

Full-MultiReg-models_Fueltraits.R

samsp

2022-05-17

```
#Msweli et al_ms R1_20220510

setwd("C:/Users/samsp/Documents/1_to be published/Fueltraits/Msweli_Fueltraits paper/Fuel tra
its manuscript/")

library(readxl)
FueltraitsDataset <- read_excel("CompleteFlammability datasets_Msweli_ST - Copy.xlsx", sheet
 = "FuelTraits_Dataset")
View(FueltraitsDataset)

library(Matrix)
library(lme4)

library(car)
library(effects)

library(ggplot2)

library(knitr)
library(rmarkdown)

##STEPWISE MULTIREG MODELS

#1. Run stepwise Multiple Linear Regression -lm() Function - model for each flammability vari
able

maximumtemperatureRegM <- lm(scale(AverageMaximumTemperature) ~
                             scale(AverageFineFuels) + scale(AverageCoarseFuels) + scale(Av
erageDeadFuel)+
                             scale(AverageFBP) + scale(AverageDryBiomass) + scale(AverageFu
elMoisture),
                             data = FueltraitsDataset)
summary(maximumtemperatureRegM)
```

```
##
## Call:
## lm(formula = scale(AverageMaximumTemperature) ~ scale(AverageFineFuels) +
##     scale(AverageCoarseFuels) + scale(AverageDeadFuel) + scale(AverageFBP) +
##     scale(AverageDryBiomass) + scale(AverageFuelMoisture), data = FueltraitsDataset)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.56828 -0.23074  0.00387  0.36478  1.41254
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -2.947e-17  1.296e-01   0.000  1.00000
## scale(AverageFineFuels) -3.490e-02  1.860e-01  -0.188  0.85279
## scale(AverageCoarseFuels) -1.879e-01  2.557e-01  -0.735  0.46985
## scale(AverageDeadFuel)   8.095e-02  1.702e-01   0.476  0.63885
## scale(AverageFBP)       1.969e-01  1.763e-01   1.117  0.27562
## scale(AverageDryBiomass)  7.083e-01  1.910e-01   3.708  0.00116 **
## scale(AverageFuelMoisture) -4.038e-01  1.625e-01  -2.485  0.02068 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.7097 on 23 degrees of freedom
## Multiple R-squared:  0.6005, Adjusted R-squared:  0.4963
## F-statistic: 5.762 on 6 and 23 DF,  p-value: 0.0008845
```

```
step(maximumtemperatureRegM, direction = "backward")
```

```

## Start: AIC=-14.54
## scale(AverageMaximumTemperature) ~ scale(AverageFineFuels) +
##   scale(AverageCoarseFuels) + scale(AverageDeadFuel) + scale(AverageFBP) +
##   scale(AverageDryBiomass) + scale(AverageFuelMoisture)
##
##           Df Sum of Sq   RSS   AIC
## - scale(AverageFineFuels)    1    0.0177 11.603 -16.4973
## - scale(AverageDeadFuel)     1    0.1139 11.700 -16.2496
## - scale(AverageCoarseFuels)  1    0.2720 11.858 -15.8469
## - scale(AverageFBP)          1    0.6282 12.214 -14.9590
## <none>                        11.585 -14.5432
## - scale(AverageFuelMoisture) 1    3.1098 14.695  -9.4100
## - scale(AverageDryBiomass)   1    6.9240 18.509  -2.4874
##
## Step: AIC=-16.5
## scale(AverageMaximumTemperature) ~ scale(AverageCoarseFuels) +
##   scale(AverageDeadFuel) + scale(AverageFBP) + scale(AverageDryBiomass) +
##   scale(AverageFuelMoisture)
##
##           Df Sum of Sq   RSS   AIC
## - scale(AverageDeadFuel)     1    0.1126 11.716 -18.2076
## - scale(AverageCoarseFuels)  1    0.2545 11.858 -17.8465
## - scale(AverageFBP)          1    0.6123 12.216 -16.9544
## <none>                        11.603 -16.4973
## - scale(AverageFuelMoisture) 1    3.1892 14.793 -11.2124
## - scale(AverageDryBiomass)   1    7.4841 19.087  -3.5651
##
## Step: AIC=-18.21
## scale(AverageMaximumTemperature) ~ scale(AverageCoarseFuels) +
##   scale(AverageFBP) + scale(AverageDryBiomass) + scale(AverageFuelMoisture)
##
##           Df Sum of Sq   RSS   AIC
## - scale(AverageFBP)          1    0.5254 12.241 -18.8915
## - scale(AverageCoarseFuels)  1    0.6493 12.365 -18.5894
## <none>                        11.716 -18.2076
## - scale(AverageFuelMoisture) 1    3.0968 14.813 -13.1715
## - scale(AverageDryBiomass)   1    7.4689 19.185  -5.4125
##
## Step: AIC=-18.89
## scale(AverageMaximumTemperature) ~ scale(AverageCoarseFuels) +
##   scale(AverageDryBiomass) + scale(AverageFuelMoisture)
##
##           Df Sum of Sq   RSS   AIC
## <none>                        12.241 -18.8915
## - scale(AverageCoarseFuels)  1    1.4268 13.668 -17.5840
## - scale(AverageFuelMoisture) 1    2.7869 15.028 -14.7380
## - scale(AverageDryBiomass)   1    6.9701 19.211  -7.3709

```

```
##
## Call:
## lm(formula = scale(AverageMaximumTemperature) ~ scale(AverageCoarseFuels) +
##     scale(AverageDryBiomass) + scale(AverageFuelMoisture), data = FueltraitsDataset)
##
## Coefficients:
##             (Intercept)  scale(AverageCoarseFuels)  scale(AverageDryBiomass)
##             -2.447e-17                -3.209e-01                6.765e-01
## scale(AverageFuelMoisture)
##             -3.640e-01
```

```
COBRegM <- lm(scale(AverageCompletenessOfBurn) ~
              scale(AverageFineFuels) + scale(AverageCoarseFuels) + scale(AverageDeadFuel)+
              scale(AverageFBP) + scale(AverageDryBiomass) + scale(AverageFuelMoisture),
              data = FueltraitsDataset)
summary(COBRegM)
```

```
##
## Call:
## lm(formula = scale(AverageCompletenessOfBurn) ~ scale(AverageFineFuels) +
##     scale(AverageCoarseFuels) + scale(AverageDeadFuel) + scale(AverageFBP) +
##     scale(AverageDryBiomass) + scale(AverageFuelMoisture), data = FueltraitsDataset)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.70281 -0.49944  0.07098  0.58951  1.32703
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -9.183e-16  1.579e-01  0.000  1.0000
## scale(AverageFineFuels)  3.590e-01  2.266e-01  1.584  0.1269
## scale(AverageCoarseFuels) -2.185e-01  3.117e-01 -0.701  0.4902
## scale(AverageDeadFuel)  -1.598e-01  2.074e-01 -0.771  0.4488
## scale(AverageFBP)       1.835e-01  2.148e-01  0.854  0.4018
## scale(AverageDryBiomass)  4.965e-01  2.328e-01  2.132  0.0439 *
## scale(AverageFuelMoisture) -2.348e-01  1.980e-01 -1.186  0.2479
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.8649 on 23 degrees of freedom
## Multiple R-squared:  0.4067, Adjusted R-squared:  0.252
## F-statistic: 2.628 on 6 and 23 DF,  p-value: 0.04337
```

```
step(COBRegM, direction = "backward")
```

```

## Start: AIC=-2.68
## scale(AverageCompletenessOfBurn) ~ scale(AverageFineFuels) +
##   scale(AverageCoarseFuels) + scale(AverageDeadFuel) + scale(AverageFBP) +
##   scale(AverageDryBiomass) + scale(AverageFuelMoisture)
##
##           Df Sum of Sq   RSS   AIC
## - scale(AverageCoarseFuels)  1    0.3678 17.573 -4.0454
## - scale(AverageDeadFuel)     1    0.4441 17.649 -3.9154
## - scale(AverageFBP)          1    0.5459 17.751 -3.7428
## - scale(AverageFuelMoisture) 1    1.0516 18.256 -2.9003
## <none>                       17.205 -2.6800
## - scale(AverageFineFuels)    1    1.8765 19.081 -1.5744
## - scale(AverageDryBiomass)   1    3.4017 20.607  0.7325
##
## Step: AIC=-4.05
## scale(AverageCompletenessOfBurn) ~ scale(AverageFineFuels) +
##   scale(AverageDeadFuel) + scale(AverageFBP) + scale(AverageDryBiomass) +
##   scale(AverageFuelMoisture)
##
##           Df Sum of Sq   RSS   AIC
## - scale(AverageDeadFuel)     1    0.17392 17.747 -5.7499
## - scale(AverageFBP)          1    1.14236 18.715 -4.1559
## <none>                       17.573 -4.0454
## - scale(AverageFuelMoisture) 1    1.89459 19.467 -2.9737
## - scale(AverageFineFuels)    1    2.57437 20.147 -1.9440
## - scale(AverageDryBiomass)   1    3.03554 20.608 -1.2651
##
## Step: AIC=-5.75
## scale(AverageCompletenessOfBurn) ~ scale(AverageFineFuels) +
##   scale(AverageFBP) + scale(AverageDryBiomass) + scale(AverageFuelMoisture)
##
##           Df Sum of Sq   RSS   AIC
## - scale(AverageFBP)          1    1.1762 18.923 -5.8247
## <none>                       17.747 -5.7499
## - scale(AverageFuelMoisture) 1    1.7893 19.536 -4.8682
## - scale(AverageFineFuels)    1    2.4136 20.160 -3.9245
## - scale(AverageDryBiomass)   1    3.5504 21.297 -2.2788
##
## Step: AIC=-5.82
## scale(AverageCompletenessOfBurn) ~ scale(AverageFineFuels) +
##   scale(AverageDryBiomass) + scale(AverageFuelMoisture)
##
##           Df Sum of Sq   RSS   AIC
## <none>                       18.923 -5.8247
## - scale(AverageFuelMoisture) 1    1.6594 20.582 -5.3029
## - scale(AverageDryBiomass)   1    2.5612 21.484 -4.0164
## - scale(AverageFineFuels)    1    3.5784 22.501 -2.6286

```

```
##
## Call:
## lm(formula = scale(AverageCompletenessOfBurn) ~ scale(AverageFineFuels) +
##     scale(AverageDryBiomass) + scale(AverageFuelMoisture), data = FueltraitsDataset)
##
## Coefficients:
##             (Intercept)      scale(AverageFineFuels)  scale(AverageDryBiomass)
##             -8.967e-16                4.518e-01                3.666e-01
## scale(AverageFuelMoisture)
##             -2.690e-01
```

```
TimeToIgnitionRegM <- lm(scale(AverageTimeToIgnition) ~
                          scale(AverageFineFuels) + scale(AverageCoarseFuels) + scale(AverageDeadFuel)+
                          scale(AverageFBP) + scale(AverageDryBiomass) + scale(AverageFuelMoisture),
                          data = FueltraitsDataset)
summary(TimeToIgnitionRegM)
```

```
##
## Call:
## lm(formula = scale(AverageTimeToIgnition) ~ scale(AverageFineFuels) +
##     scale(AverageCoarseFuels) + scale(AverageDeadFuel) + scale(AverageFBP) +
##     scale(AverageDryBiomass) + scale(AverageFuelMoisture), data = FueltraitsDataset)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.85758 -0.51614 -0.01551  0.50059  2.23063
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -3.319e-17  1.671e-01  0.000    1.000
## scale(AverageFineFuels) -3.089e-01  2.398e-01 -1.288    0.211
## scale(AverageCoarseFuels)  1.834e-01  3.298e-01  0.556    0.584
## scale(AverageDeadFuel)    2.953e-01  2.195e-01  1.345    0.192
## scale(AverageFBP)         1.581e-01  2.273e-01  0.695    0.494
## scale(AverageDryBiomass)  1.725e-01  2.464e-01  0.700    0.491
## scale(AverageFuelMoisture) 3.166e-01  2.096e-01  1.511    0.144
##
## Residual standard error: 0.9153 on 23 degrees of freedom
## Multiple R-squared:  0.3356, Adjusted R-squared:  0.1623
## F-statistic: 1.936 on 6 and 23 DF,  p-value: 0.1176
```

```
step(TimeToIgnitionRegM, direction = "backward")
```

```

## Start: AIC=0.72
## scale(AverageTimeToIgnition) ~ scale(AverageFineFuels) + scale(AverageCoarseFuels) +
##   scale(AverageDeadFuel) + scale(AverageFBP) + scale(AverageDryBiomass) +
##   scale(AverageFuelMoisture)
##
##
##           Df Sum of Sq   RSS   AIC
## - scale(AverageCoarseFuels)  1  0.25907 19.527 -0.88169
## - scale(AverageFBP)          1  0.40514 19.673 -0.65813
## - scale(AverageDryBiomass)   1  0.41075 19.679 -0.64956
## <none>                       19.268  0.71763
## - scale(AverageFineFuels)    1  1.38972 20.658  0.80691
## - scale(AverageDeadFuel)     1  1.51611 20.784  0.98991
## - scale(AverageFuelMoisture) 1  1.91227 21.180  1.55634
##
## Step: AIC=-0.88
## scale(AverageTimeToIgnition) ~ scale(AverageFineFuels) + scale(AverageDeadFuel) +
##   scale(AverageFBP) + scale(AverageDryBiomass) + scale(AverageFuelMoisture)
##
##
##           Df Sum of Sq   RSS   AIC
## - scale(AverageFBP)          1  0.22366 19.751 -2.54004
## - scale(AverageDryBiomass)   1  0.76417 20.291 -1.73007
## - scale(AverageDeadFuel)     1  1.27434 20.802 -0.98514
## <none>                       19.527 -0.88169
## - scale(AverageFineFuels)    1  1.89612 21.423 -0.10154
## - scale(AverageFuelMoisture) 1  2.97053 22.498  1.36649
##
## Step: AIC=-2.54
## scale(AverageTimeToIgnition) ~ scale(AverageFineFuels) + scale(AverageDeadFuel) +
##   scale(AverageDryBiomass) + scale(AverageFuelMoisture)
##
##
##           Df Sum of Sq   RSS   AIC
## - scale(AverageDryBiomass)   1  0.56922 20.320 -3.6877
## - scale(AverageDeadFuel)     1  1.23775 20.989 -2.7165
## <none>                       19.751 -2.5400
## - scale(AverageFineFuels)    1  1.68783 21.439 -2.0800
## - scale(AverageFuelMoisture) 1  3.04566 22.797 -0.2377
##
## Step: AIC=-3.69
## scale(AverageTimeToIgnition) ~ scale(AverageFineFuels) + scale(AverageDeadFuel) +
##   scale(AverageFuelMoisture)
##
##
##           Df Sum of Sq   RSS   AIC
## - scale(AverageDeadFuel)     1  0.9339 21.254 -4.3395
## <none>                       20.320 -3.6877
## - scale(AverageFuelMoisture) 1  2.4913 22.811 -2.2182
## - scale(AverageFineFuels)    1  3.8132 24.133 -0.5282
##
## Step: AIC=-4.34
## scale(AverageTimeToIgnition) ~ scale(AverageFineFuels) + scale(AverageFuelMoisture)
##
##
##           Df Sum of Sq   RSS   AIC
## <none>                       21.254 -4.3395
## - scale(AverageFuelMoisture) 1  2.3872 23.641 -3.1462
## - scale(AverageFineFuels)    1  2.9586 24.213 -2.4297

```

```
##
## Call:
## lm(formula = scale(AverageTimeToIgnition) ~ scale(AverageFineFuels) +
##     scale(AverageFuelMoisture), data = FueltraitsDataset)
##
## Coefficients:
##             (Intercept)      scale(AverageFineFuels)  scale(AverageFuelMoisture)
##             -1.207e-18                -3.361e-01                3.019e-01
```

#1.2 run the MultiReg models with the lowest AIC

```
MaximumtemperatureMod <- lm(formula = scale(AverageMaximumTemperature) ~ scale(AverageCoarseFuels) +
                             scale(AverageDryBiomass) + scale(AverageFuelMoisture),
                             data = FueltraitsDataset)
summary(MaximumtemperatureMod)
```

```
##
## Call:
## lm(formula = scale(AverageMaximumTemperature) ~ scale(AverageCoarseFuels) +
##     scale(AverageDryBiomass) + scale(AverageFuelMoisture), data = FueltraitsDataset)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.69005 -0.29667 -0.02941  0.36152  1.20850
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -2.447e-17  1.253e-01   0.000  1.000000
## scale(AverageCoarseFuels) -3.209e-01  1.843e-01  -1.741  0.093535 .
## scale(AverageDryBiomass)   6.765e-01  1.758e-01   3.848  0.000695 ***
## scale(AverageFuelMoisture) -3.640e-01  1.496e-01  -2.433  0.022159 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.6862 on 26 degrees of freedom
## Multiple R-squared:  0.5779, Adjusted R-squared:  0.5292
## F-statistic: 11.86 on 3 and 26 DF, p-value: 4.406e-05
```

```
COBMod <- lm(formula = scale(AverageCompletenessOfBurn) ~ scale(AverageFineFuels) +
              scale(AverageDryBiomass) + scale(AverageFuelMoisture),
              data = FueltraitsDataset)
summary(COBMod)
```



```
##
## Call:
## lm(formula = scale(AverageCompletenessOfBurn) ~ scale(AverageFineFuels) +
##     scale(AverageDryBiomass) + scale(AverageFuelMoisture), data = FueltraitsDataset)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.76016 -0.53417  0.00984  0.60709  1.45938
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -8.967e-16  1.558e-01   0.000  1.0000
## scale(AverageFineFuels)  4.518e-01  2.037e-01  2.217  0.0355 *
## scale(AverageDryBiomass)  3.666e-01  1.954e-01  1.876  0.0719 .
## scale(AverageFuelMoisture) -2.690e-01  1.781e-01 -1.510  0.1431
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.8531 on 26 degrees of freedom
## Multiple R-squared:  0.3475, Adjusted R-squared:  0.2722
## F-statistic: 4.615 on 3 and 26 DF,  p-value: 0.0102
```

```
TimeToIgnitionMod <- lm(formula = scale(AverageTimeToIgnition) ~ scale(AverageFineFuels) + scale(AverageFuelMoisture),
                        data = FueltraitsDataset)
summary(TimeToIgnitionMod)
```

```
##
## Call:
## lm(formula = scale(AverageTimeToIgnition) ~ scale(AverageFineFuels) +
##     scale(AverageFuelMoisture), data = FueltraitsDataset)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.82846 -0.43221  0.02414  0.33697  1.96583
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -1.207e-18  1.620e-01   0.000  1.0000
## scale(AverageFineFuels) -3.361e-01  1.733e-01 -1.939  0.0631 .
## scale(AverageFuelMoisture)  3.019e-01  1.733e-01  1.741  0.0930 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.8872 on 27 degrees of freedom
## Multiple R-squared:  0.2671, Adjusted R-squared:  0.2128
## F-statistic: 4.92 on 2 and 27 DF,  p-value: 0.01507
```