Irrigated Agriculture

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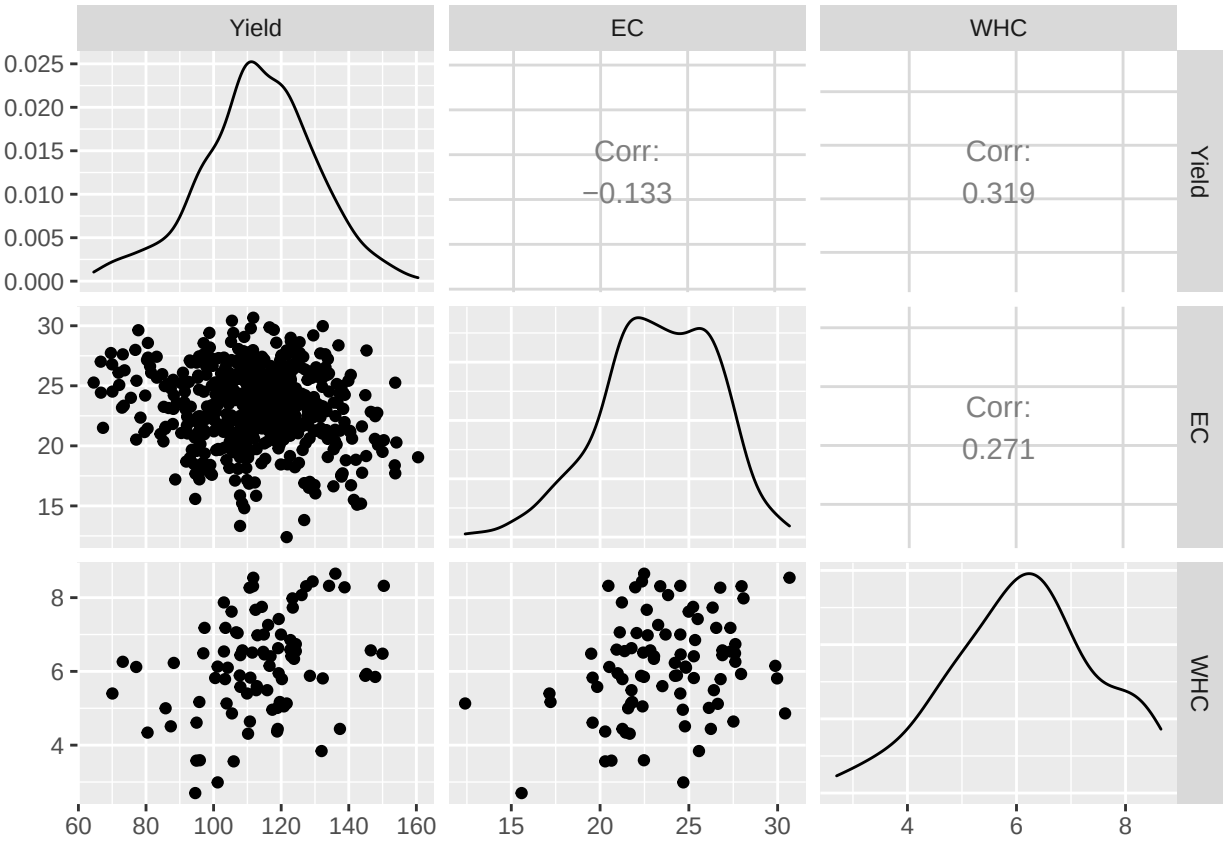
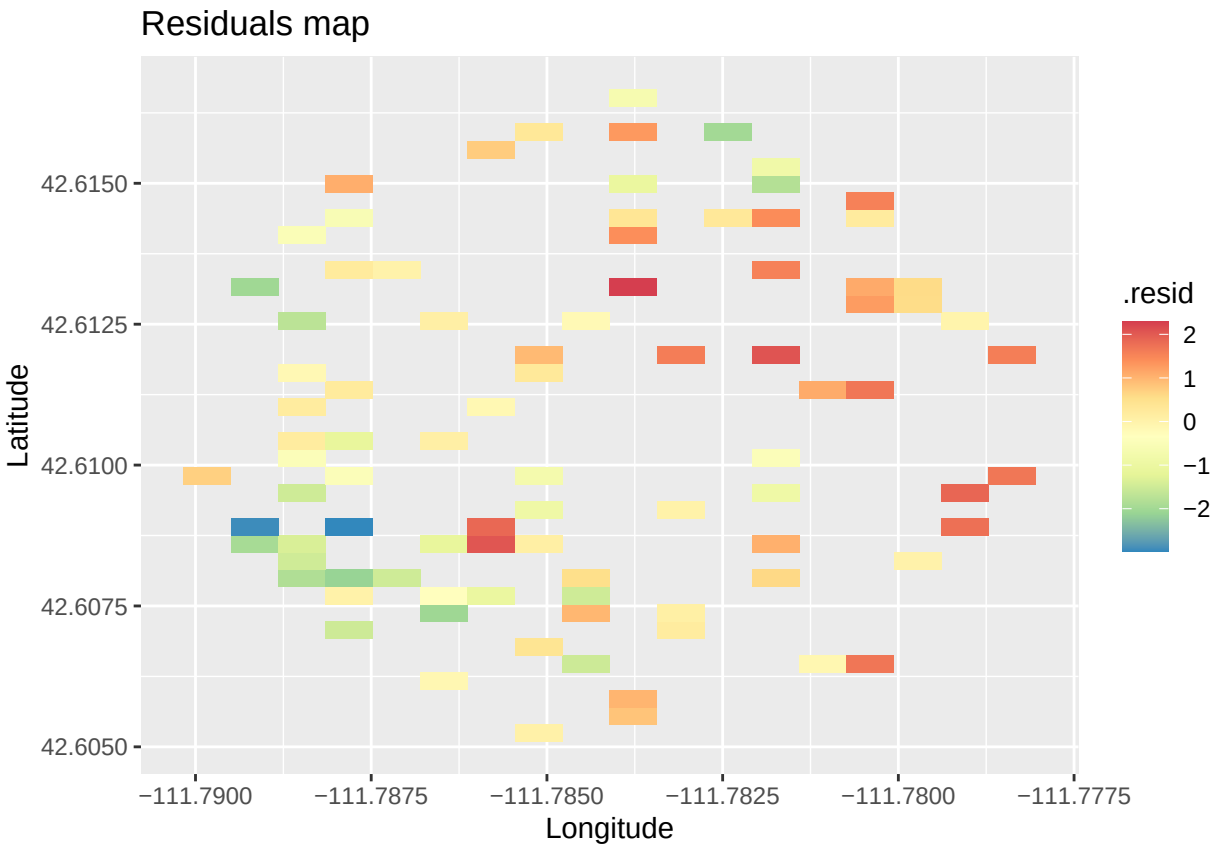
3/25/2020

1.

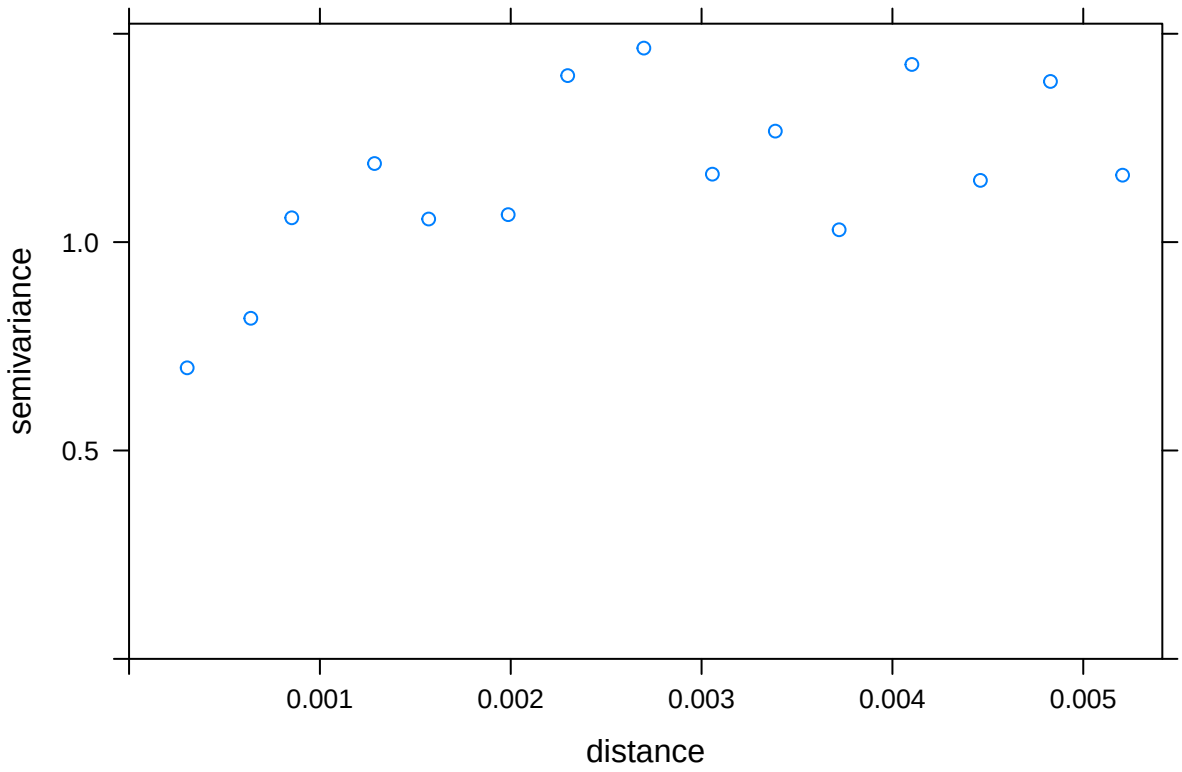


It appears that there is a small positive relationship between both crop yield and electroconductivity and water holding capacity.

2.



From a plot of the residuals of an independent model, it seems that there is spatial correlation, since tiles close to each other tend to have similar residual values.



It also seems from the variogram that there is spatial correlation, since the semivariance increases with distance.

3.

In order to find which correlation structure to use, I fit models with exponential, spherical, and gaussian correlation functions, and compared their AIC values. The model with an exponential correlation function had the lowest AIC score with an AIC of 272.37.

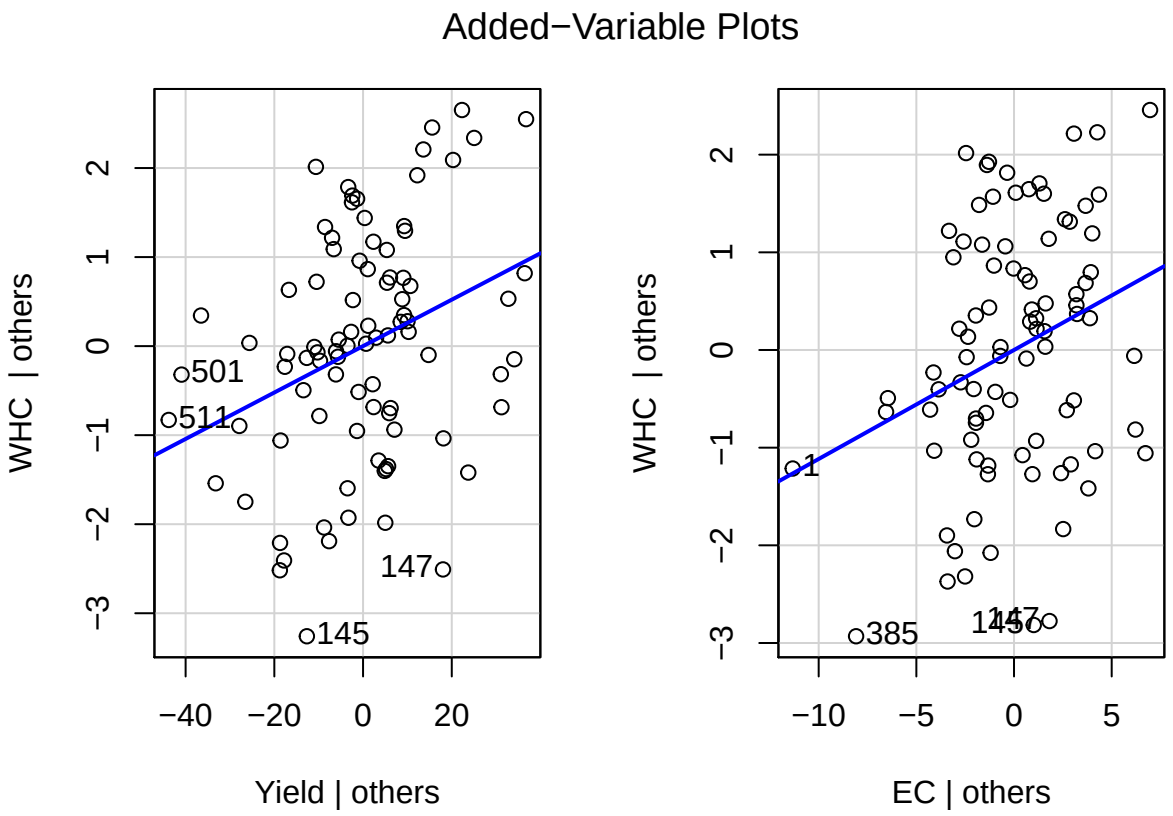
4.

$$\mathbf{y} \sim N(\mathbf{X}\boldsymbol{\beta}, \sigma^2\mathbf{R})$$

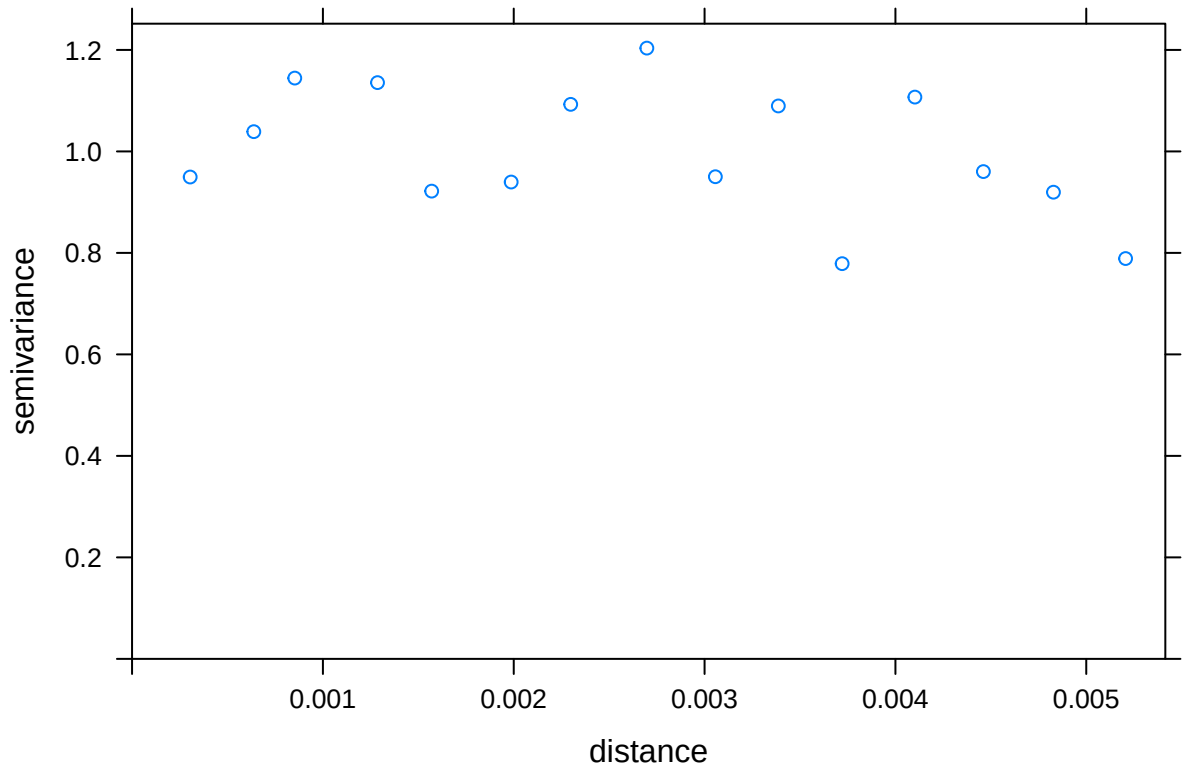
where nondiagonal entries of $\mathbf{R}$ are $\rho(\mathbf{s}_i, \mathbf{s}_j) = e^{\frac{-\|\mathbf{s}_i - \mathbf{s}_j\|}{\phi}}$

$\mathbf{y}$ is a vector containing the water holding capacity from each observation. $\mathbf{X}$ is the design matrix which contains a column of ones, a column with the crop yield counts, and a column with the electroconductivity measurements. $\boldsymbol{\beta}$ is a vector containing the intercept coefficient, crop yield coefficient, and electroconductivity coefficient. σ^2 is the variance of the data from the predicted values. ϕ is a parameter which decides how soon the spatial correlation decays.

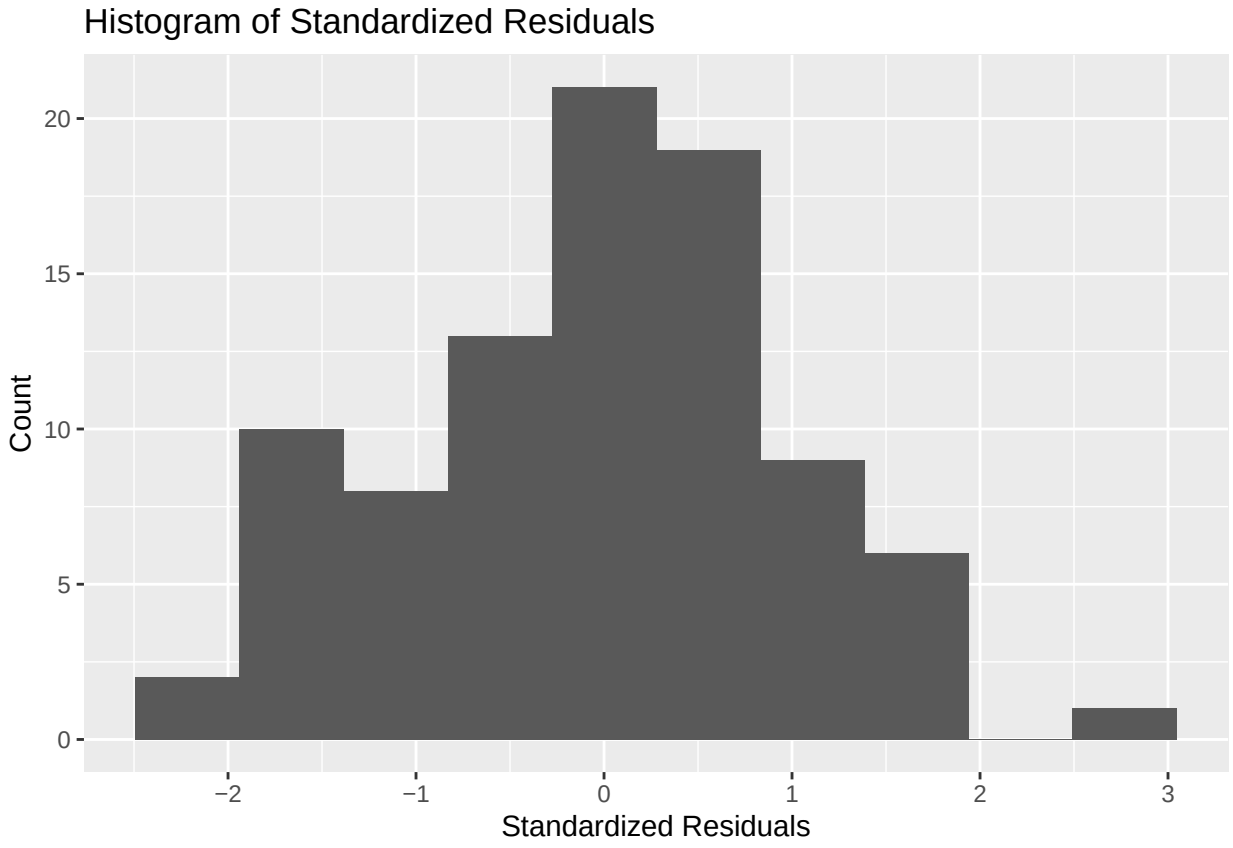
5.



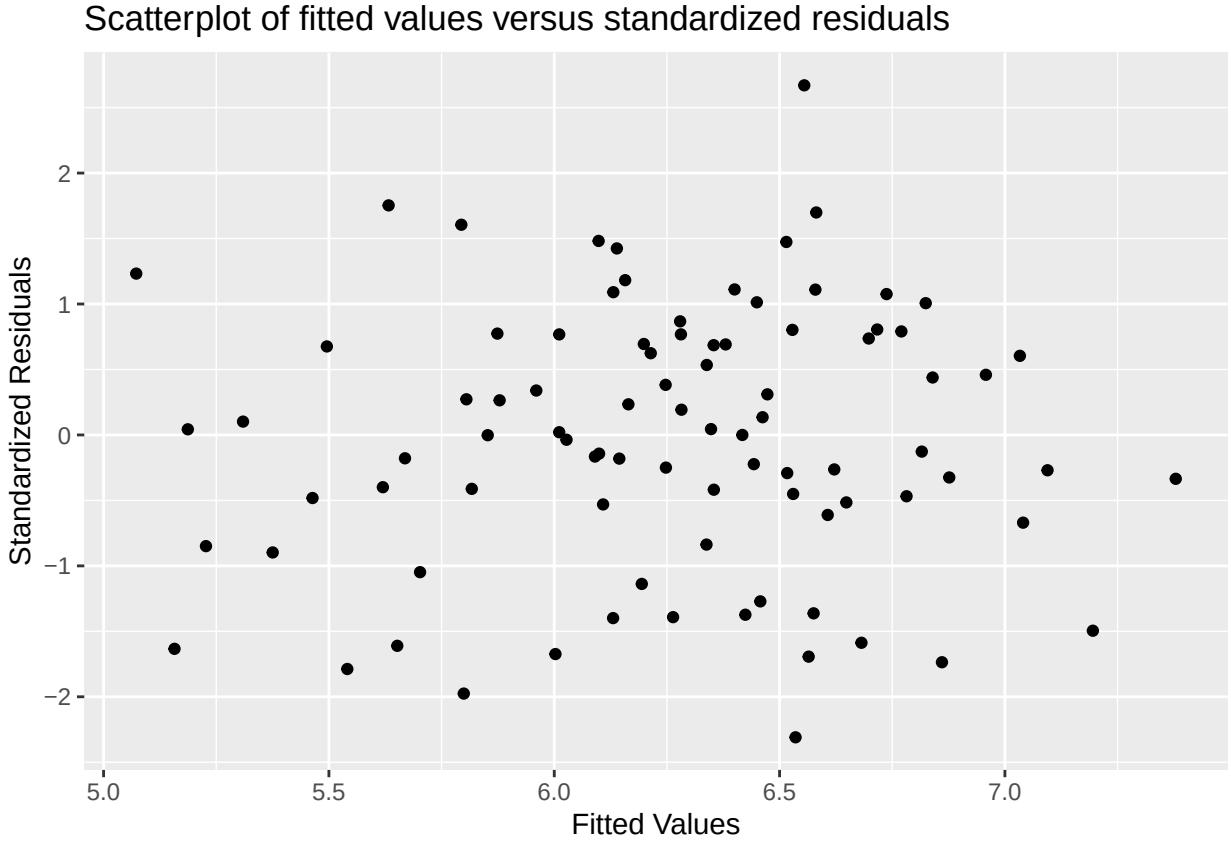
Added variable plots of crop yield and electroconductivity with water holding capacity show that they have a linear relationship.



The variogram of the residuals from the spatial model seems to show that there no longer exists spatial correlation in the residuals of the model, since semivariance does not appear to increase with distance.



A histogram of the residuals appears to show that the model residuals follow a normal distribution.

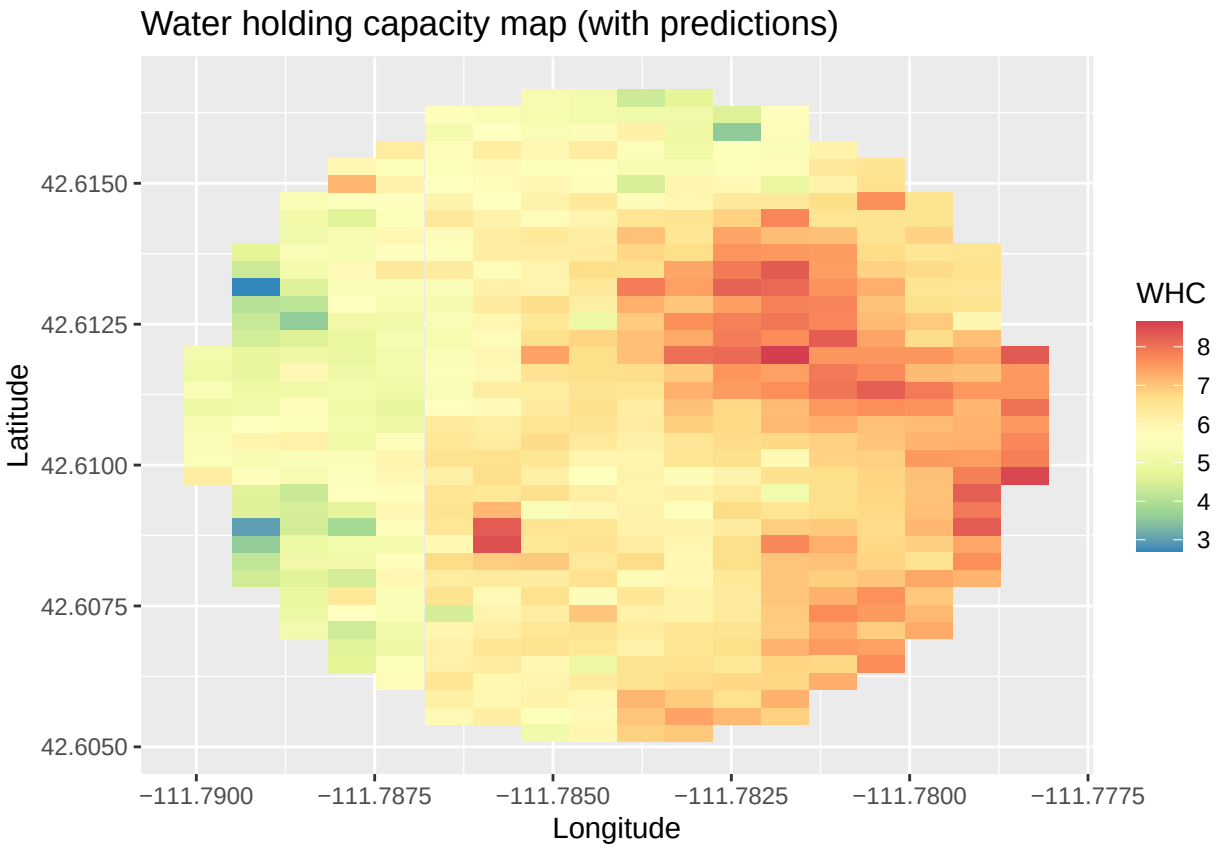


A scatterplot of fitted values versus standardized residuals shows that the variance of the standardized residuals does not depend on fitted values, so the assumption of equal variance seems to be met.

6.

A hypothesis test for whether $\beta_{yield} > 0$ returns a p-value of 0.00321. Therefore, crop yield has a significantly positive impact on water holding capacity. We are 95% confident that when crop yield increases by one, water holding capacity increases by between 0.0072 and 0.0443.

7.


Water holding capacity map (with predictions)
Latitude
42.6150
42.6125
42.6100
42.6075
42.6050
−111.7900
−111.7875
−111.7850
−111.7825
−111.7800
−111.7775
Longitude
WHC
8
7
6
5
4
3