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Ecological Niche Modelling of an Industrially Important Mushroom - *Ganoderma lucidum* (Leys.) Karsten: A Machine Learning Global Appraisal

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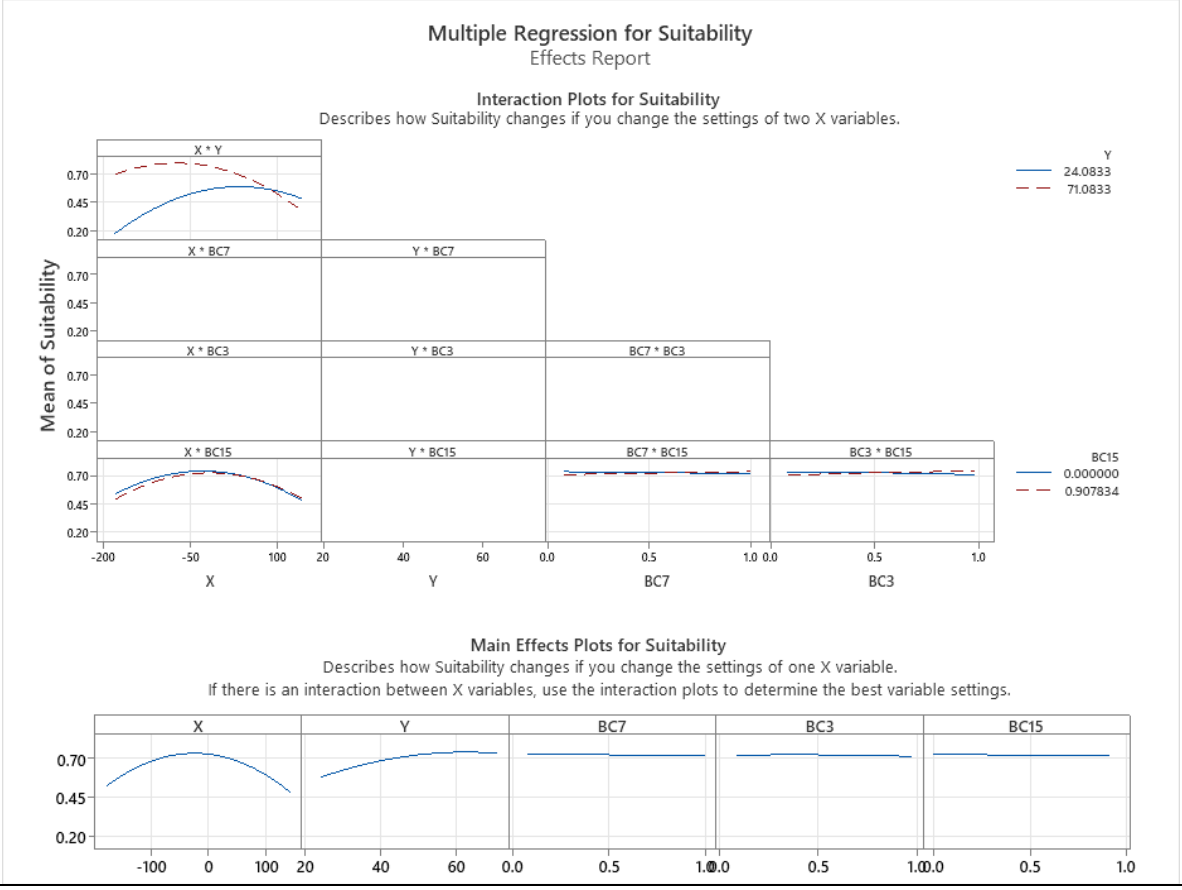
Supplementary Tables and Figures

Supplementary Table 1 — Predictive variables (Current and Future) Bio-Climatic Data Variables. Calculation criterion of each variable can be found at https://pubs.usgs.gov/ds/691/ds691.pdf.

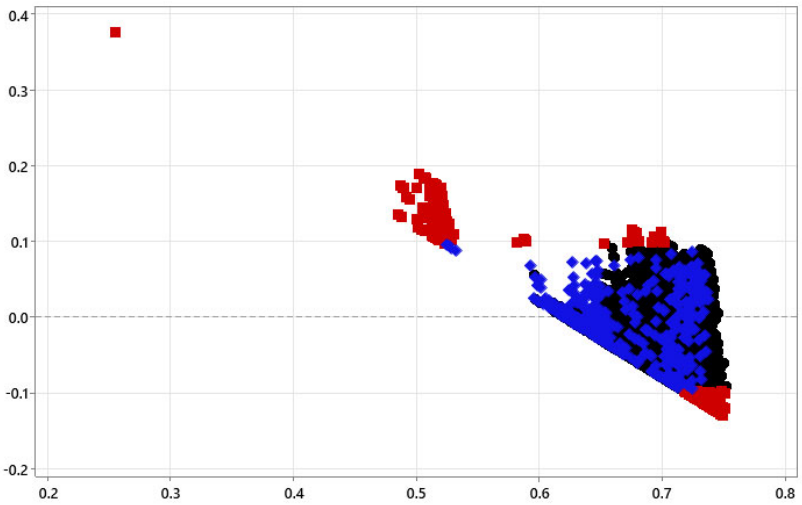
Code	Environmental variables	Scaling Factor	Unit
BC-1	Annual Mean Temperature	10	°C
BC-2	Mean Diurnal Range (Mean of monthly (max temp - min temp))	10	°C
BC-3	Isothermality (BC2/BC7) (×100)	100	Percent



Multiple Regression for Suitability

Diagnostic Report

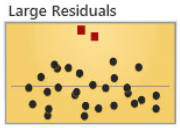
Residuals vs Fitted Values



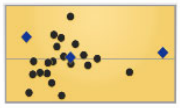
Look for patterns, such as strong curvature or clusters, that may indicate problems with the regression model. Ideally, the points should fall randomly on both sides of zero. Identify any large residuals that could have a strong influence on the model.

Look for these patterns:

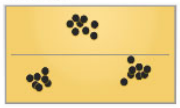
Large Residuals



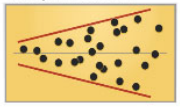
Unusual X Values



Clusters



Unequal Variation



Multiple Regression for Suitability

Model Building Report

X1: X X2: Y X3: BC7 X4: BC3 X5: BC15

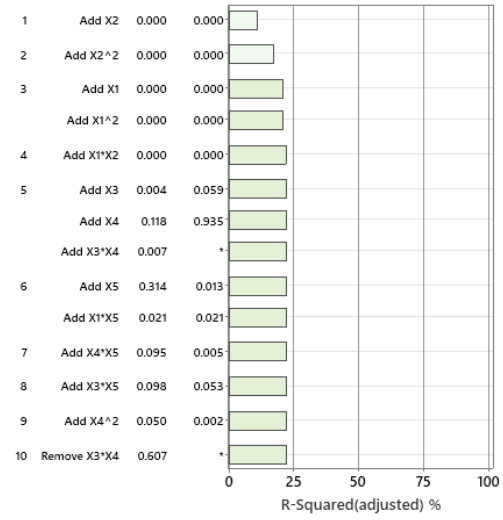
Final Model Equation

Suitability = 0.3166 + 0.001563 X1 + 0.013943 X2 - 0.01903 X3 + 0.0061 X4 - 0.0617 X5 - 0.000009 X1^2 - 0.000109 X2^2 - 0.03027 X4^2 - 0.000041 X1*X2 + 0.000224 X1*X5 + 0.0526 X3*X5 + 0.0727 X4*X5

Model Building Sequence

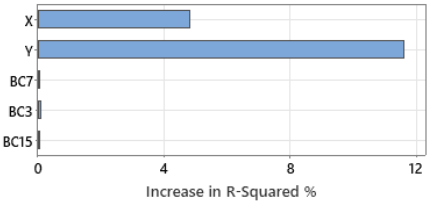
Displays the order in which terms were added or removed.

Step	Change	Step P	Final P
1	Add X2	0.000	0.000
2	Add X2^2	0.000	0.000
3	Add X1	0.000	0.000
	Add X1^2	0.000	0.000
4	Add X1*X2	0.000	0.000
5	Add X3	0.004	0.059
	Add X4	0.118	0.935
	Add X3*X4	0.007	*
6	Add X5	0.314	0.013
	Add X1*X5	0.021	0.021
7	Add X4*X5	0.095	0.005
8	Add X3*X5	0.098	0.053
9	Add X4^2	0.050	0.002
10	Remove X3*X4	0.607	*



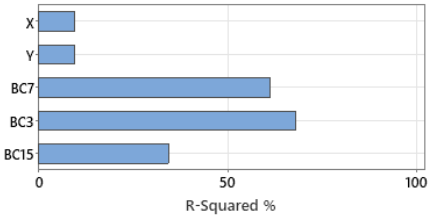
Incremental Impact of X Variables

Long bars represent Xs that contribute the most new information to the model.



Each X Regressed on All Other Terms

Gray bars represent Xs that do not help explain additional variation in Y.



A gray bar represents an X variable not in the model.

Multiple Regression for Suitability

Prediction and Optimization Report

Goal: Maximize Suitability

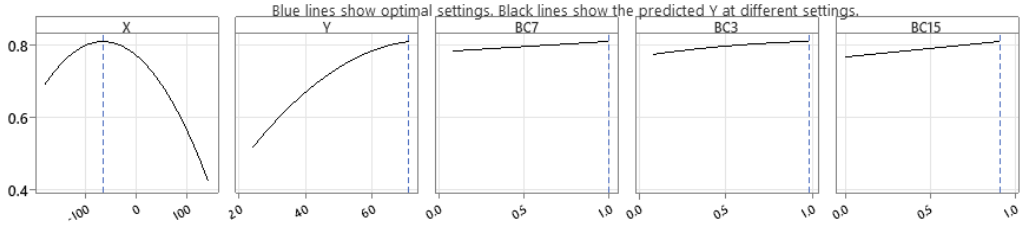
Predicted Y	0.810287
95% PI	(0.70612, 0.91445)

Solution: Optimal Settings

X1: X	-64.2352	X4: BC3	0.978947
X2: Y	71.0833	X5: BC15	0.907834
X3: BC7	0.998584		

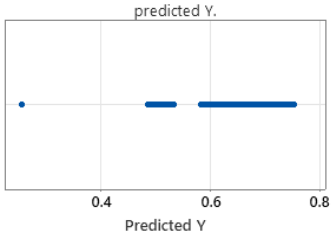
Settings and Sensitivity for Optimal Solution

Blue lines show optimal settings. Black lines show the predicted Y at different settings.



Predicted Y for All Sample Points

Use brushing to see the X values for any predicted Y.



Top Five Alternative Solutions

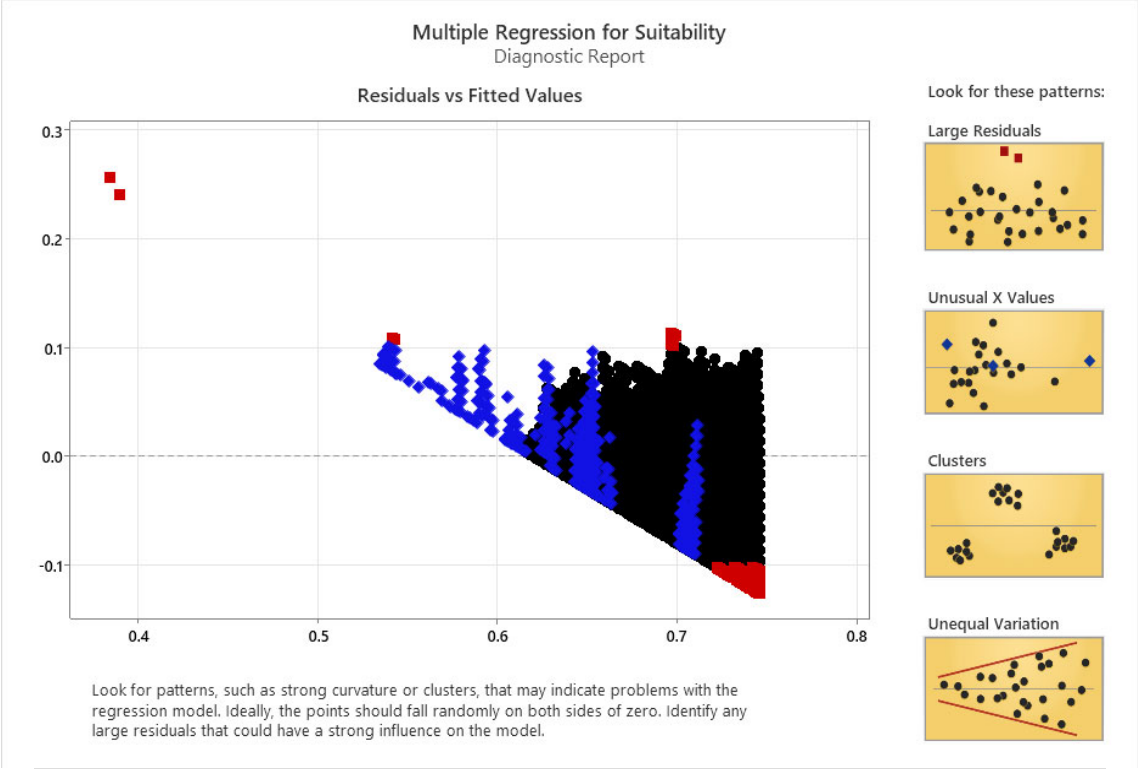
Sample points with predicted Y values closest to the optimal solution. Evaluate these and the optimal solution to determine if any are adequate.

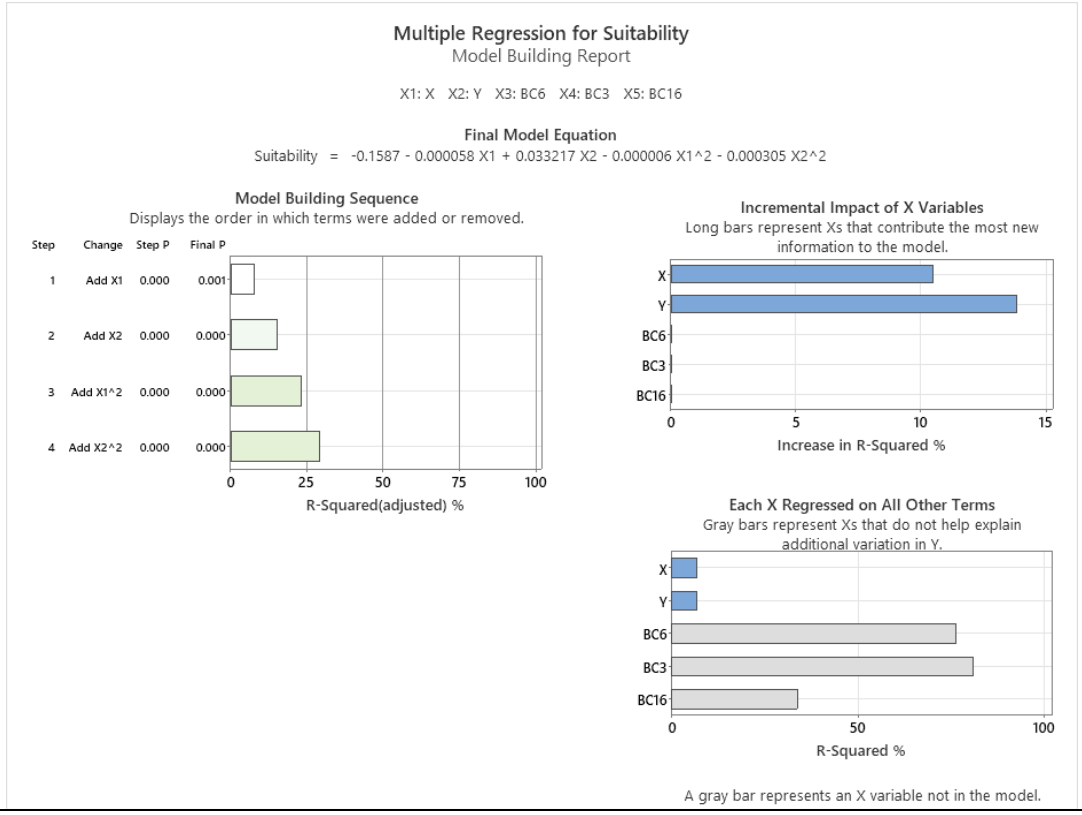
X1	X2	X3	X4	X5	Predicted Y
-3.91667	57.4167	0.348442	0.273684	0.119816	0.751695
-3.91667	57.0833	0.362606	0.252632	0.129032	0.750754
-4.08333	57.0833	0.393768	0.252632	0.124424	0.750596
-4.08333	57.4167	0.485836	0.126316	0.101382	0.750183
-3.41667	56.5833	0.390935	0.231579	0.133641	0.749062

Multiple Regression for Suitability

Report Card

Check	Status	Description
Amount of Data	ℹ	Your sample is large enough (n = 16877) to obtain a precise estimate of the strength of the relationship.
Unusual Data	⚠	• Large residuals: 444 data points have large residuals and are not well fit by the equation. These points are marked in red on the Diagnostic Report. • Unusual X values: 500 data points have unusual X values, which can strongly influence the model equation. These points are marked on the Diagnostic Report. You can hover over a point or use Minitab's brushing feature to identify the worksheet rows. Because unusual data can have a strong influence on the results, try to identify the cause for their unusual nature. Correct any data entry or measurement errors. Consider removing data that are associated with special causes and redoing the analysis.
Normality	✓	Because you have at least 15 data points, normality is not an issue. If the number of data points is small and the residuals are not normally distributed, the p-values used to determine whether there is a significant relationship between the Xs and Y may not be accurate.
Evaluate Solutions	ℹ	The Prediction and Optimization Report displays the optimal solution, which is calculated using a numerical algorithm. It also displays a list of alternative solutions. When evaluating these solutions, consider the following: • The feasibility of the optimal solution from a practical perspective. • The sensitivity of Y to departures from the optimal X values. • The true optimal solution may not be located in the current sample space. • The alternative solutions may be more practical than the optimal solution. Once you have selected a solution, perform 20-30 confirmation runs to validate the optimal X values.

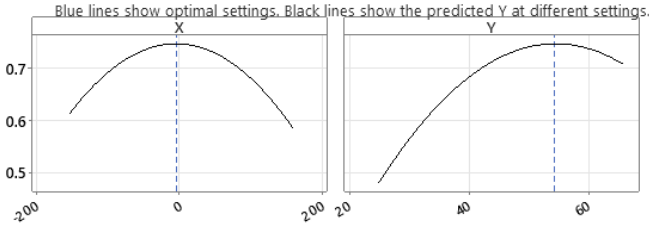

Multiple Regression for Suitability
Diagnostic Report
Residuals vs Fitted Values
0.3
0.2
0.1
0.0
-0.1
0.4
0.5
0.6
0.7
0.8
Look for these patterns:
Large Residuals
Unusual X Values
Clusters
Unequal Variation
Look for patterns, such as strong curvature or clusters, that may indicate problems with the regression model. Ideally, the points should fall randomly on both sides of zero. Identify any large residuals that could have a strong influence on the model.


Multiple Regression for Suitability
Model Building Report
X1: X X2: Y X3: BC6 X4: BC3 X5: BC16
Final Model Equation
Suitability = -0.1587 - 0.000058 X1 + 0.033217 X2 - 0.000006 X1^2 - 0.000305 X2^2
Model Building Sequence
Displays the order in which terms were added or removed.
Step Change Step P Final P
1 Add X1 0.000 0.001
2 Add X2 0.000 0.000
3 Add X1^2 0.000 0.000
4 Add X2^2 0.000 0.000
0 25 50 75 100
R-Squared(adjusted) %
Incremental Impact of X Variables
Long bars represent Xs that contribute the most new information to the model.
X
Y
BC6
BC3
BC16
0 5 10 15
Increase in R-Squared %
Each X Regressed on All Other Terms
Gray bars represent Xs that do not help explain additional variation in Y.
X
Y
BC6
BC3
BC16
0 50 100
R-Squared %
A gray bar represents an X variable not in the model.

Multiple Regression for Suitability
Prediction and Optimization Report

Goal: Maximize Suitability		Solution: Optimal Settings	
Predicted Y	0.745977	X1: X	-4.92508
95% PI	(0.64647, 0.84548)	X2: Y	54.3207

Settings and Sensitivity for Optimal Solution
Blue lines show optimal settings. Black lines show the predicted Y at different settings.



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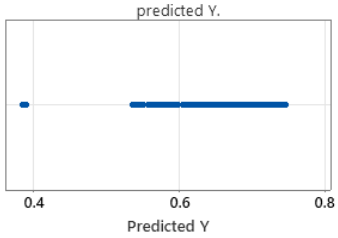

Top Five Alternative Solutions
Sample points with predicted Y values closest to the optimal solution. Evaluate these and the optimal solution to determine if any are adequate.

X1	X2	Predicted Y
-4.58333	54.4167	0.745982
-4.41667	54.4167	0.745981
-5.41667	54.4167	0.745980
-5.58333	54.4167	0.745979
-4.91667	54.5833	0.745978

Multiple Regression for Suitability
Report Card

Check	Status	Description
Amount of Data	ℹ	Your sample is large enough (n = 20791) to obtain a precise estimate of the strength of the relationship.
Unusual Data	⚠	• Large residuals: 620 data points have large residuals and are not well fit by the equation. These points are marked in red on the Diagnostic Report. • Unusual X values: 943 data points have unusual X values, which can strongly influence the model equation. These points are marked on the Diagnostic Report. You can hover over a point or use Minitab's brushing feature to identify the worksheet rows. Because unusual data can have a strong influence on the results, try to identify the cause for their unusual nature. Correct any data entry or measurement errors. Consider removing data that are associated with special causes and redoing the analysis.
Normality	✓	Because you have at least 15 data points, normality is not an issue. If the number of data points is small and the residuals are not normally distributed, the p-values used to determine whether there is a significant relationship between the Xs and Y may not be accurate.
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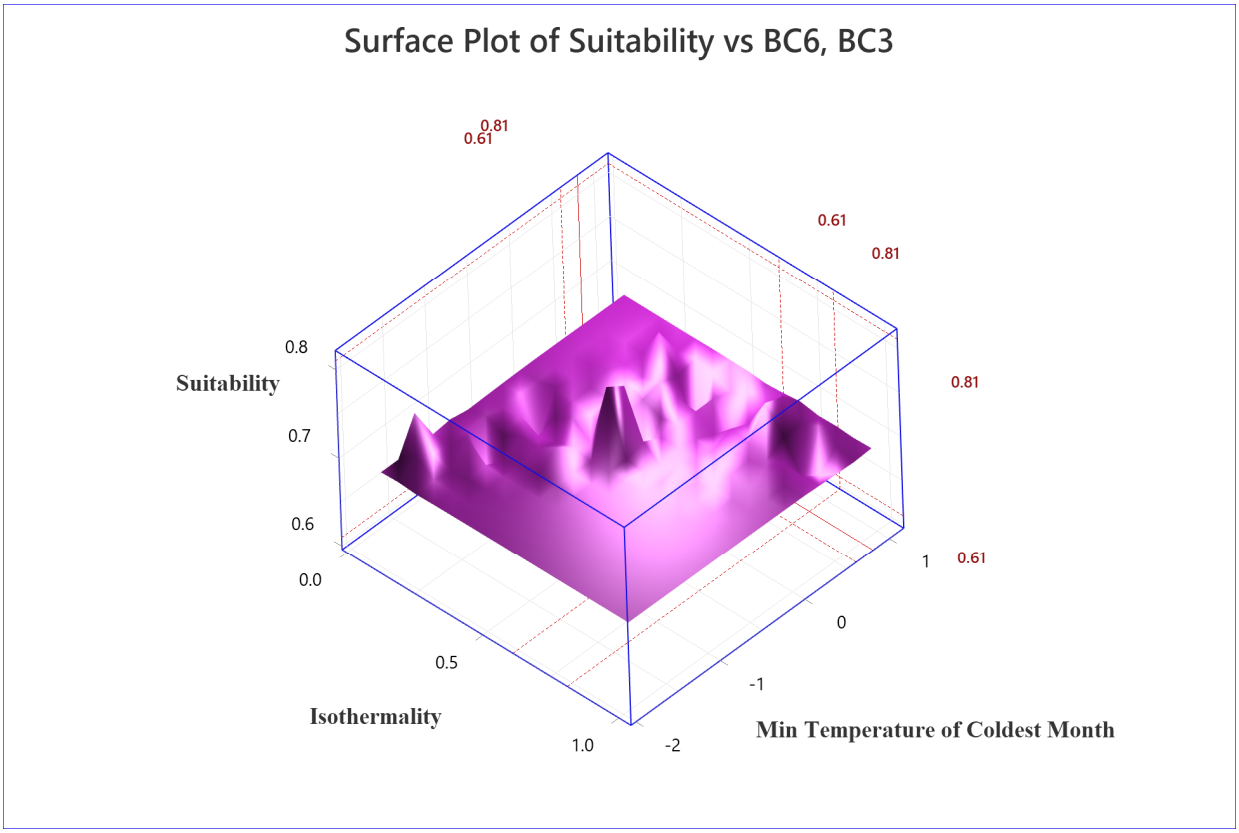
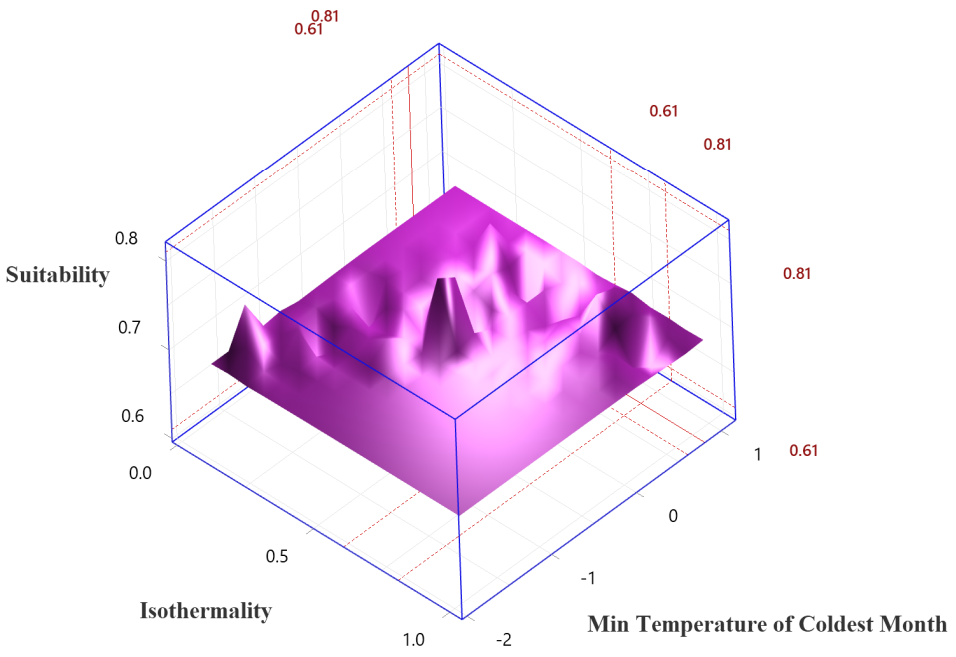
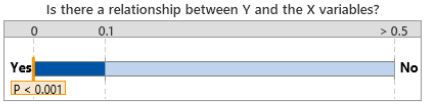

Surface Plot of Suitability vs BC6, BC3
0.81
0.61
0.61
0.81
0.81
0.61
Suitability
0.8
0.7
0.6
0.0
0.5
1.0
Isothermality
1
0
-1
-2
Min Temperature of Coldest Month



BC-4	Temperature Seasonality (standard deviation ×100	100	-
BC-5	Max Temperature of Warmest Month	10	°C
BC-6	Min Temperature of Coldest Month	10	°C
	2050RCP60.CSV		
	Multiple Regression for Suitability		

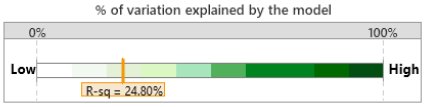
Multiple Regression for Suitability
Summary Report

Is there a relationship between Y and the X variables?



The relationship between Y and the X variables in the model is statistically significant (p < 0.10).

% of variation explained by the model



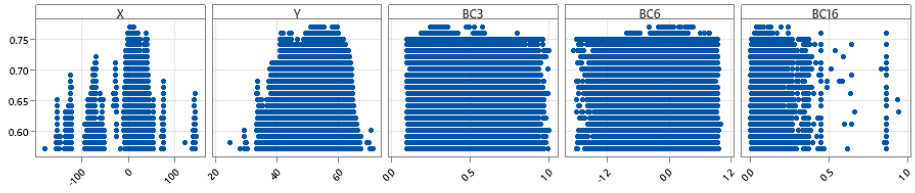
24.80% of the variation in Y can be explained by the regression model.

Comments

The following terms are in the fitted equation that models the relationship between Y and the X variables:
X1: X
X2: Y
X3: BC3
X4: BC6
X5: BC16
X1^2, X2^2, X1*X2, X3*X4, X3*X5

If the model fits the data well, this equation can be used to predict Suitability for specific values of the X variables, or find the settings for the X variables that correspond to a desired value or range of values for Suitability.

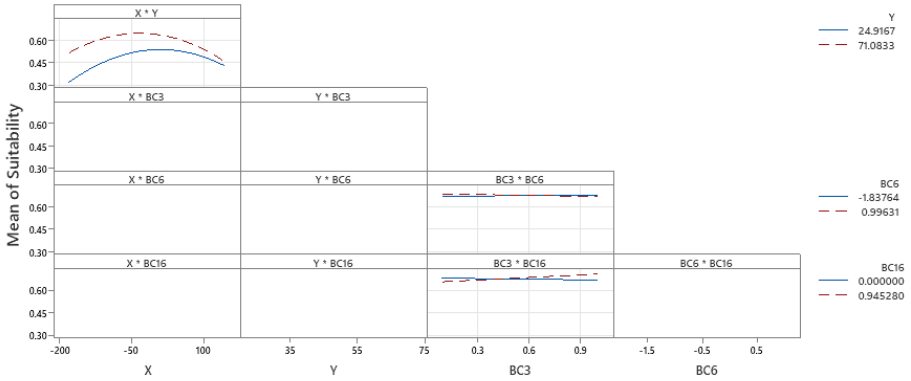
Suitability vs X Variables



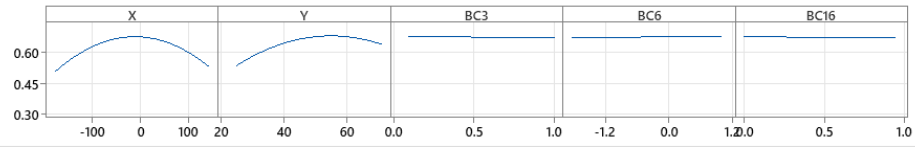
A gray background represents an X variable not in the model.

Multiple Regression for Suitability
Effects Report

Interaction Plots for Suitability
Describes how Suitability changes if you change the settings of two X variables.



Main Effects Plots for Suitability
Describes how Suitability changes if you change the settings of one X variable.
If there is an interaction between X variables, use the interaction plots to determine the best variable settings.



Multiple Regression for Suitability
Diagnostic Report

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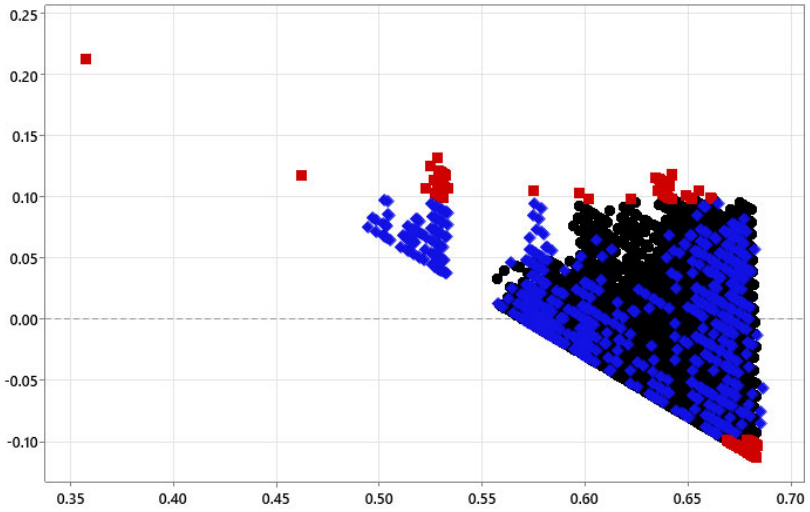
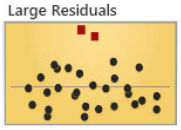


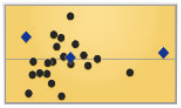
Look for patterns, such as strong curvature or clusters, that may indicate problems with the regression model. Ideally, the points should fall randomly on both sides of zero. Identify any large residuals that could have a strong influence on the model.

Look for these patterns:

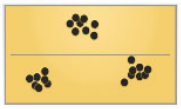
Large Residuals



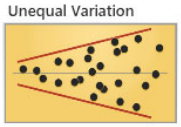
Unusual X Values



Clusters



Unequal Variation



Multiple Regression for Suitability
Model Building Report

X1: X X2: Y X3: BC3 X4: BC6 X5: BC16

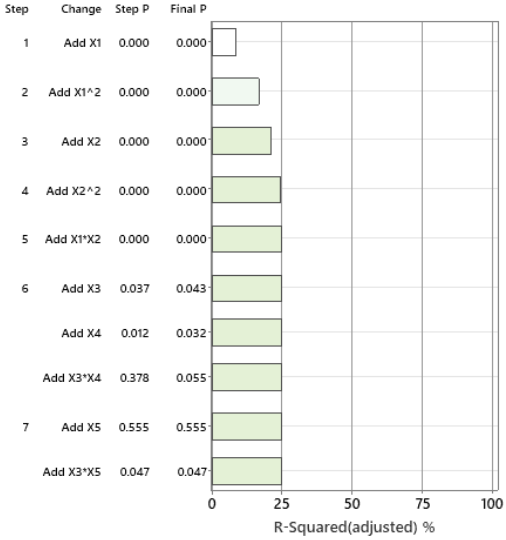
Final Model Equation

Suitability = 0.2062 + 0.000411 X1 + 0.017487 X2 - 0.01505 X3 + 0.00605 X4 - 0.0329 X5 - 0.000006 X1^2 - 0.000159 X2^2 - 0.000011 X1*X2 - 0.00898 X3*X4 + 0.0751 X3*X5

Model Building Sequence

Displays the order in which terms were added or removed.

Step	Change	Step P	Final P
1	Add X1	0.000	0.000
2	Add X1^2	0.000	0.000
3	Add X2	0.000	0.000
4	Add X2^2	0.000	0.000
5	Add X1*X2	0.000	0.000
6	Add X3	0.037	0.043
	Add X4	0.012	0.032
	Add X3*X4	0.378	0.055
7	Add X5	0.555	0.555
	Add X3*X5	0.047	0.047



Incremental Impact of X Variables

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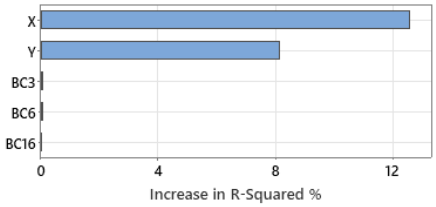

Each X Regressed on All Other Terms

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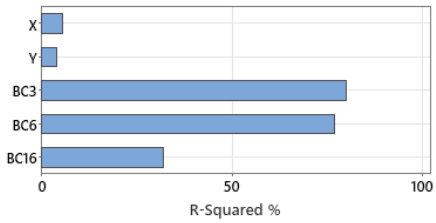


A gray bar represents an X variable not in the model.

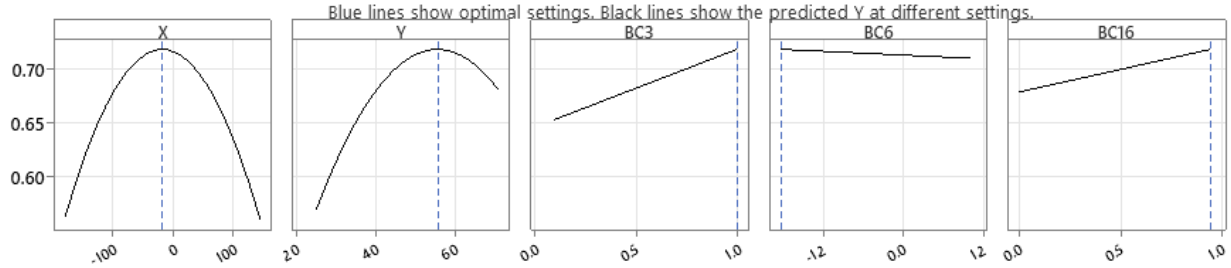
Multiple Regression for Suitability
Prediction and Optimization Report

Goal: Maximize Suitability

Solution: Optimal Settings

Predicted Y	0.718624	X1: X	-17	X4: BC6	-1.83764
95% PI	(0.61325, 0.82400)	X2: Y	55.6944	X5: BC16	0.945280
		X3: BC3	1		

Settings and Sensitivity for Optimal Solution
Blue lines show optimal settings. Black lines show the predicted Y at different settings.



Predicted Y for All Sample Points
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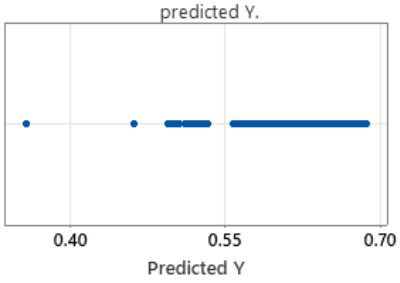


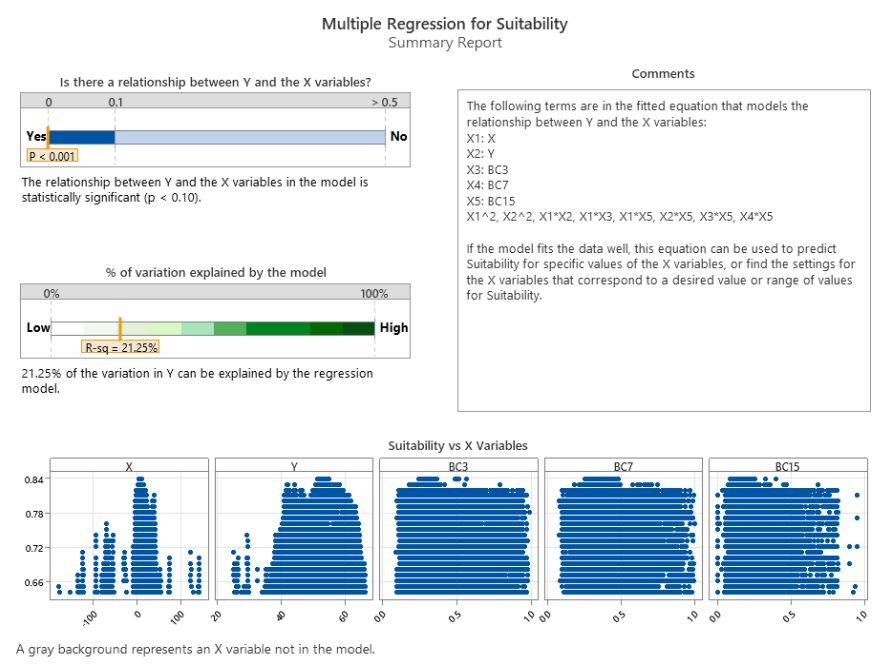
Top Five Alternative Solutions
Sample points with predicted Y values closest to the optimal solution. Evaluate these and the optimal solution to determine if any are adequate.

X1	X2	X3	X4	X5	Predicted Y
-4.41667	52.9167	0.610526	0.793358	0.664159	0.686502
-3.75	52.25	0.547368	0.590406	0.868372	0.685570
-2.08333	55.9167	0.936842	0.811808	0.382287	0.685204
-1.75	52.25	0.821053	0.719557	0.392441	0.683727
-6.75	55.25	0.221053	7.380E-03	0.0479504	0.683681

Multiple Regression for Suitability
Report Card

Check	Status	Description
Amount of Data	ⓘ	Your sample is large enough (n = 24774) to obtain a precise estimate of the strength of the relationship.
Unusual Data	⚠	• Large residuals: 421 data points have large residuals and are not well fit by the equation. These points are marked in red on the Diagnostic Report. • Unusual X values: 996 data points have unusual X values, which can strongly influence the model equation. These points are marked on the Diagnostic Report. You can hover over a point or use Minitab's brushing feature to identify the worksheet rows. Because unusual data can have a strong influence on the results, try to identify the cause for their unusual nature. Correct any data entry or measurement errors. Consider removing data that are associated with special causes and redoing the analysis.
Normality	✓	Because you have at least 15 data points, normality is not an issue. If the number of data points is small and the residuals are not normally distributed, the p-values used to determine whether there is a significant relationship between the Xs and Y may not be accurate.
Evaluate Solutions	ⓘ	The Prediction and Optimization Report displays the optimal solution, which is calculated using a numerical algorithm. It also displays a list of alternative solutions. When evaluating these solutions, consider the following: • The feasibility of the optimal solution from a practical perspective. • The sensitivity of Y to departures from the optimal X values. • The true optimal solution may not be located in the current sample space. • The alternative solutions may be more practical than the optimal solution. Once you have selected a solution, perform 20-30 confirmation runs to validate the optimal X values.

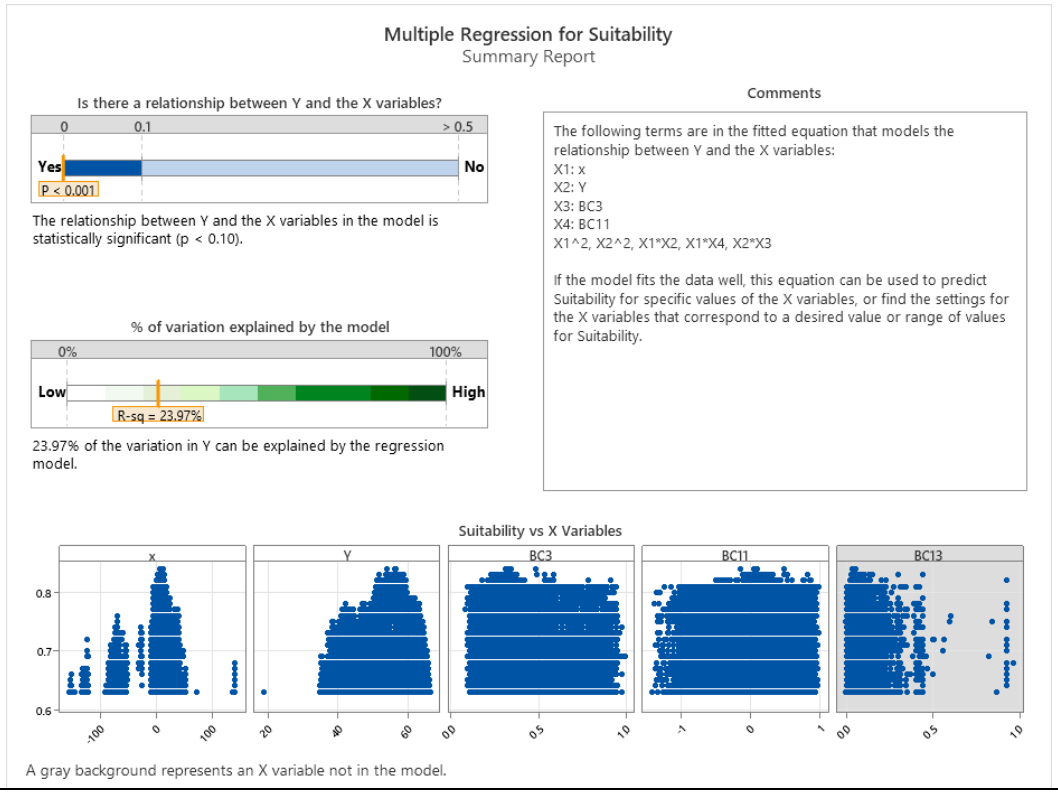
BC-7	Temperature Annual Range (BC 5-BC 6)	10	°C

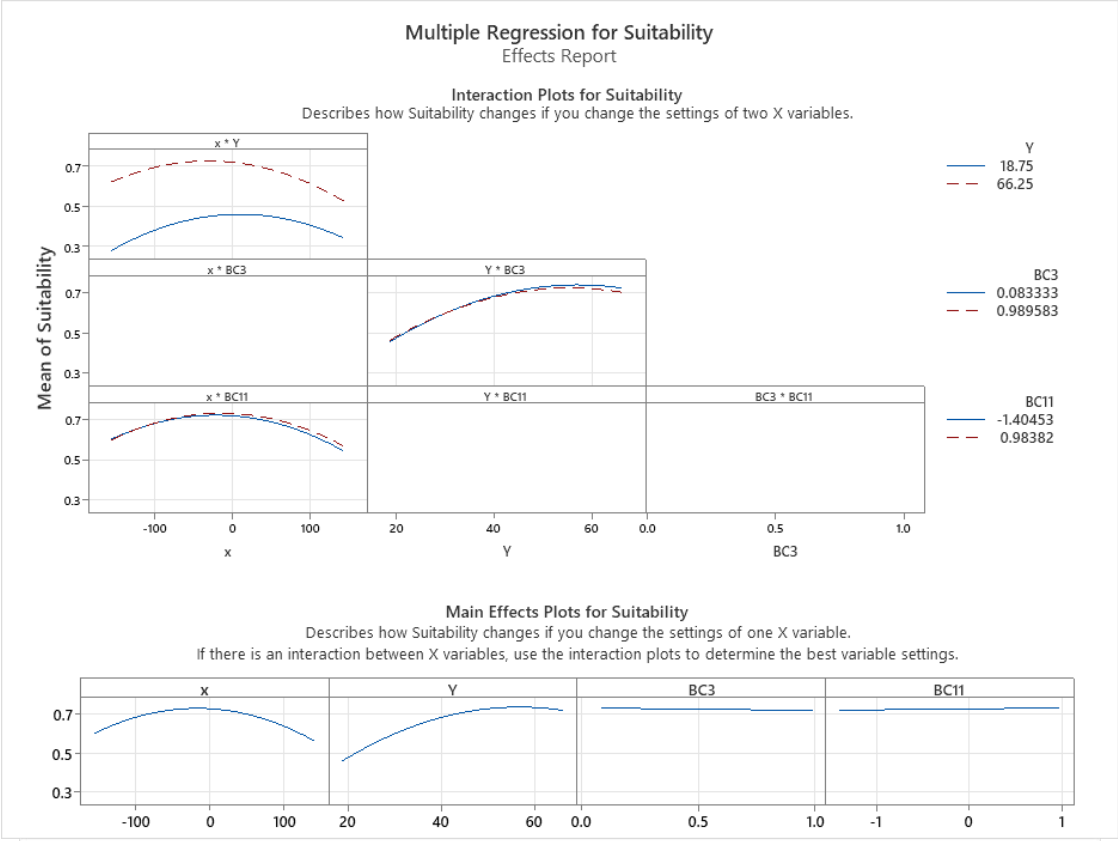


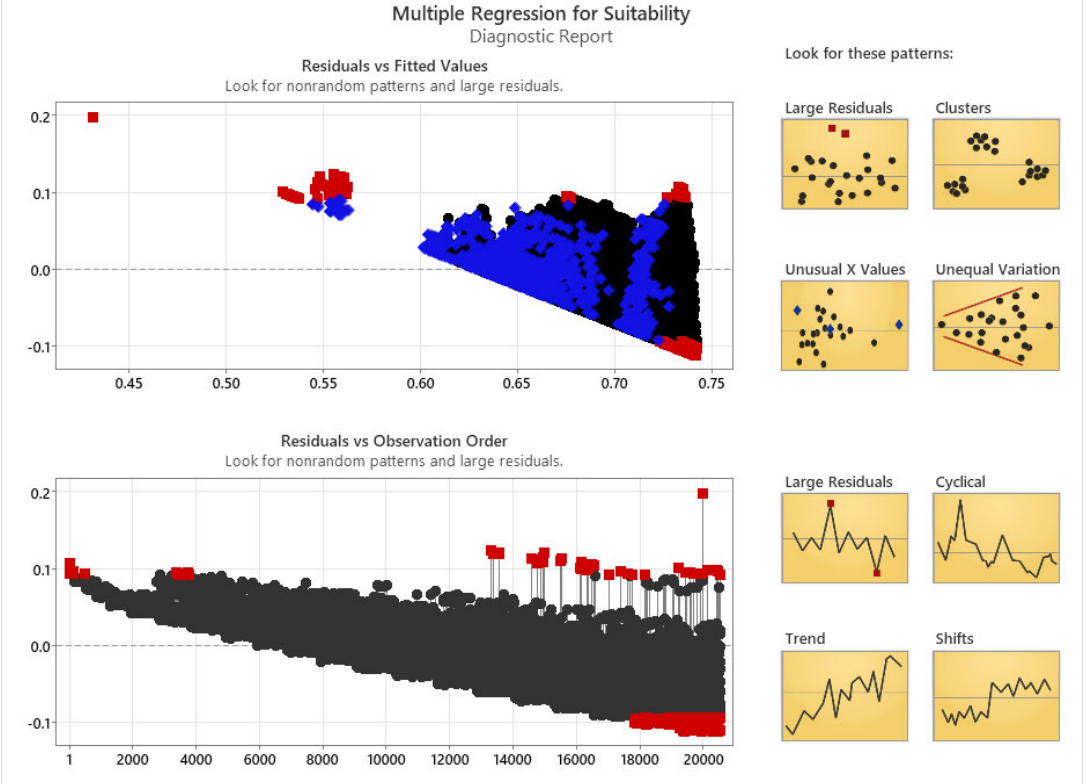
BC-8	Mean Temperature of Wettest Quarter	10	°C
BC-9	Mean Temperature of Driest Quarter	10	°C
BC-10	Mean Temperature of Warmest Quarter	10	°C
BC-11	Mean Temperature of Coldest Quarter	10	°C

2070RCP60.CSV

Multiple Regression for Suitability




Multiple Regression for Suitability
Effects Report
Interaction Plots for Suitability
Describes how Suitability changes if you change the settings of two X variables.
x * Y
x * BC3
Y * BC3
x * BC11
Y * BC11
BC3 * BC11
Mean of Suitability
Y
18.75
66.25
BC3
0.083333
0.989583
BC11
-1.40453
0.98382
x
Y
BC3
Main Effects Plots for Suitability
Describes how Suitability changes if you change the settings of one X variable.
If there is an interaction between X variables, use the interaction plots to determine the best variable settings.
x
Y
BC3
BC11


Multiple Regression for Suitability
Diagnostic Report
Residuals vs Fitted Values
Look for nonrandom patterns and large residuals.
Look for these patterns:
Large Residuals
Clusters
Unusual X Values
Unequal Variation
Residuals vs Observation Order
Look for nonrandom patterns and large residuals.
Large Residuals
Cyclical
Trend
Shifts

Multiple Regression for Suitability

Model Building Report

X1: x X2: Y X3: BC3 X4: BC11 X5: BC13

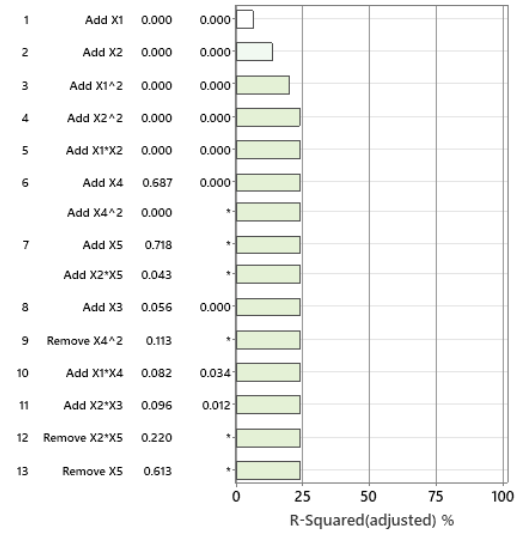
Final Model Equation

Suitability = 0.1113 + 0.000328 X1 + 0.022045 X2 + 0.0204 X3 + 0.00463 X4 - 0.000007 X1^2 - 0.000192 X2^2 - 0.000011 X1*X2 + 0.000041 X1*X4 - 0.000670 X2*X3

Model Building Sequence

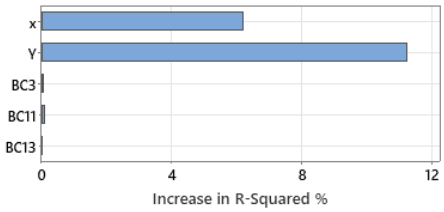
Displays the order in which terms were added or removed.

Step	Change	Step P	Final P
1	Add X1	0.000	0.000
2	Add X2	0.000	0.000
3	Add X1^2	0.000	0.000
4	Add X2^2	0.000	0.000
5	Add X1*X2	0.000	0.000
6	Add X4	0.687	0.000
	Add X4^2	0.000	*
7	Add X5	0.718	*
	Add X2*X5	0.043	*
8	Add X3	0.056	0.000
9	Remove X4^2	0.113	*
10	Add X1*X4	0.082	0.034
11	Add X2*X3	0.096	0.012
12	Remove X2*X5	0.220	*
13	Remove X5	0.613	*



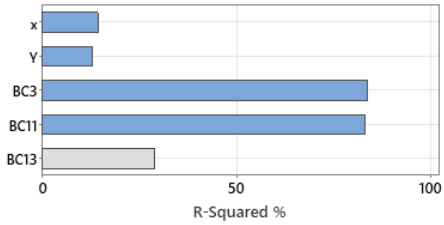
Incremental Impact of X Variables

Long bars represent Xs that contribute the most new information to the model.



Each X Regressed on All Other Terms

Gray bars represent Xs that do not help explain additional variation in Y.



A gray bar represents an X variable not in the model.

Multiple Regression for Suitability

Prediction and Optimization Report

Goal: Maximize Suitability

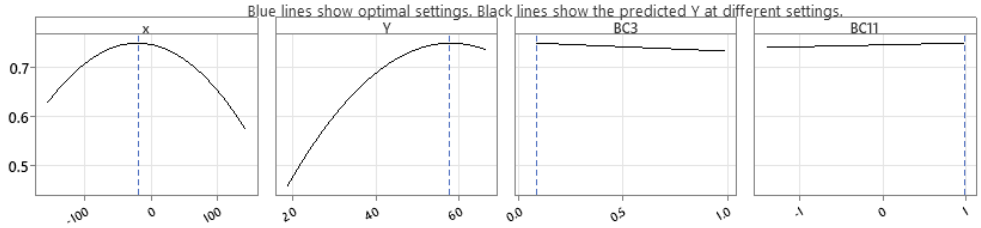
Predicted Y	0.749692
95% PI	(0.65871, 0.84067)

Solution: Optimal Settings

X1: x	-20.0682	X3: BC3	0.0833333
X2: Y	57.6136	X4: BC11	0.983819

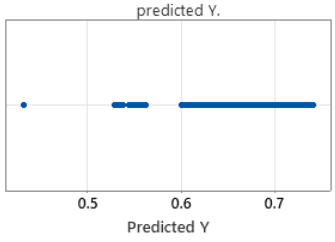
Settings and Sensitivity for Optimal Solution

Blue lines show optimal settings. Black lines show the predicted Y at different settings.



Predicted Y for All Sample Points

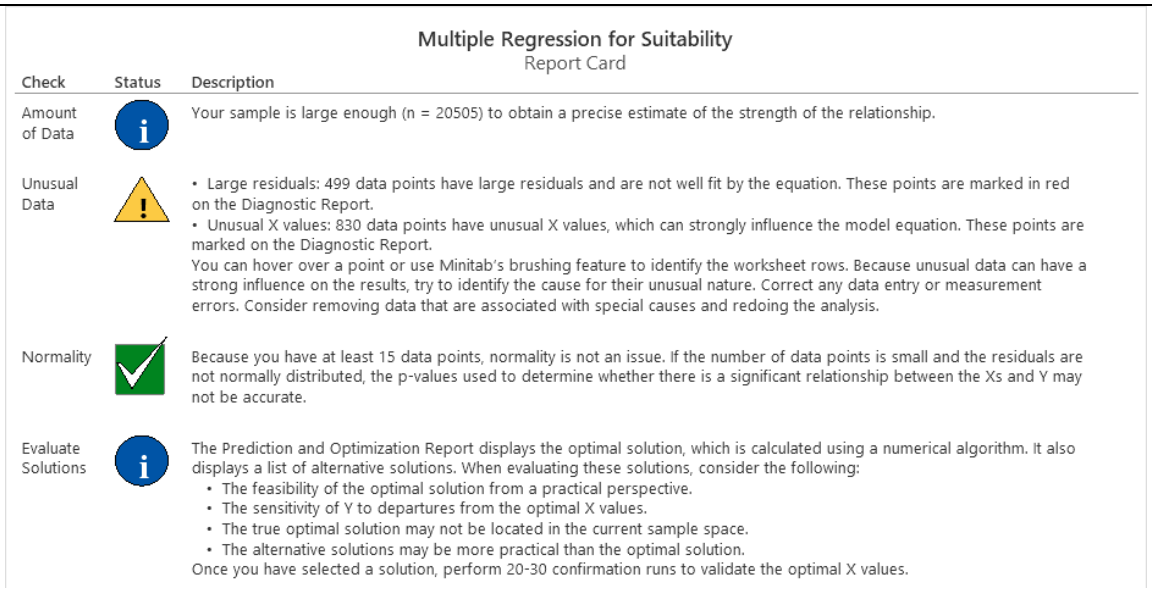
Use brushing to see the X values for any predicted Y.



Top Five Alternative Solutions

Sample points with predicted Y values closest to the optimal solution. Evaluate these and the optimal solution to determine if any are adequate.

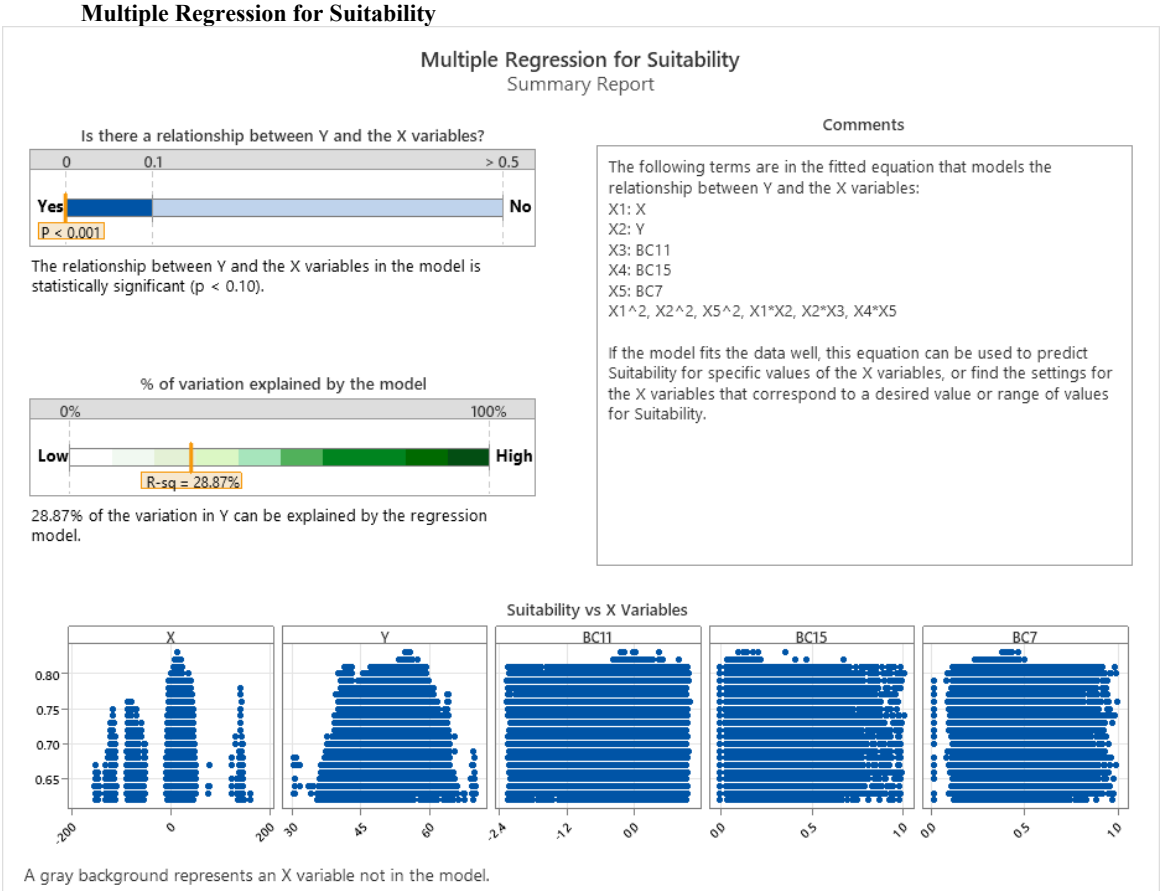
X1	X2	X3	X4	Predicted Y
-5.58	56.75	0.229167	0.116505	0.741727
-3.92	56.42	0.28125	0.411003	0.741675
-5.08	56.92	0.21875	0.0776699	0.741645
-6.25	55.58	0.25	0.174757	0.741329
-3.92	57.08	0.239583	0.113269	0.741156

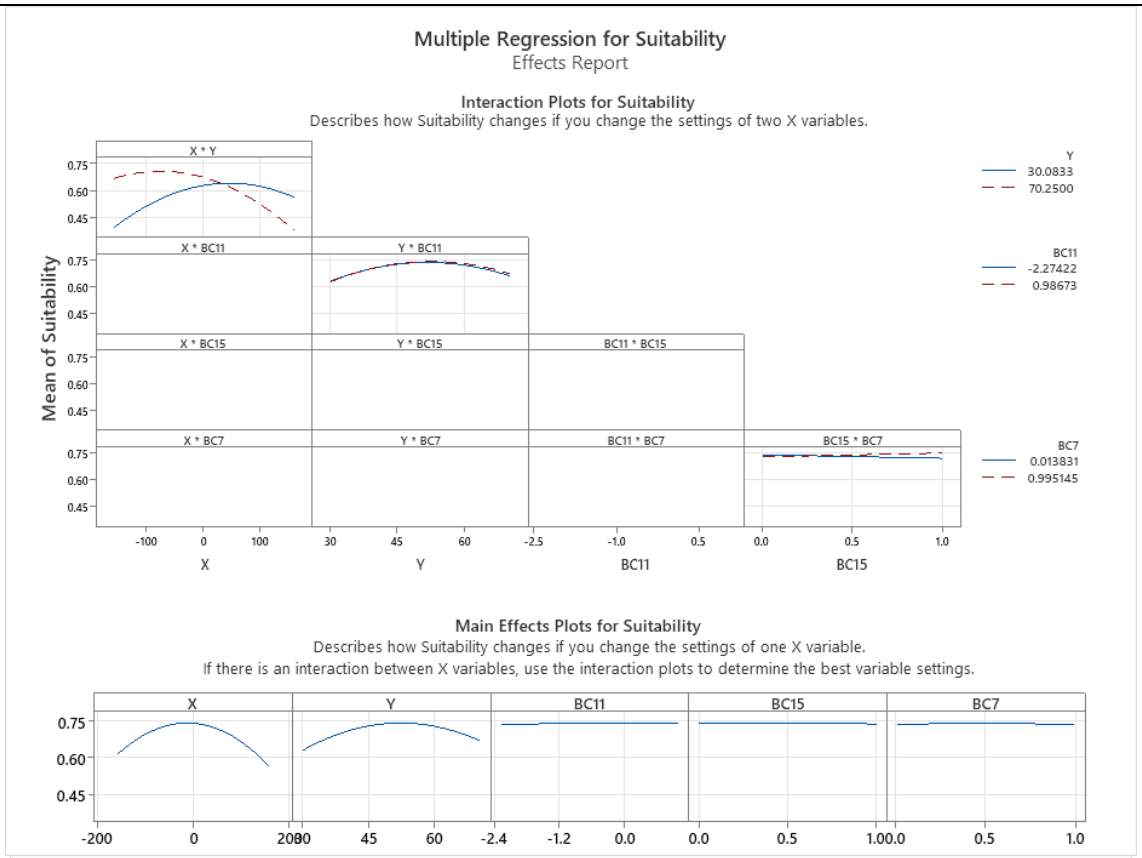


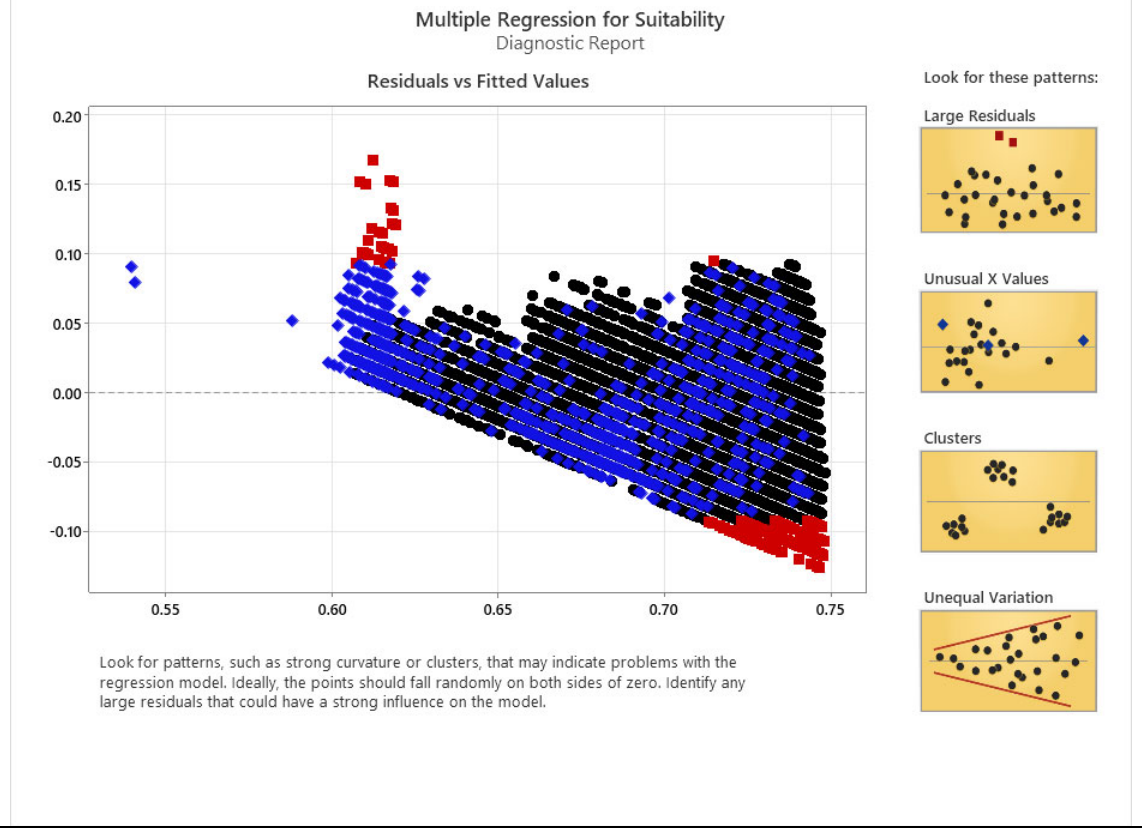
BC-12	Annual Precipitation	1	mm
BC-13	Precipitation of Wettest Month	1	mm
BC-14	Precipitation of Driest Month	100	mm
BC-15	Precipitation Seasonality (Coefficient of Variation)	1	Percent

CURRENTENSEBLEVZ.CSV

Multiple Regression for Suitability




Multiple Regression for Suitability
Effects Report
Interaction Plots for Suitability
Describes how Suitability changes if you change the settings of two X variables.
X * Y
X * BC11
Y * BC11
X * BC15
Y * BC15
BC11 * BC15
X * BC7
Y * BC7
BC11 * BC7
BC15 * BC7
Mean of Suitability
X
Y
BC11
BC15
Y
30.0833
70.2500
BC11
-2.27422
0.98673
BC7
0.013831
0.995145
Main Effects Plots for Suitability
Describes how Suitability changes if you change the settings of one X variable.
If there is an interaction between X variables, use the interaction plots to determine the best variable settings.
X
Y
BC11
BC15
BC7


Multiple Regression for Suitability
Diagnostic Report
Residuals vs Fitted Values
Look for these patterns:
Large Residuals
Unusual X Values
Clusters
Unequal Variation
Look for patterns, such as strong curvature or clusters, that may indicate problems with the regression model. Ideally, the points should fall randomly on both sides of zero. Identify any large residuals that could have a strong influence on the model.

Multiple Regression for Suitability

Model Building Report

X1: X X2: Y X3: BC11 X4: BC15 X5: BC7

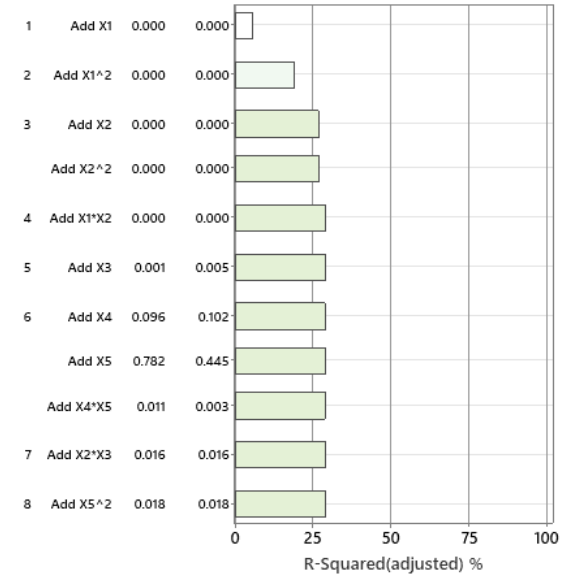
Final Model Equation

Suitability = 0.1140 + 0.001645 X1 + 0.023911 X2 - 0.00508 X3 - 0.02082 X4 + 0.00911 X5 - 0.000006 X1^2 - 0.000227 X2^2 - 0.02070 X5^2 - 0.000036 X1*X2 + 0.000130 X2*X3 + 0.0420 X4*X5

Model Building Sequence

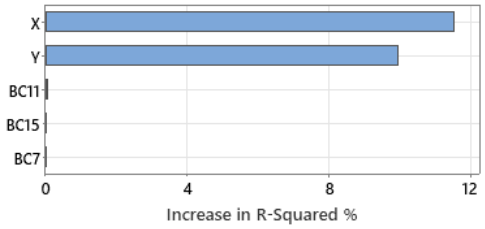
Displays the order in which terms were added or removed.

Step	Change	Step P	Final P
1	Add X1	0.000	0.000
2	Add X1^2	0.000	0.000
3	Add X2	0.000	0.000
	Add X2^2	0.000	0.000
4	Add X1*X2	0.000	0.000
5	Add X3	0.001	0.005
6	Add X4	0.096	0.102
	Add X5	0.782	0.445
	Add X4*X5	0.011	0.003
7	Add X2*X3	0.016	0.016
8	Add X5^2	0.018	0.018



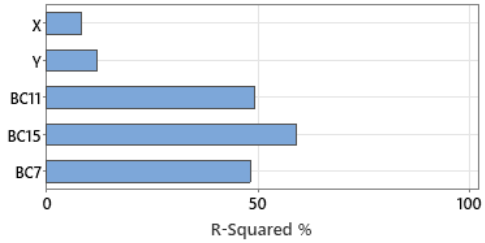
Incremental Impact of X Variables

Long bars represent Xs that contribute the most new information to the model.



Each X Regressed on All Other Terms

Gray bars represent Xs that do not help explain additional variation in Y.



A gray bar represents an X variable not in the model.

Multiple Regression for Suitability

Prediction and Optimization Report

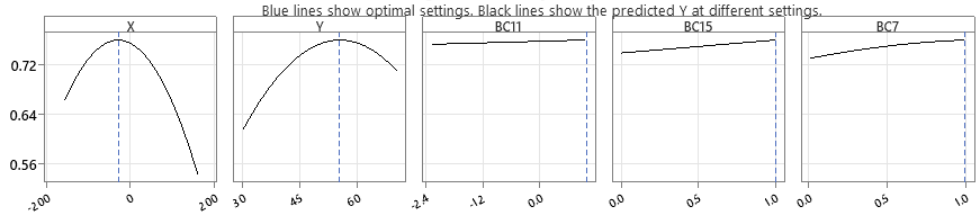
Goal: Maximize Suitability

Solution: Optimal Settings

Predicted Y	0.760418	X1: X	-28.4386	X4: BC15	1
95% PI	(0.66857, 0.85226)	X2: Y	55.2382	X5: BC7	0.995145
		X3: BC11	0.986733		

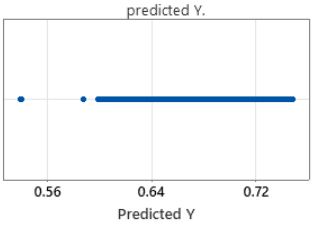
Settings and Sensitivity for Optimal Solution

Blue lines show optimal settings. Black lines show the predicted Y at different settings.



Predicted Y for All Sample Points

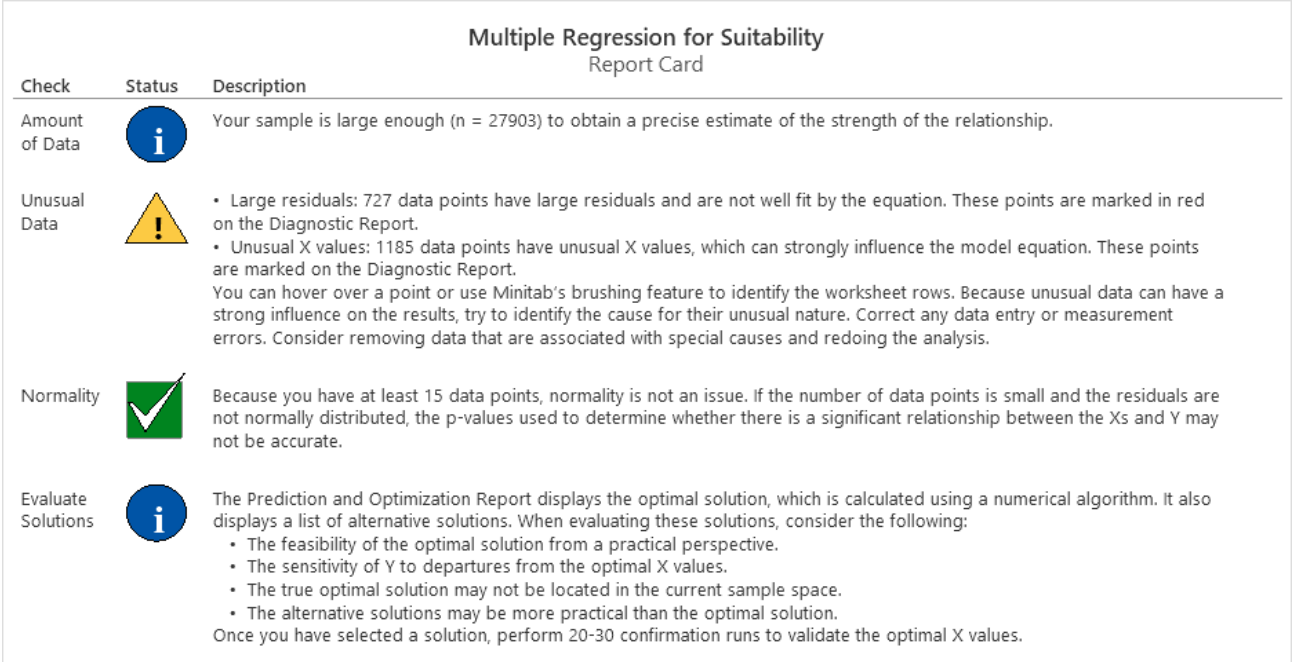
Use brushing to see the X values for any predicted Y.



Top Five Alternative Solutions

Sample points with predicted Y values closest to the optimal solution. Evaluate these and the optimal solution to determine if any are adequate.

X1	X2	X3	X4	X5	Predicted Y
-7.08333	53.4167	0.867352	0.0671370	0.140660	0.748132
-8.75	53.0833	0.420694	0.0872346	0.390814	0.747705
-9.25	53.75	0.482608	0.413247	0.546332	0.747630
-8.41667	53.4167	0.133890	0.0524399	0.307821	0.747570
-7.75	52.9167	0.133890	0.0524399	0.307821	0.747381



Multiple Regression for Suitability

Report Card

Check	Status	Description
Amount of Data		Your sample is large enough (n = 27903) to obtain a precise estimate of the strength of the relationship.
Unusual Data		• Large residuals: 727 data points have large residuals and are not well fit by the equation. These points are marked in red on the Diagnostic Report. • Unusual X values: 1185 data points have unusual X values, which can strongly influence the model equation. These points are marked on the Diagnostic Report. You can hover over a point or use Minitab's brushing feature to identify the worksheet rows. Because unusual data can have a strong influence on the results, try to identify the cause for their unusual nature. Correct any data entry or measurement errors. Consider removing data that are associated with special causes and redoing the analysis.
Normality		Because you have at least 15 data points, normality is not an issue. If the number of data points is small and the residuals are not normally distributed, the p-values used to determine whether there is a significant relationship between the Xs and Y may not be accurate.
Evaluate Solutions		The Prediction and Optimization Report displays the optimal solution, which is calculated using a numerical algorithm. It also displays a list of alternative solutions. When evaluating these solutions, consider the following: • The feasibility of the optimal solution from a practical perspective. • The sensitivity of Y to departures from the optimal X values. • The true optimal solution may not be located in the current sample space. • The alternative solutions may be more practical than the optimal solution. Once you have selected a solution, perform 20-30 confirmation runs to validate the optimal X values.

BC-16	Precipitation of Wettest Quarter	1	mm
BC-17	Precipitation of Driest Quarter	1	mm
BC-18	Precipitation of Warmest Quarter	1	mm
BC-19	Precipitation of Coldest Quarter	1	mm

Supplementary Table 2 —.Outputs of multi-collinearity tests conducted for different climatic data-sets. √ = use for analysis and x remove from analysis as they have significant correlation with other variables

Variables		2050				2070			
	Current	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
BC-1	x	√	x	x	x	x	x	x	x
BC-3	x	x	√	√	√	√	√	√	√
BC-4	x	√	x	x	x	x	x	x	x
BC-5	√	x	√	√	√	√	√	x	√
BC-6	√	x	√	√	√	x	x	√	x
BC-7	√	√	x	x	x	√	√	x	x
BC-8	x	√	√	√	√	√	√	√	x
BC-9	x	x	√	√	√	√	x	√	x
BC-10	x	x	x	x	√	x	x	√	x
BC-11	√	x	x	x	x	x	x	√	x
BC-12	√	√	√	x	x	x	x	x	x
BC-13	√	x	x	x	x	x	√	√	x
BC-14	x	√	√	√	x	√	x	√	√
BC-15	√	x	x	x	√	√	√	√	√
BC-16	x	√	√	√	√	√	x	x	√
BC-17	x	√	√	√	√	x	x	x	x
BC-18	x	√	√	√	√	√	√	√	√

BC-2 and BC-19 were excluded from all analysis; x =eliminated variables due to their significant co-linearity with other variables

Supplementary Table 3 — Habitat suitability model evaluation parameters with different individual algorithm and ensemble approach calculated with current bio-climatic conditions and with non-bioclimatic variables

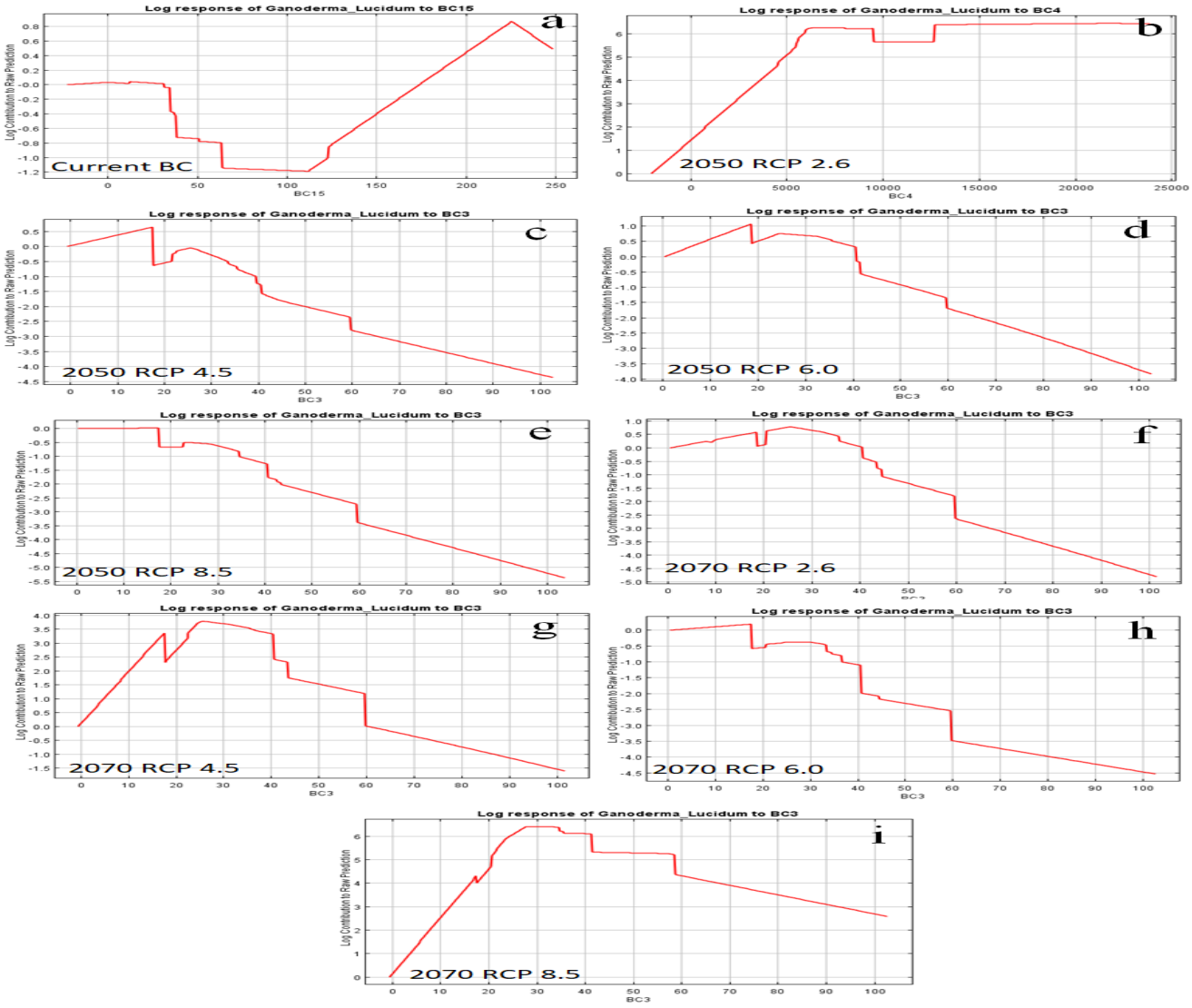
Ecosystem Rooting Depth (95%), Current Bio-climatic, Pasture and Croplands and Total plant available water storage capacity of the rooting zone and Soil	AUC	Sensitivity	Specificity	Kappa	TSS
GLM	0.86	0.86	0.87	0.72	0.73
GAM	0.89	0.88	0.89	0.77	0.78
MARS	0.88	0.89	0.87	0.75	0.76
CTA	0.85	0.86	0.84	0.69	0.70
RF	0.89	0.88	0.91	0.77	0.79
MAXENT	0.88	0.89	0.88	0.45	0.77
ANN	0.85	0.88	0.82	0.70	0.70
SVM	0.89	0.87	0.90	0.76	0.77
Ensemble	0.87	0.88	0.87	0.76	0.75

Supplementary Table 4 — Habitat suitability model evaluation parameters with different individual algorithm and ensemble approach calculated with projected 2050 bio-climatic prediction with different RCPs

Algorithms	AUC	Sensitivity	Specificity	Kappa	TSS
		2050 RCP 2.6			
GLM	0.84	0.82	0.85	0.66	0.67
GAM	0.88	0.89	0.88	0.75	0.76
MARS	0.88	0.88	0.88	0.75	0.76
CTA	0.86	0.85	0.87	0.73	0.73
RF	0.90	0.90	0.90	0.80	0.80
MAXENT	0.89	0.89	0.88	0.40	0.77
ANN	0.88	0.88	0.87	0.75	0.75
SVM	0.88	0.87	0.89	0.76	0.76
Ensemble	0.88	0.87	0.88	0.77	0.75
		2050 RCP 4.5			
GLM	0.85	0.85	0.85	0.68	0.70
GAM	0.89	0.89	0.89	0.76	0.78
MARS	0.88	0.87	0.88	0.74	0.75
CTA	0.88	0.89	0.87	0.76	0.76
RF	0.89	0.90	0.89	0.79	0.79
MAXENT	0.89	0.88	0.89	0.43	0.77
ANN	0.88	0.89	0.87	0.76	0.76
SVM	0.89	0.88	0.91	0.78	0.78
Ensemble	0.88	0.88	0.88	0.75	0.76
		2050 RCP 6.0			
GLM	0.85	0.86	0.84	0.68	0.71
GAM	0.88	0.88	0.88	0.75	0.77
MARS	0.88	0.88	0.88	0.74	0.75
CTA	0.86	0.85	0.87	0.72	0.72
RF	0.91	0.91	0.90	0.81	0.81
MAXENT	0.89	0.88	0.90	0.44	0.78
ANN	0.87	0.87	0.88	0.74	0.74
SVM	0.88	0.87	0.89	0.76	0.76
Ensemble	0.88	0.88	0.88	0.75	0.76
		2050 RCP 8.5			
GLM	0.86	0.86	0.85	0.70	0.72
GAM	0.89	0.89	0.89	0.77	0.78
MARS	0.88	0.88	0.88	0.75	0.77
CTA	0.88	0.87	0.89	0.75	0.75
RF	0.91	0.91	0.92	0.83	0.83
MAXENT	0.89	0.90	0.89	0.42	0.78
ANN	0.87	0.87	0.87	0.75	0.75
SVM	0.89	0.88	0.90	0.78	0.78
Ensemble	0.88	0.88	0.89	0.75	0.77

Supplementary Table 5 — Habitat suitability model evaluation parameters with different individual algorithm and ensemble approach calculated with projected 2070 bio-climatic prediction with different RCPs

Algorithms	AUC	Sensitivity	Specificity	Kappa	TSS
		2070 RCP 2.6			
GLM	0.85	0.87	0.84	0.69	0.71
GAM	0.88	0.89	0.88	0.75	0.77
MARS	0.88	0.88	0.89	0.75	0.77
CTA	0.86	0.86	0.86	0.72	0.72
RF	0.91	0.91	0.90	0.81	0.81
MAXENT	0.89	0.90	0.88	0.41	0.78
ANN	0.87	0.87	0.88	0.75	0.75
SVM	0.88	0.88	0.88	0.76	0.76
Ensemble	0.88	0.88	0.88	0.75	0.76
		2070 RCP 4.5			
GLM	0.84	0.86	0.83	0.66	0.69
GAM	0.88	0.87	0.88	0.74	0.75
MARS	0.89	0.88	0.89	0.76	0.77
CTA	0.87	0.87	0.88	0.75	0.75
RF	0.90	0.90	0.90	0.80	0.80
MAXENT	0.89	0.89	0.89	0.43	0.79
ANN	0.86	0.88	0.85	0.73	0.73
SVM	0.88	0.86	0.90	0.76	0.76
Ensemble	0.88	0.88	0.88	0.75	0.76
		2070 RCP 6.0			
GLM	0.86	0.87	0.84	0.69	0.71
GAM	0.89	0.90	0.87	0.75	0.77
MARS	0.88	0.89	0.87	0.74	0.76
CTA	0.88	0.86	0.89	0.75	0.75
RF	0.91	0.91	0.90	0.81	0.81
MAXENT	0.89	0.89	0.90	0.44	0.78
ANN	0.87	0.86	0.88	0.73	0.73
SVM	0.89	0.87	0.90	0.77	0.77
Ensemble	0.88	0.88	0.88	0.77	0.76
		2070 RCP 8.5			
GLM	0.81	0.84	0.78	0.58	0.61
GAM	0.88	0.89	0.87	0.74	0.76
MARS	0.88	0.89	0.87	0.74	0.76
CTA	0.86	0.85	0.87	0.73	0.73
RF	0.91	0.89	0.90	0.79	0.79
MAXENT	0.88	0.88	0.88	0.39	0.76
ANN	0.87	0.88	0.87	0.74	0.74
SVM	0.86	0.85	0.87	0.72	0.72
Ensemble	0.87	0.87	0.86	0.75	0.76



Supplementary Figure 1 — ROC Curves of different dominate bio-climatic variable during two climatic-timeframes and four RCPs. (a): current bio-climatic timeframe, Precipitation Seasonality; (b): 2050 RCP -2.6 Temperature Seasonality; (c): 2050 RCP-4.5; (d) 2050 RCP 6.0; (e): 2050 RCP- 8.5; (f) 2070 RCP-2.6; (g): 2070 RCP-4.5; (h): 2070 RCP – 6.0 and (i) 2070 RCP-8.5 are showing trends of habitat suitability of *G. lucidum* with Isothermality