

CHAPTER 3

WATER DEMAND FORECASTING USING ACCRUAL MOVING AVERAGE

3.1 Introduction

This chapter covers theory on forecasting and its application of the technique that is currently used by the MWA. Moving average technique, accrual moving average technique, the results of forecasting as well as the comparison with the actual demand are presented.

3.2 Moving average technique

The accrual moving average is the method currently used by the MWA to forecast water demand. It employs the concept of moving average technique that is the time series analysis. Moving average is a technique that averages the preceding actual values to be a forecast value. The moving average forecast can be computed using the following equation:

$$MA_n = (\sum A_i)/n \quad (3.1)$$

Where i = refers to the most recent period,

n = number of periods in the moving average,

A_i = actual value with age i

MA_n = Forecast

For example, MA_3 refers to a three-period moving average forecast. So three preceding data will be averaged to be the forecast.

3.3 Accrual moving average technique

The simple moving average technique described above might not be appropriate for water demand forecasting because moving average technique uses just the most recent value to calculate the moving average that might not fit to the seasonal data such as water demand. So the MWA adapted moving average the accrual moving average and uses it as the current method for water demand forecasting. Like the moving average technique, the accrual method takes the historical data to calculate the water demand but it takes the last year three consecutive monthly value of the previous year to calculate the water demand of the following year. For example, the actual demand of April, May and June 1998 will be averaged to be the forecast of May 1999.

3.4 Water demand forecasting using accrual moving average

As mentioned earlier, Planning and Budgeting Department which always monitors monthly water demand, will collect the historical data and then compute water demand forecast with accrual moving average technique. Water demand forecast will then be reported to related departments which are Production Planning and Quality Control Department, Distribution Control Department, and 13 Branch Offices as shown in Figure 1.1.

Table 3.1 presents the calculation of water demand forecast by accrual moving average of the Fiscal Year 1999 to 2000.

Table 3.1: Calculation of Water Demand Forecast by Accrual Moving Average

Forecast of month/ Fiscal Year	Months/Fiscal Year for Calculation	Calculation	Result
1/1999	12/1997, 1/1998 and 2/1998	$(135.535+139.690+132.816) / 3$	136.014
2/1999	1/1998, 2/1998 and 3/1998	$(139.690+132.816+132.507) / 3$	135.004

Table 3.1: Calculation of Water Demand Forecast by Accrual Moving Average (cont.)

Forecast of month/ Fiscal Year	Months/Fiscal Year for Calculation	Calculation	Result
3/1999	2/1998, 3/1998 and 4/1998	$(132.816+132.507+127.791) / 3$	131.038
4/1999	3/1998, 4/1998 and 5/1998	$(132.507+127.791+115.680) / 3$	125.326
5/1999	4/1998, 5/1998 and 6/1998	$(127.791+115.680+131.821) / 3$	125.097
6/1999	5/1998, 6/1998 and 7/1998	$(115.680+131.821+128.608) / 3$	125.370
7/1999	6/1998, 7/1998 and 8/1998	$(131.281+128.608+133.325) / 3$	131.251
8/1999	7/1998, 8/1998 and 9/1998	$(128.608+133.325+127.774) / 3$	129.902
9/1999	8/1998, 9/1998 and 10/1998	$(133.325+127.774+130.188) / 3$	130.429
10/1999	9/1998, 10/1998 and 11/1998	$(127.774+130.188+129.880) / 3$	129.281
11/1999	10/1998,11/1998 and 12/1998	$(130.188+129.880+125.130) / 3$	128.399
12/1999	11/1998,12/1998 and 1/1999	$(129.880+125.130+125.615) / 3$	126.875
1/2000	12/1998, 1/1999 and 2/1999	$(125.130+125.615+120.288) / 3$	123.678
2/2000	1/1999, 2/1999 and 3/1999	$(125.615+120.288+122.178) / 3$	122.694
3/2000	2/1999, 3/1999 and 4/1999	$(120.288+122.178+116.473) / 3$	119.646
4/2000	3/1999, 4/1999 and 5/1999	$(122.178+116.473+107.640) / 3$	115.430
5/2000	4/1999, 5/1999 and 6/1999	$(116.473+107.640+119.846) / 3$	114.653
6/2000	5/1999, 6/1999 and 7/1999	$(107.640+119.846+117.141) / 3$	114.876
7/2000	6/1999, 7/1999 and 8/1999	$(119.846+117.141+120.188) / 3$	119.058
8/2000	7/1999, 8/1999 and 9/1999	$(117.141+120.188+114.476) / 3$	117.268
9/2000	8/1999, 9/1999 and 10/1999	$(120.188+114.476+118.664) / 3$	117.776
10/2000	9/1999, 10/1999 and 11/1999	$(114.476+118.664+117.962) / 3$	117.034
11/2000	10/1999, 11/1999 and 12/1999	$(118.664+117.962+114.712) / 3$	117.113
12/2000	11/1999, 12/1999 and 1/2000	$(117.962+114.712+118.809) / 3$	117.161
1/2001	12/1999, 1/2000 and 2/2000	$(114.712+118.809+114.873) / 3$	116.131
2/2001	1/2000, 2/2000 and 3/2000	$(118.809+114.873+116.305) / 3$	116.662
3/2001	2/2000, 3/2000 and 4/2000	$(114.873+116.305+117.371) / 3$	116.183
4/2001	3,2000, 4/2000 and 5/2000	$(116.305+117.371+112.215) / 3$	115.297
5/2001	4/2000, 5/2000 and 6/2000	$(117.371+112.215+127.292) / 3$	118.959
6/2001	5/2000, 6/2000 and 7/2000	$(112.215+127.292+121.321) / 3$	120.276

Table 3.2 presents the comparison between actual and water demand forecast from accrual moving average technique of the Fiscal Year 1999 and 2000. Table 3.3 presents the comparison between actual and water demand forecast from accrual moving average technique of the first sixth months of the Fiscal Year 2001.

Table 3.2: Comparison between Actual and Water Demand Forecast from Accrual Moving Average of the Fiscal Year 1999 and 2000

Month/Fiscal Year	Actual (million cu.m³)	Forecast (million cu.m³)	Error (million cu.m³)
1/1999	125.615	136.014	10.399
2/1999	120.288	135.004	14.716
3/1999	122.178	131.038	8.860
4/1999	116.473	125.326	8.853
5/1999	107.640	125.097	17.457
6/1999	119.846	125.370	5.524
7/1999	117.141	131.251	14.110
8/1999	120.188	129.902	9.714
9/1999	114.476	130.429	15.953
10/1999	118.664	129.281	10.617
11/1999	117.962	128.399	10.437
12/1999	114.712	126.875	12.163
Total for 1999 Error = 9.81%	1,415.183	1,553.987	138.804
1/2000	118.809	123.678	4.869
2/2000	114.873	122.694	7.821
3/2000	116.305	119.646	3.341
4/2000	117.371	115.430	-1.941
5/2000	112.215	114.653	2.438
6/2000	127.292	114.876	-12.416
7/2000	121.321	119.058	-2.263
8/2000	123.678	117.268	-6.410
9/2000	120.474	117.776	-2.698
10/2000	123.071	117.034	-6.037
11/2000	124.099	117.113	-6.986
12/2000	119.909	117.161	-2.748
Total for 2000 Error = -3.20%	1,439.417	1393.357	-46.060
Overall Error = 4.06%	2,858.600	2,970.374	115.774

Table 3.3: Comparison between Actual and Water Demand Forecast from Accrual Moving Average of the first sixth months of the Fiscal Year 2001

Month/Fiscal Year	Actual (million cu.m³)	Forecast (million cu.m³)	Error (million cu.m³)
1/2001	122.747	116.131	-6.616
2/2001	120.083	116.662	-3.421
3/2001	122.484	116.183	-6.301
4/2001	123.109	115.297	-7.812
5/2001	113.644	118.959	5.315
6/2001	127.312	120.276	-7.036
Total	729.379	703.509	-25.870
Error = -3.55%			

From Tables 3.2 and 3.3, the accrual moving average presents inaccurate water demand forecasting. Although the percentages of errors shown in the tables are not too high, the value of water saved is many million cubic meters that means many millions of Baht can be saved.

3.5 Conclusion

At the current situation, the errors of water demand forecast from accrual moving average technique as shown in table 3.2 to 3.4 are found to be unsatisfactory. Hence other techniques should be introduced and tested whether they can provide better forecasting result.