will be a new window appeared.

4. At Network/Data Manager, click "Import" to import the data to Network/Data Manager. Specify data to be input or target.

5. At Network/Data Manager, click "New Network" to create a network. A "Create New Network" is opened. Specify these following parameters:

1. Network Name

2. Network Type

3. Input Range

4. Training Function

5. Performance Function

6. Number of layers

7. Number of neurons and Transfer function of each layer.

Then click "Create" to create the network. In Network/Data Manager, there will be a name of the network that user has just created in Network List.

6. Select the name of the network and click "Train". Specify input, target, and training parameters. Then click "Train Network" to train network. Wait for the training process to finish. Collect the results.

7. At Network/Data Manager, click "Simulate". Specify input and click "Simulate Network". Collect the results.

APPENDIX B

MEAN SQUARED ERROR OF WATER DEMAND

FORCASTING USING ACCRUAL MOVING AVERAGE

Table B.1 provides the Mean Squared Error of Water Demand Forecasting by Accrual Moving Average for comparison with the MSE of Water Demand Forecasting by Neural Network in section 4.6, 4.7, 4.8, 4.10 and 4.12.

Table B.2 provides the Mean Squared Error of Water Demand Forecasting by Accrual Moving Average for comparison with the MSE of Water Demand Forecasting by Neural Network in section 4.9.

Table B.3 provides the Mean Squared Error of Water Demand Forecasting by Accrual Moving Average for comparison with the MSE of Water Demand Forecasting by Neural Network in section 4.11 and 4.13.

Table B.1: – Mean Squared Error of Water Demand Forecast using Accrual Moving Average of the fiscal year 1999 and 2000

Month/ Fiscal Year	Actual (million cu.m^3)	Forecast (million cu.m^3)	Error (million cu.m^3)	Squared Error
1/1999	125.615	136.014	10.399	108.132
2/1999	120.288	135.004	14.716	216.570
3/1999	122.178	131.038	8.860	78.500
4/1999	116.473	125.326	8.853	78.376
5/1999	107.640	125.097	17.457	304.758
6/1999	119.846	125.370	5.524	30.511
7/1999	117.141	131.251	14.110	199.102
8/1999	120.188	129.902	9.714	94.368
9/1999	114.476	130.429	15.953	254.498
10/1999	118.664	129.281	10.617	112.714
11/1999	117.962	128.399	10.437	108.938
12/1999	114.712	126.875	12.163	147.939
1/2000	118.809	123.678	4.869	23.704
2/2000	114.873	122.694	7.821	61.163
3/2000	116.305	119.646	3.341	11.165
4/2000	117.371	115.430	-1.941	3.766
5/2000	112.215	114.653	2.438	5.944
6/2000	127.292	114.876	-12.416	154.165
7/2000	121.321	119.058	-2.263	5.120
8/2000	123.678	117.268	-6.410	41.084
9/2000	120.474	117.776	-2.698	7.279
10/2000	123.071	117.034	-6.037	36.445
11/2000	124.099	117.113	-6.986	48.809
12/2000	119.909	117.161	-2.748	7.552
Sum	2,858.600	2,970.374	115.774	2,140.600
			MSE = 89.19	

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Table B.2: Mean Squared Error of Water Demand Forecasting using the Accrual
Moving Average of the Fiscal Year 1999 and 2000 except the data of 5th and 6th
months of both Fiscal Year

Month/ Fiscal Year	Actual (million cu.m^3)	Forecast (million cu.m^3)	Error (million cu.m^3)	Squared Error
1/1999	125.615	136.014	10.399	108.132
2/1999	120.288	135.004	14.716	216.570
3/1999	122.178	131.038	8.860	78.500
4/1999	116.473	125.326	8.853	78.376
7/1999	117.141	131.251	14.110	199.102
8/1999	120.188	129.902	9.714	94.368
9/1999	114.476	130.429	15.953	254.498
10/1999	118.664	129.281	10.617	112.714
11/1999	117.962	128.399	10.437	108.938
12/1999	114.712	126.875	12.163	147.939
1/2000	118.809	123.678	4.869	23.704
2/2000	114.873	122.694	7.821	61.163
3/2000	116.305	119.646	3.341	11.165
4/2000	117.371	115.430	-1.941	3.766
7/2000	121.321	119.058	-2.263	5.120
8/2000	123.678	117.268	-6.410	41.084
9/2000	120.474	117.776	-2.698	7.279
10/2000	123.071	117.034	-6.037	36.445
11/2000	124.099	117.113	-6.986	48.809
12/2000	119.909	117.161	-2.748	7.552
Sum	**2,615.093**	**2,740.845**	**102.771**	**1,645.222**
			MSE = 82.26	

Table B.3: *Mean Squared Error of Water Demand Forecasting using Accrual Moving*
Average of the first sixth months of the Fiscal Year 2001

Month/ Fiscal Year	Actual (million cu.m^3)	Forecast (million cu.m^3)	Error (million cu.m^3)	Squared Error
1/2001	122.747	116.131	-6.616	43.767
2/2001	120.083	116.662	-3.421	11.701
3/2001	122.484	116.183	-6.301	39.703
4/2001	123.109	115.297	-7.812	61.027
5/2001	113.644	118.959	5.315	28.253
6/2001	127.312	120.276	-7.036	49.505
Sum	**729.379**	**703.509**	**-25.870**	**233.956**
			MSE = 38.99	

BIOGRAPHY

Rapee Supradish Na Ayudhya was born in 1977 in Bangkok, Thailand. He completed his undergraduate studies at Chulalongkorn Univeristy in Industrial Engineering. Then he studied for Master of Engineering in Engineering Management and Master of Science in Engineering Business Management at the Regional Centre for Manufacturing Systems Engineering, Chulalongkorn University.