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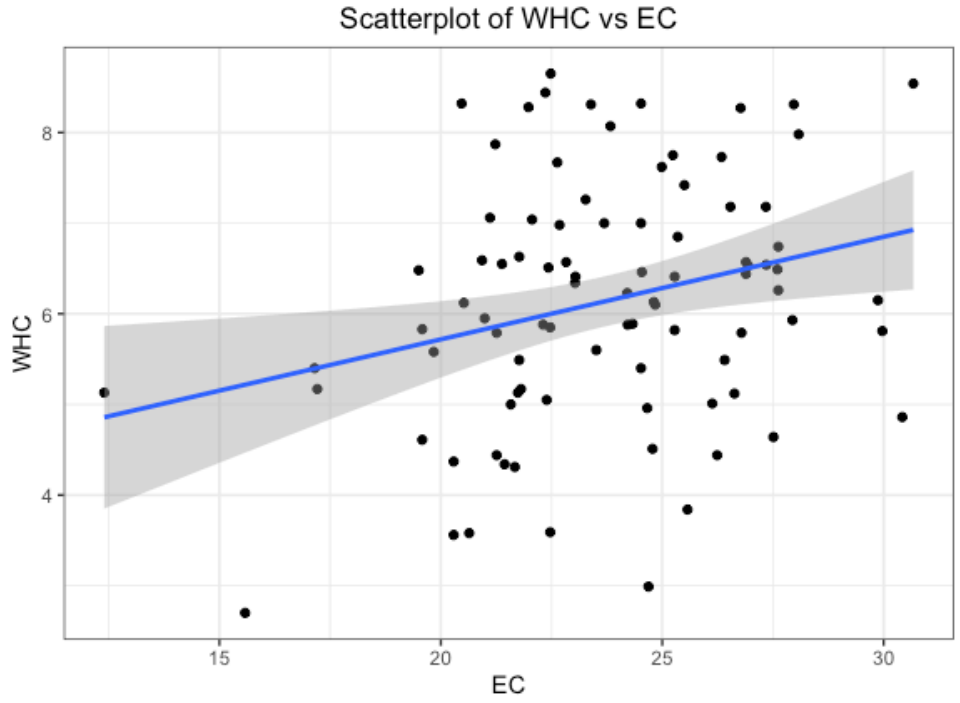
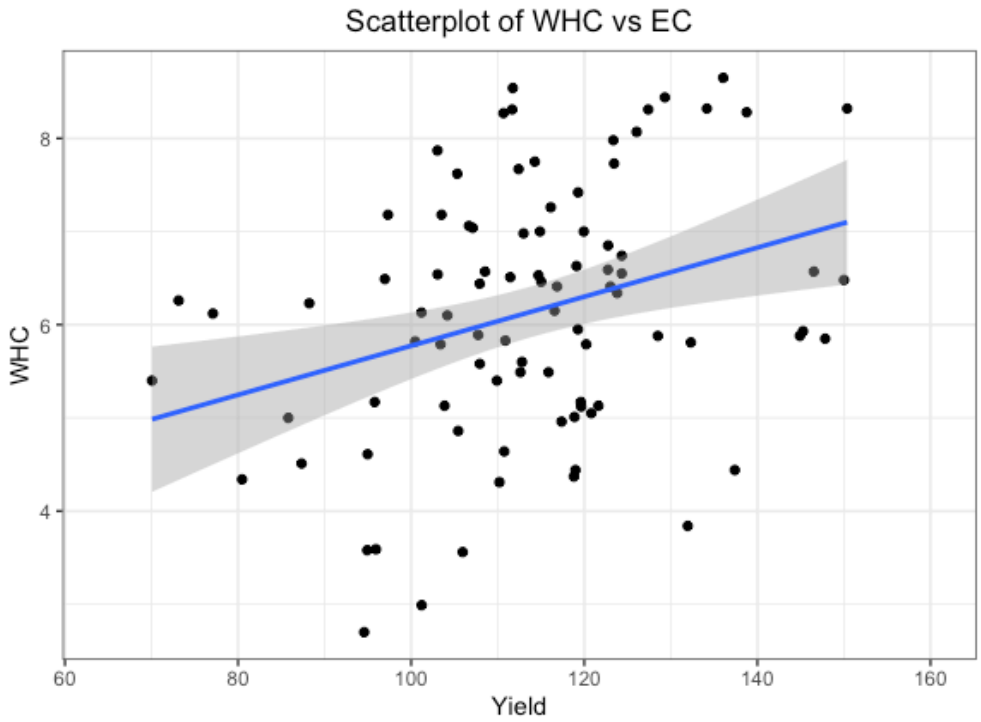
HW 5 – Irrigated Agriculture

1. The following are exploratory scatter plots of the Agriculture data. Yield is crop yield, EC is electroconductivity, and WHC is water holding content. All points are based upon different locations within a field.





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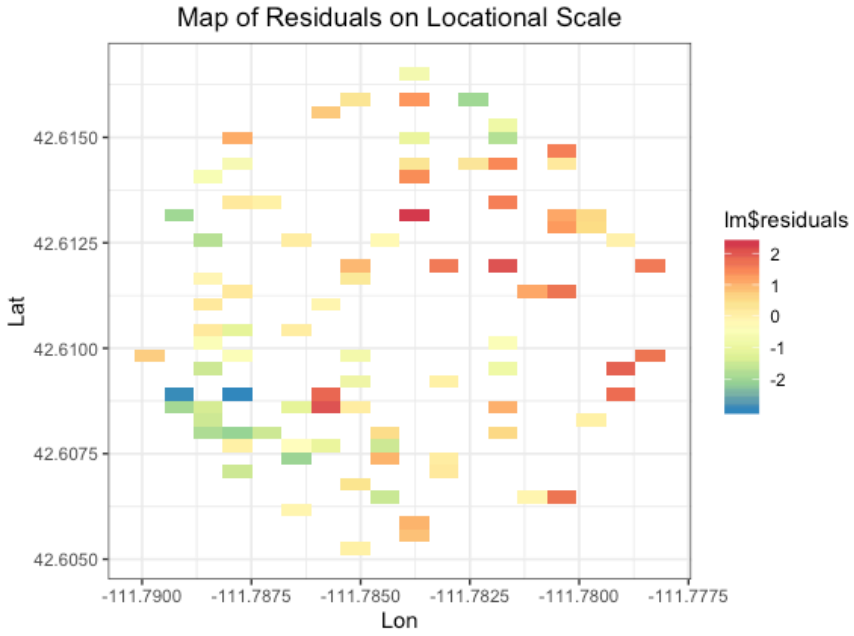
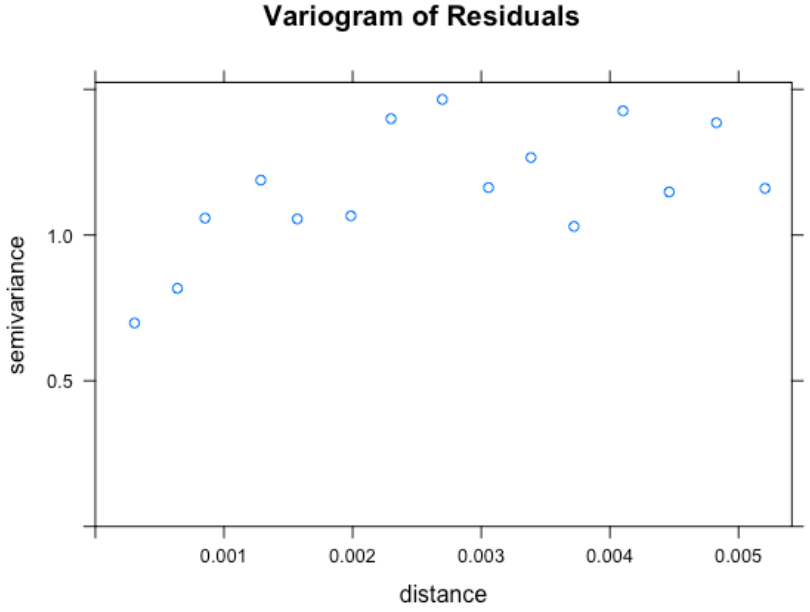
WHC is our exploratory explanatory variable while Yield and EC are our independent variables. Based upon the scatter plots both variables show a positive effect on WHC.

2. We fit an independent linear model to the data to look at the residuals and created the following plot.



We can see the field here by the Lon(longitude) and Lat(Latitude) scale with the residuals from our linear model. We are looking for correlation and we can see that there are areas that look more red (top right) and others that look more blue (bottom left). This indicates likely spatial correlation; to check this a variogram was created.



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No spatial correlation in a variogram should show basically a straight line, and we see an incline here, so there must be some spatial correlation.

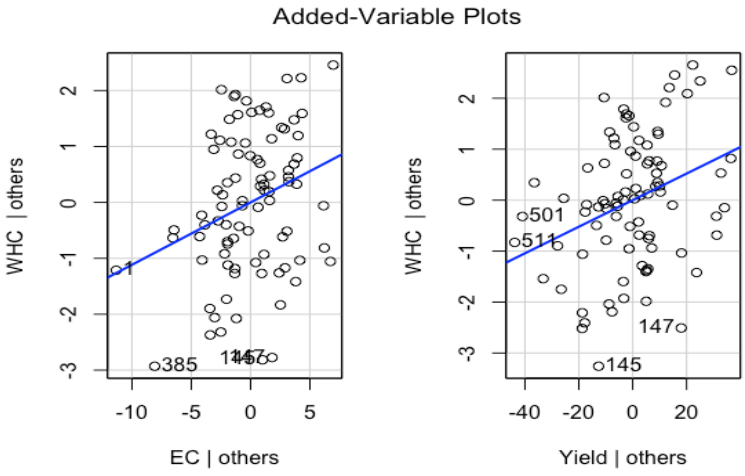
3. In order to fit the best Spatial MLR model, we must look at the various correlation functions. The Gaussian, Exponential, and Spherical correlation models were created and the AIC was calculated for each: 273.4, 272.4, 273.0 respectively. Exponential AIC was the lowest so this was the model choice as lowest AIC usually means the best fit.

4. The model we wish to use uses the form:

$$y \sim \mathcal{N}(\mathcal{X}\beta, \sigma^2\mathcal{R}(\Phi, \omega))$$

y = explanatory variable, WHC
$\mathcal{N}$ = residuals should follow a normal distribution
$\mathcal{X}$ = The X matrix, with each independent variable (Yield and EC)
β = The Beta matrix, the coefficient for each independent variable, it shows the effect of each variable in the X matrix on the y
$\sigma^2\mathcal{R}$ = residuals following a correlations structure defined by R
Φ = parameter from the exponential correlation structure, each point is correlated by $p(s_i, s_j) = \exp(- ||s_i - s_j|| / \Phi)$
ω = parameter for the nugget in our correlation structure to insure we can have data from the identical point without perfect correlation where $Cor(s_i , s_j) = w$ if $|| s_i - s_j || = 0$, otherwise $(1-w)*p(s_i , s_j)$

5. The model was fit, assumptions must be meet. We assume that:
   a. Each set of independent and dependent variables show Linearity. Based on the AV plots below, we can assume Linearity is met.



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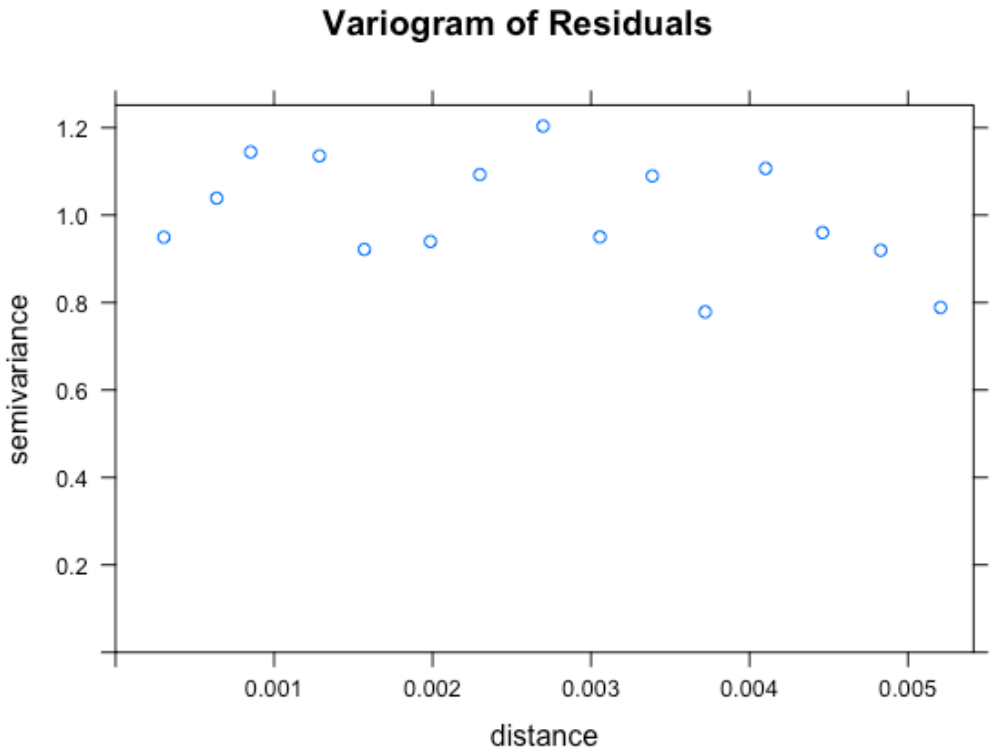
b. That the residuals are independent, now we already declared that the residuals were not independent so we would like to now show that with our new model, the residuals show independence now. This indicates that our model has adjusted for the lack of independence from previously and is shown in the new variogram below.



c. Normality among the residuals will is our next assumption and is shown in the plot below; the residuals have been decorrelated and this plot proves normality is true.

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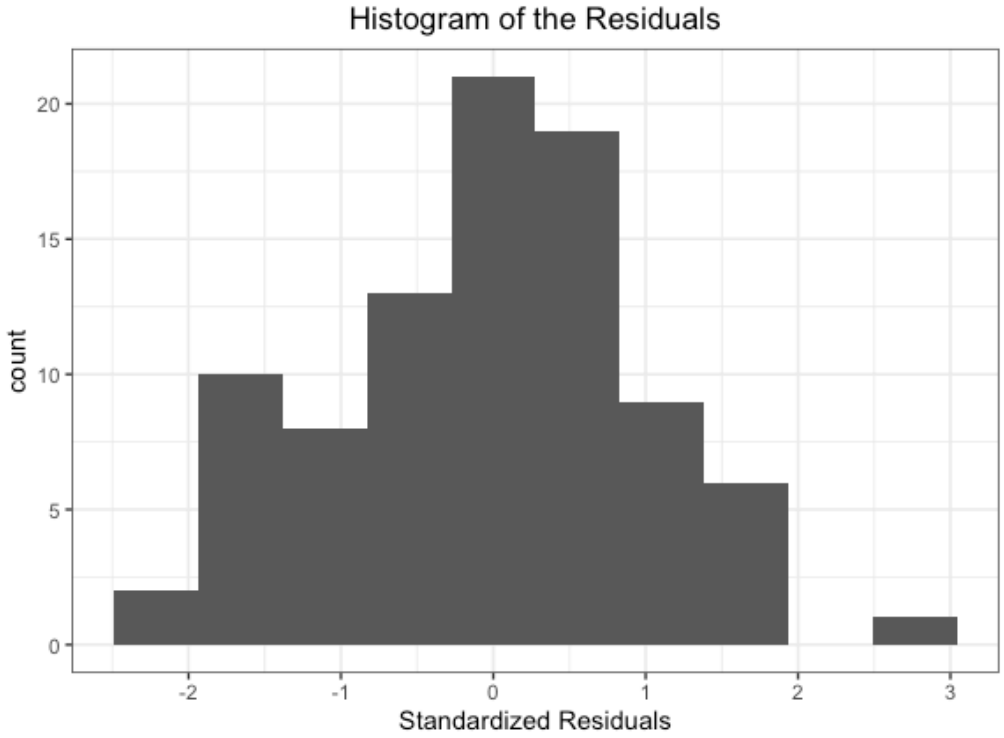
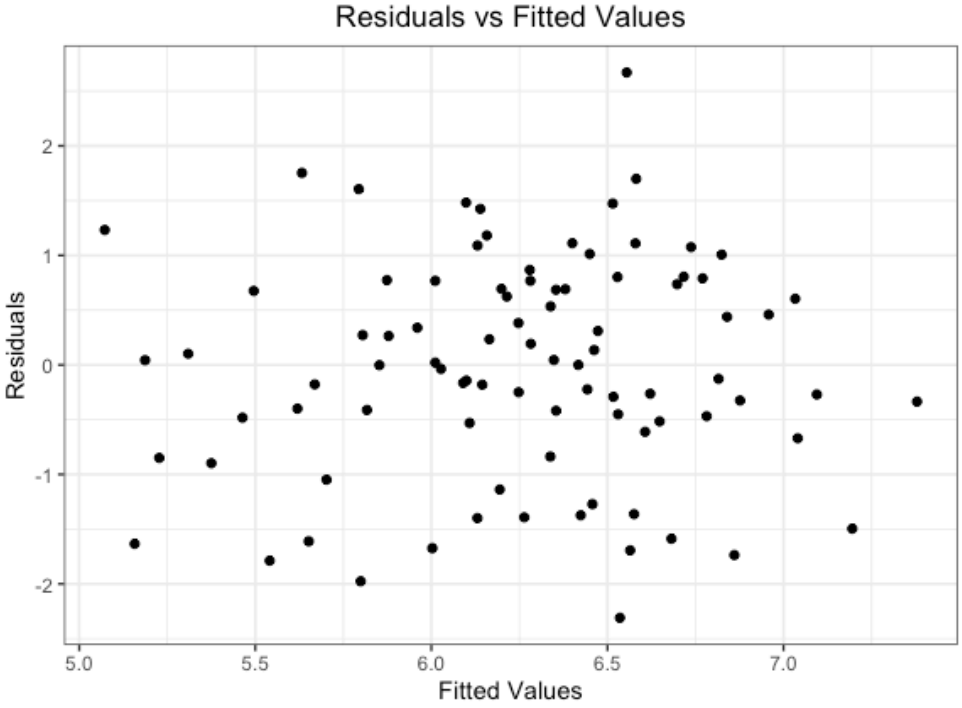


d. The last assumption that must be met in that our residuals show equal variance; again, the residuals have been decorrelated and plotted vs the fitted values.



This show our residuals meet the equal variance assumptions and that ends with all assumptions meet for this model.

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6. A hypothesis test was done to see if the effect of Yield is positive on WHC, we believe that it should be. Null hypothesis is the Beta coefficient for Yield <= 0 and the Alternative is that the Beta coefficient for Yield > 0. The p-value from this test came back as .003 so we reject the null and accept that the Yield has a positive effect on WHC. The confidence interval for this parameter was calculated to be .0070 to .045. We interpret this as, we are 95% confident that the true effect of Yield on WHC, or when Yield increases by 1, we expect WHC to change between .007 and .045.

7. Predictions of all the locations that didn't have WHC were created based upon the model and values collected; and then all were plotted on the spatial map below.