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Modeling Water Consumption and the Impact of Watering Restrictions

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The Water Supply Problem

As the world's population rapidly grows, so does the demand for fresh water supply. This has resulted in depletion of global water resources, and the emergence of sustainable water resource management as an issue (Zilberman & Lipper, 1999). Perth, Western Australia is no exception to this worldwide trend.

The problem facing the WA Water Corporation (WC) is to meet Perth's increasing demand for water at a time when supply is decreasing. The traditional solution has been to exploit new water sources (supply augmentation), however; another option is to decrease demand through water conservation methods (demand management).

Supply augmentation incurs two types of costs, monetary costs to society and environmental costs from ecosystem degradation (depleting aquifers, damming rivers, destroying wetlands). Other sustainable options must therefore be considered.
Demand management can result in substantial savings. If permanent reductions in per capita water usage can be achieved, then the rate at which new sources need to be exploited will be reduced (WRC 2002).

Demand management strategies that have been implemented in Perth and are studied in this thesis include three levels of water restrictions

- 'Stage 1' restrictions. These were imposed between 1st November 1994 and the 31st May 1995. This only permitted the use of sprinklers at night, between 6 pm and 9 am.
- 'Stage 3'. These were introduced in 1995/96 where water use was permitted only at night between 6 pm and 9 am three days a week
- 'Stage 4' restrictions were imposed on 8th September 2001 and will remain in place in 2003, or until targeted water levels in the dams are reached. These restrictions

apply to reticulation systems using scheme water and require that households and businesses water only twice a week and at night between the hours of 6 pm and 9 am. The public has been encouraged to contact the Water Corporation if they notice households acting contrary to the restrictions (Water Corporation, 2002; Water Corporation, 2003).

Achieving Sustainable Water Management

In order to achieve sustainable water management, both demand management and supply augmentation strategies should be integrated into water management policies. This will reduce the chance of severe water shortage occurring, and continue to satisfy the demand for water supply (Boland, 1986; Winpenny, 1994).

Deriving an appropriate balance of supply augmentation and demand management strategies requires an evaluation of each in terms of their objectives, costs and benefits (OECD, 1989).

Along with a balanced approach to augmentation and demand management, it seems that within demand management, a combination of market and non-market policies is appropriate. A method to evaluate the effectiveness of each type of strategy on reducing water usage would therefore prove valuable. There are well-known standard techniques that can be used to evaluate supply augmentation projects and market based (price) demand management strategies. However, little research has been done in assessing the effectiveness of the non-market strategies (advertising and water restrictions). Knowing what impact non-market techniques have on water usage is necessary for making comparisons with other strategies. This is important when choosing strategies as part of a policy designed for sustainable water management (Winpenny, 1994).

The lack of suitable methods to evaluate non-market strategies led Data Analysis Australia (DAA) and the Water Corporation to develop a daily water consumption model in 2000. This model was used to predict the effectiveness of advertising campaigns and water restrictions on daily water consumption (DAA, 2002).

Aim of the Study

The aim of this study was to create a model to more accurately predict the effectiveness of advertising campaigns and water restrictions (non-market demand management strategies) on Perth's water usage. This was done by extending the statistical analysis of the Water Consumption Model currently used by the WC, in order to identify shortcomings and make improvements. Once improvements were made, the effectiveness of campaigns and restrictions was re-estimated and checked for difference with those of the original model.

The Water Consumption Model

The Water Consumption Model (WCM) was constructed in January 2000, and uses values of daily water use (dating back to 1980), for the Perth/Mandurah region. It uses multivariate regression techniques to explain the variation in the daily water usage data in terms of explanatory variables. The model can be used to assess the impact of these variables on water consumption, but was primarily created to assess the effectiveness of advertising campaigns and water restrictions on water usage. This can be achieved by simulating the model, with and without the campaign and restriction variables, then testing the significance of the difference in water use.

The WCM was constructed in the statistical package *S-Plus 2000* as a generalized linear model (GLM) with a semi-log functional form, using 'maximum likelihood' techniques to relate the dependant variable, (log of water consumption) to a linear combination of the independent variables (DAA, 2000). The t-statistics and p-values associated with each coefficient are then used to determine if each variable has a significant impact on water consumption.

Problems with the WCM

Time Trend Data

The original WCM is assumed to have a simple linear time trend for the increasing trend in water consumption since 1980. However, with a model as complex as this, a simple linear trend for water consumption is unlikely to have the best fit (Burton, 2003). It is likely that a more complex form will be more appropriate, such as a logarithmic or polynomial form. Hill *et al*, (1997) state that is important to specify the correct functional form of a model and its variables before conducting a regression, because changing this will effect the parameter estimation and statistical analyses. Therefore, if the time trend data is not correct, it is possible that the estimation of the other parameters will not be accurate, especially as the restrictions are all clustered at the end of the time period.

Weather Effects

There are two major problems with the original WCM in regard to the impact of weather on water consumption. These are:

- The lack of suitable data accounting for the effect of long-term past rainfall events.
- Inaccuracies resulting from the use of sinusoidal functions to model seasonality in water use.

These problems affect the accuracy of predicted water consumption and therefore the predicted effectiveness of advertising campaigns.

Sinusoidal Functions

Water consumption is highly seasonal, reflecting changes in water availability through rainfall, and evaporation of available rainfall, leading to peak demand in summer, and lower demand in winter. The WCM incorporates this seasonal pattern by using sinusoidal functions, which can generate highly flexible annual patterns of water demand. However, these patterns are deterministic, and may not reflect the unpredictable nature of weather which causes 'wet' or 'dry' seasons, and hence changes in household demand. A potential issue is that this may cause systematic errors in prediction of water use within years, which may get confused with shifts due to WC advertising and restrictions

In order to see if this is an issue in the original model, the annual average error in water consumption is correlated with the annual average rainfall for the year. As figure I below indicates, there is a significant relationship between the two, implying that the model systematically over predicts water demand in wet years, and systematically under predicts demand in dry years. This relationship is significant at a 6% level.

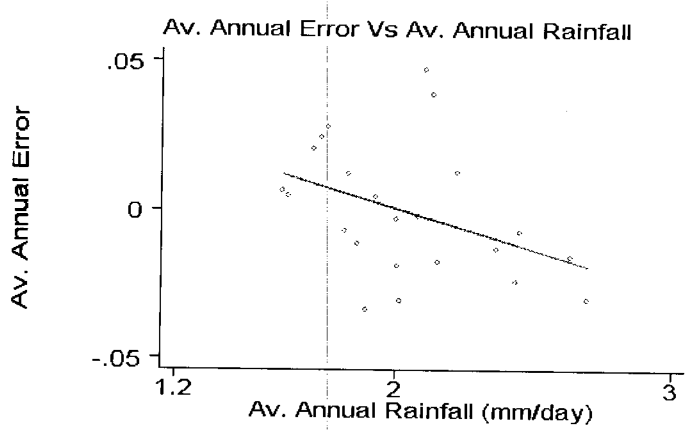

Figure 4.1. Regression of average annual error and average annual rainfall (1980/01 – 2001/02)

Long Term Past Rainfall Data

In an attempt to allow for this effect, cumulative rainfall effects are included in the re-specified model. Water use in gardens will depend on water availability to plants, and this will, in turn depend on the moisture content within the soil. Thus, rainfall over previous periods will have an impact on current water usage. The original WCM allows only for the effect of past rainfall that has fallen over a period of 48 hours prior to 9 am on any given day. In reality, water use in relation to rainfall is more likely to be determined by the amount of rain that has occurred in the past over a longer time span. If this data is included in the model, uncharacteristic and long-term rainfall events would be better accounted for, and a more accurate prediction generated for water consumption.

Other Excluded Variables

The random error component in the water consumption model includes those factors that effect water consumption but have not been included in the model as variables. If some of these components were theoretically identified and included in the model its accuracy and predictive ability would be improved.

The New Water Consumption Model

Improvements to the WCM were made by identifying and constructing variables that were not included in the original WCM, but were thought to influence water consumption. *Stata Ver. 6.0* was the statistical package chosen to conduct all analyses in this thesis, whereas DAA used *S-Plus 2000* to construct the original WCM. See Appendix 1 for a glossary of terms used to describe the variables used in the model. See Appendix 2 for the full regression analysis of the New Model.

New Time Trend Variable

A preliminary analysis was done in which a series of different regressions (linear, logarithmic, polynomial, exponential and power) for average water consumption over time, were calculated. The resultant R^2 values were compared for each regression line to determine which type of trend line best fitted the water consumption data. A polynomial trend was chosen as being most appropriate.

The appropriate degree of polynomial trend was then determined by testing time trend variables up to the fourth degree (i.e. **days**, **days^2**, **days^3** and **days^4**). In this test, all four **days** variables were added to the new model, and the regression simulated to test for their significance, and a polynomial time trend to the third degree (**days**, **days^2**, **days^3**) was used to explain the non-linear increase in water consumption since 1980.

New Variables for the Moving Average of Rainfall

New weather variables were created which consist of moving averages of rainfall. Due to the importance of past rainfall events, these moving averages are calculated as the average amount of rain (millimeters) that has fallen over a series of previous days. This has the potential to capture the impact of uncharacteristic seasons on water consumption by isolating its influence from the effects of the advertising campaigns, thereby allowing more accurate predictions of campaign effectiveness. Sixteen new variables were created with moving averages of 3 up to 63 days. Sixteen additional moving average variables were then created which are the squared values of each of the previous sixteen variables. In deciding which of the thirty-two moving average variables to include in the New Model, a search technique was used in which each new variable was added sequentially to the model and its significance determined by re-estimating the model. Significant variables were left in the model and insignificant variables were discarded before the next variable was tested.

New Advertising Budget Variable

Since the amount of funds spent on advertising campaigns influences their effectiveness, a variable was created for advertising budget (**ab**) using deflated advertising budget data from 1994/95 to 2001/02. This data was sourced from DAA (2000) and Regan (2003).
The budget variable (**ab**) was then created as a daily budget value for each advertising campaign from 1994/95 to 2001/02. The use of a daily value eliminates the bias caused by campaigns run over different time spans, thus enabling comparisons to be made between different advertising campaigns.
A squared daily budget variable (**ab^2**) was also created for the same time span, and which, with a positive coefficient, will create a trend of decreasing marginal benefit. This is important because basic economic theory states that an increase in effort (budget) will increase benefit gained (reduced water consumption), at a reducing rate, eventually tending towards no extra benefit (Tietenberg, 1996).
The **ab^2** term creates the effect of a diminishing marginal benefit for an increase in budget. Including it in the model assumes that, for this data set the WC have saturated the market for advertising campaigns so that the trend of decreasing marginal benefit is

evident. This was not the case for this data set, and therefore was not included in further analyses.

New Interaction Variables

Advertising Budget and Moving Average Rainfall

Advertising campaigns will be less effective in times of rain since demand for water will be reduced. Therefore, the impact of advertising budget on water consumption is likely to be effected by the amount of rainfall that has occurred. The influence of rain will be to reduce the effectiveness of advertising budget at a decreasing rate (a decreasing marginal impact).

To model the influence of rain on the effectiveness of advertising budget, sixteen new interaction variables were created (**ab*rainX**, where **X** is the number of days used to determine the moving average rainfall variable.

An additional sixteen variables were created, which are the squared values of the initial sixteen (**(ab*rainX)**^{2}). Positive coefficients on the squared variables will account for the fact that an increasing level of rainfall will decrease the marginal impact of daily advertising budget at a decreasing rate.

Each of the thirty-two 'budget/rainfall' interaction variables were tested individually in the model for a significant effect on water consumption. Each variable was added sequentially to the model, which was re-estimated to determine the effect of the new variable. Significant variables were left in the model and insignificant variables discarded before the next variable was tested.

Of the significant variables, only those that contained moving rainfall averages also found to be significant were chosen. This was done to maintain continuity in the model. On this basis the significant variables **ab*rain3**, **ab*rain23** and **ab*rain3sq** were chosen for inclusion in the final version of the New Model.

Advertising Budget and Weekly Cycle of Water Use

The effect of advertising budget on water consumption may also be influenced by the day of the week. According to DAA (2000) water consumption follows a significant weekly cycle. The effect of advertising budget will be more noticeable during times of high water use and therefore, will be more effective when community water use is the highest.

To capture this effect, interaction variables were created for advertising budget and weekly cycle: **ab*sw1**, **ab*sw2**, **ab*sw3**, **ab*cw1**, **ab*cw2** and **ab*cw3**. All six were included as one weekly cycle is represented by all six sinusoidal functions, which are weighted according to their coefficients.

Testing the New Model for an Improved Fit

Wald tests can be used to formally test for improved fit by determining the significance of a group of restrictions (Judge et al, 1980). If the Wald statistic is greater than the chi-squared value, the groups of new variables significantly improve the fit of the model (Greene, 1997).

When a Wald test is conducted on the new variables it indicates a better model fit compared to the original WCM (Chi^2 = 125.8 at 10 degrees of freedom, p-value =0.00). Therefore, it can be concluded that the New Model is an improvement over the WCM in terms of predictive accuracy.

Results

The New Model was simulated twice:

1. With the inclusion of advertising and restriction variables.
2. Excluding the advertising and restriction variables (the variables themselves and all interaction terms that they appear in).

The cumulative water consumption over each year was then calculated.

The year 1994 was the first year that advertising campaigns and water restrictions were introduced in Perth. These are present each year to the end of the data set. The results for cumulative water consumption for this period are reported in Table 1 below.

Table 1. Yearly cumulative water consumption (GL) with advertising and restrictions (Present) and without advertising and restrictions (Absent) for the New Model

Year	Cumulative Water Consumption (GL)		Difference (GL) Absent - Present
	Absent	Present	
1994/95	227.5	221.4	6.1 (2.7%)
1995/96	228.9	223.8	5.1 (2.2%)
1996/97	224.6	230.3	-5.8 (-2.6%)
1997/98	242.2	248.6	-6.3 (-2.6%)
1998/99	237.9	233.9	4.0 (1.7%)
1999/00	244.7	248.7	-4.0 (-1.6%)
2000/01	266.5	271.4	-4.9 (-1.8%)
2001/02	273.2	225.2	48.0 (17.6%)

Year 2001/02

In this year, the impact of campaigns and restrictions is positive and notably higher than other years, implying that these particular campaigns and restrictions were more effective in reducing consumption. This has been attributed to the introduction of Stage 4 restrictions (Ban 3). Whether the reduction in water use is due to this new initiative, will be determined from continued use of this ban in the years to come.

Years 1994/95, 1995/96, 1998/99 and 2001/02

For these years, the model predicts a decrease in water consumption as a result of campaigns and restrictions.

Years 1996/97, 1997/98, 1999/00 and 2000/01

These years see a predicted increase in water use by both models, when advertising campaigns and water restrictions are implemented.

Conclusions

Model Development

This thesis describes the development of a new water consumption model to predict the effectiveness of advertising campaigns and water restrictions on reducing water consumption in the Perth/Mandurah region.

The New Model builds upon the 2002 Water Corporation model developed by DAA, by including a number of new variables, which were found to significantly effect water consumption. These variables accounted for the influence of; trend effects, moving averages of rainfall, advertising budget and the interaction of 'budget/rainfall' and 'budget/weekly cycle of water use', on water consumption.

Model Results

Comparison of the WCM and New Model Estimates

A comparison of yearly cumulative water consumption predictions between the models showed that the New Model predictions are relatively similar to those of WCM. The predictions between models varied by only 2 or 3%, and therefore, it is concluded that both models are essentially predicting the same values for the effectiveness of campaigns/restrictions. However, it is recommended that the WCM be updated to include some of the additional variables that have been found to be significant in this study.

Effectiveness of Restrictions and Campaigns

The results indicate that the effectiveness of the campaigns and restrictions changes throughout the study period. Some campaigns increase water use, others decrease water use, however it seems that the introduction of the Stage 4 restrictions, in 2001/02 was extremely effective at reducing water use, compared to the other stages.

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Appendix 1
Glossary of Variables

days	number of days in the model from 2 (today 1st Jan 1980 to Thursday 8th Oct 2002)
Sa1	sin*π*2*(days/365.25)
Sa2	sin*π*4*(days/365.25);
Sa3	sin*π*6*(days/365.25)
Ca1	cos* π*2*(days/365.25)
Ca2	cos* π*4*(days/365.25)
Ca3	cos* π*6*(days/365.25)
Sw1	sin*π*2*(DOW/7)
Sw2	sin*π*4*(DOW/7)
Sw3	sin*π*6*(DOW/7)
cw1	cos*π*2*(DOW/7)
cw2	cos*π*4*(DOW/7)
cw3	cos*π*6*(DOW/7)
adjmax	adjusted maximum temperature
ar108	auto-regressively smoothed version of maximum temperature greater than 25°C with a smoothing parameter of 0.8
hot35	number of degrees in excess of 35°C
adjmin	adjusted minimum temperature
rain	rain in 24hrs after 9am
postrain	rain in 24hrs before 9am
prevrain	rain in 24hrs starting 49hrs before 9am
allow75	free water allowance of 75 kL
allow0	free water allowance of 0 kL
ban1	sprinkler ban 16/11/1994 → 1/4/1995
ban2	sprinkler ban 16/11/1995 → end of data set
ban3	sprinkler ban 8/9/2003 → end of data set
adv9596	advertising campaign 16/11/1995 → 1/4/1996
adv9697	advertising campaign 16/11/1996 → 1/4/1997
adv9798	advertising campaign 16/11/1997 → 1/4/1998
adv9899	advertising campaign 16/8/1998 → 1/4/1999
adv9900	advertising campaign 16/11/1999 → 1/4/2000
adv0001	advertising campaign 25/11/2000 → 1/4/2001
rootrain	sqaure root rain

Appendix 2
New Model

Residual df	8163	8163	No. of obs	8277
Pearson X2	1.191688	1.182671	Deviance	1.194352
Dispersion	.000146	.0001449	Dispersion	.0001463

lwcon	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
days	1.60E-04	4.32E-06	37.11	0.00	1.52E-04	1.69E-04
days^2	-2.08E-08	1.33E-09	-15.61	0.00	-2.34E-08	-1.82E-08
days^3	1.44E-12	1.10E-13	13.13	0.00	1.23E-12	1.66E-12
sa1	6.23E-02	1.06E-02	5.88	0.00	4.15E-02	8.30E-02
sa2	6.34E-03	1.09E-02	0.58	0.56	-1.49E-02	2.76E-02
sa3	-5.77E-02	7.95E-03	-7.26	0.00	-7.32E-02	-4.21E-02
ca1	1.86E-01	1.16E-02	16.01	0.00	1.64E-01	2.09E-01
ca2	9.52E-02	1.01E-02	9.38	0.00	7.53E-02	1.15E-01
ca3	-1.15E-02	7.61E-03	-1.51	0.13	-2.64E-02	3.40E-03
sw1	1.43E-02	1.26E-03	11.36	0.00	1.18E-02	1.67E-02
sw2	2.25E-03	1.25E-03	1.80	0.07	-2.02E-04	4.71E-03
sw3	-3.97E-03	1.25E-03	-3.16	0.00	-6.42E-03	-1.51E-03
cw1	-1.33E-02	1.25E-03	-10.60	0.00	-1.58E-02	-1.08E-02
cw2	-5.20E-03	1.25E-03	-4.15	0.00	-7.65E-03	-2.74E-03
cw3	7.06E-03	1.25E-03	5.64	0.00	4.61E-03	9.51E-03
adjmax	1.69E-02	4.29E-04	39.39	0.00	1.61E-02	1.77E-02
ar10825	1.54E-04	3.00E-05	5.13	0.00	9.51E-05	2.13E-04
hot35	-8.19E-04	1.67E-03	-0.49	0.62	-4.08E-03	2.45E-03
adjmin	-4.25E-03	3.36E-04	-12.67	0.00	-4.91E-03	-3.60E-03
rain	9.88E-03	5.33E-04	18.55	0.00	8.83E-03	1.09E-02
postrain	6.06E-03	5.02E-04	12.09	0.00	5.08E-03	7.05E-03
prevrain	3.43E-03	5.35E-04	6.41	0.00	2.38E-03	4.47E-03
allow75	-2.07E-02	5.09E-03	-4.07	0.00	-3.07E-02	-1.08E-02
allow0	-3.71E-02	5.53E-03	-6.72	0.00	-4.80E-02	-2.63E-02
ban1	-1.68E-02	9.83E-03	-1.71	0.09	-3.61E-02	2.47E-03
ban2	3.48E-02	5.75E-03	6.05	0.00	2.35E-02	4.61E-02
ban3	1.37E-01	3.33E-02	4.12	0.00	7.19E-02	2.02E-01
adv9596	-6.09E-02	9.19E-03	-6.63	0.00	-7.89E-02	-4.29E-02

adv9697	5.24E-03	8.64E-03	0.61	0.54	-1.17E-02	2.22E-02
adv9798	4.83E-03	8.39E-03	0.58	0.57	-1.16E-02	2.13E-02
adv9899	-6.22E-02	6.82E-03	-9.12	0.00	-7.56E-02	-4.88E-02
adv9900	(dropped)					
adv0001	-1.81E-02	9.10E-03	-2.00	0.05	-3.60E-02	-3.15E-04
adv0102	4.45E-02	1.31E-02	3.41	0.00	1.90E-02	7.01E-02
days*sa1	-1.02E-06	5.30E-07	-1.93	0.05	-2.06E-06	1.49E-08
days*sa2	-1.61E-06	5.12E-07	-3.15	0.00	-2.61E-06	-6.09E-07
days*sa3	6.57E-07	4.94E-07	1.33	0.18	-3.12E-07	1.63E-06
days*ca1	-6.62E-06	6.99E-07	-9.47	0.00	-7.99E-06	-5.25E-06
days*ca2	-4.27E-06	5.08E-07	-8.42	0.00	-5.27E-06	-3.28E-06
days*ca3	1.38E-06	4.96E-07	2.78	0.01	4.07E-07	2.35E-06
ca1*adjm	5.95E-03	4.80E-04	12.40	0.00	5.01E-03	6.89E-03
ca1*rain	6.43E-03	7.89E-04	8.15	0.00	4.89E-03	7.98E-03
ca1*post	4.62E-03	7.78E-04	5.93	0.00	3.09E-03	6.14E-03
ca1*prev	6.70E-04	8.08E-04	0.83	0.41	-9.14E-04	2.25E-03
ca2*adjm	-3.88E-03	4.16E-04	-9.32	0.00	-4.69E-03	-3.06E-03
ca2*rain	-6.07E-04	7.37E-04	-0.82	0.41	-2.05E-03	8.38E-04
ca2*post	-1.84E-03	7.22E-04	-2.55	0.01	-3.25E-03	-4.22E-04
ca2*prev	-1.75E-03	7.63E-04	-2.29	0.02	-3.24E-03	-2.53E-04
ca3*adjm	-5.69E-05	2.86E-04	-0.20	0.84	-6.17E-04	5.03E-04
ca3*rain	9.54E-04	6.19E-04	1.54	0.12	-2.59E-04	2.17E-03
ca3*post	-9.51E-04	6.08E-04	-1.56	0.12	-2.14E-03	2.41E-04
ca3*prev	1.29E-03	6.18E-04	2.09	0.04	7.91E-05	2.50E-03
sa1*adjm	7.70E-04	4.17E-04	1.85	0.07	-4.74E-05	1.59E-03
sa1*rain	2.00E-05	6.35E-04	0.03	0.98	-1.22E-03	1.26E-03
sa1*post	8.36E-04	6.25E-04	1.34	0.18	-3.88E-04	2.06E-03
sa1*prev	1.11E-03	6.23E-04	1.78	0.07	-1.09E-04	2.33E-03
sa2*adjm	-4.64E-04	4.32E-04	-1.08	0.28	-1.31E-03	3.82E-04
sa2*rain	-3.99E-03	6.53E-04	-6.12	0.00	-5.27E-03	-2.71E-03
sa2*post	-2.10E-03	6.37E-04	-3.31	0.00	-3.35E-03	-8.57E-04
sa2*prev	-9.54E-04	6.33E-04	-1.51	0.13	-2.19E-03	2.87E-04
sa3*adjm	1.86E-03	2.99E-04	6.23	0.00	1.28E-03	2.45E-03
sa3*rain	-2.41E-03	5.66E-04	-4.26	0.00	-3.52E-03	-1.30E-03
sa3*post	-1.19E-03	5.57E-04	-2.14	0.03	-2.28E-03	-9.96E-05
sa3*prev	2.47E-04	5.63E-04	0.44	0.66	-8.57E-04	1.35E-03
b3*amax	-1.79E-02	1.68E-03	-10.64	0.00	-2.12E-02	-1.46E-02

b3*ar10825	-1.49E-04	1.26E-04	-1.18	0.24	-3.95E-04	9.77E-05
b3*amin	9.49E-03	1.28E-03	7.44	0.00	6.99E-03	1.20E-02
b3*hot35	2.06E-02	2.04E-02	1.01	0.31	-1.93E-02	6.05E-02
rootrain	-7.29E-02	2.39E-03	-30.44	0.00	-7.75E-02	-6.82E-02
rootpost	-6.58E-02	2.20E-03	-29.93	0.00	-7.01E-02	-6.15E-02
rootprev	-3.04E-02	2.36E-03	-12.88	0.00	-3.50E-02	-2.57E-02
Sa1*rtrn	-1.23E-02	2.98E-03	-4.14	0.00	-1.81E-02	-6.47E-03
sa1*rtpo	-1.17E-02	2.80E-03	-4.19	0.00	-1.72E-02	-6.24E-03
sa1*rtpr	-1.34E-02	2.82E-03	-4.75	0.00	-1.90E-02	-7.89E-03
sa2*rtrn	1.26E-02	3.02E-03	4.19	0.00	6.73E-03	1.85E-02
sa2*rtpo	7.72E-03	2.82E-03	2.74	0.01	2.19E-03	1.33E-02
sa2*rtpr	1.64E-03	2.85E-03	0.57	0.57	-3.95E-03	7.22E-03
sa3*rtrn	1.32E-02	2.72E-03	4.85	0.00	7.85E-03	1.85E-02
sa3*rtpo	4.53E-03	2.59E-03	1.75	0.08	-5.48E-04	9.61E-03
sa3*rtpr	1.85E-03	2.61E-03	0.71	0.48	-3.28E-03	6.97E-03
ca1*rtrn	-6.20E-02	3.41E-03	-18.21	0.00	-6.87E-02	-5.54E-02
ca1*rtpo	-4.56E-02	3.29E-03	-13.83	0.00	-5.20E-02	-3.91E-02
ca1*rtpr	-2.69E-02	3.35E-03	-8.01	0.00	-3.35E-02	-2.03E-02
ca2*rtrn	3.13E-03	3.25E-03	0.96	0.34	-3.24E-03	9.51E-03
ca2*rtpo	1.06E-02	3.14E-03	3.40	0.00	4.50E-03	1.68E-02
ca2*rtpr	8.88E-03	3.20E-03	2.77	0.01	2.61E-03	1.52E-02
ca3*rtrn	-1.69E-05	2.90E-03	-0.01	1.00	-5.70E-03	5.66E-03
ca3*rtpo	2.94E-03	2.77E-03	1.06	0.29	-2.49E-03	8.37E-03
ca3*rtpr	-4.84E-03	2.78E-03	-1.74	0.08	-1.03E-02	6.08E-04
sw1*b3	6.07E-03	5.65E-03	1.08	0.28	-5.00E-03	1.71E-02
sw2*b3	-8.47E-03	5.62E-03	-1.51	0.13	-1.95E-02	2.54E-03
sw3*b3	2.08E-03	5.64E-03	0.37	0.71	-8.99E-03	1.31E-02
cw1*b3	4.35E-03	5.66E-03	0.77	0.44	-6.74E-03	1.54E-02
cw2*b3	-2.20E-02	5.60E-03	-3.92	0.00	-3.30E-02	-1.10E-02
cw3*b3	-1.01E-02	5.61E-03	-1.80	0.07	-2.11E-02	8.83E-04
rain1	-2.91E-03	7.76E-04	-3.75	0.00	-4.43E-03	-1.39E-03
rain2	-1.22E-02	9.45E-04	-12.89	0.00	-1.40E-02	-1.03E-02
rain4	-3.12E-03	8.85E-04	-3.53	0.00	-4.86E-03	-1.39E-03
rain6	-2.90E-02	2.18E-03	-13.35	0.00	-3.33E-02	-2.48E-02
rain10	-2.49E-02	2.70E-03	-9.22	0.00	-3.01E-02	-1.96E-02
$rain1^2$	3.04E-05	2.72E-05	1.12	0.27	-2.30E-05	8.37E-05
$rain2^2$	6.46E-04	6.13E-05	10.54	0.00	5.26E-04	7.66E-04

rain6^2	2.80E-03	2.13E-04	13.13	0.00	2.38E-03	3.21E-03
rain10^2	1.82E-03	3.13E-04	5.82	0.00	1.21E-03	2.43E-03
ab	-1.00E-02	1.72E-03	-5.85	0.00	-1.34E-02	-6.68E-03
ab*rain1	3.58E-03	5.72E-04	6.26	0.00	2.46E-03	4.70E-03
ab*rain6	2.35E-03	6.88E-04	3.41	0.00	9.99E-04	3.70E-03
ab*rn1^2	-1.94E-05	5.18E-06	-3.75	0.00	-2.96E-05	-9.27E-06
ab*sw1	2.34E-03	1.09E-03	2.14	0.03	1.95E-04	4.48E-03
ab*sw2	3.69E-03	1.09E-03	3.39	0.00	1.55E-03	5.82E-03
ab*sw3	2.08E-03	1.09E-03	1.92	0.06	-4.86E-05	4.22E-03
ab*cw1	2.20E-03	1.09E-03	2.02	0.04	6.21E-05	4.35E-03
ab*cw2	8.33E-04	1.09E-03	0.76	0.45	-1.31E-03	2.97E-03
ab*cw3	-2.70E-03	1.09E-03	-2.47	0.01	-4.84E-03	-5.55E-04
cons	5.62	1.00E-02	561.54	0.00	5.60	5.64