

Q1 SLR: beaver dams

2024-12-06

Question 1

In recent decades, beavers have expanded beyond their typical habitats and begun colonizing the Arctic tundra. Jones et al. collected data on surface water area and surveyed beaver dams to investigate how beaver activity influences hydrology in this region. Beaver dams create localized flooding around water bodies, potentially impacting the Arctic's hydrology and carbon cycling.

Using data from the Baldwin Peninsula in Alaska, Jones and colleagues analyzed surface water area and the number of beaver dams over nearly two decades. In this question, evaluate whether the presence of beaver dams is associated with an increase in surface water in the tundra.

Perform a linear regression to assess whether there is a significant relationship between the number of beaver dams and surface water area. Write a concise paragraph summarizing your results and conclusions, ensuring you clearly interpret the regression coefficients and significance.

```
data <- read.csv('Q1-SLR-beaver-dams.csv')
head(data)
```

```
##   year dams.n area.ha
## 1 2002      2    594
## 2 2007      6    610
## 3 2008      7    623
## 4 2009     10    600
## 5 2010     15    618
## 6 2011     31    625
```

Set up regression

```
mod <- lm(area.ha ~ dams.n, data)
summary(mod)
```

```
##
## Call:
## lm(formula = area.ha ~ dams.n, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -12.639  -7.191  -1.006   6.954  14.772
##
## Coefficients:
##              Estimate Std. Error t value      Pr(>|t|)
## (Intercept)  606.00410    4.13835  146.436 < 0.0000000000000002 ***
## dams.n        0.31769    0.08037   3.953    0.00272 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 9.251 on 10 degrees of freedom
## Multiple R-squared:  0.6097, Adjusted R-squared:  0.5707
## F-statistic: 15.62 on 1 and 10 DF,  p-value: 0.002718
```

Get standardized residuals

```
dam.res <- rstandard(mod)
shapiro.test(dam.res)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  dam.res
## W = 0.92993, p-value = 0.3793
```

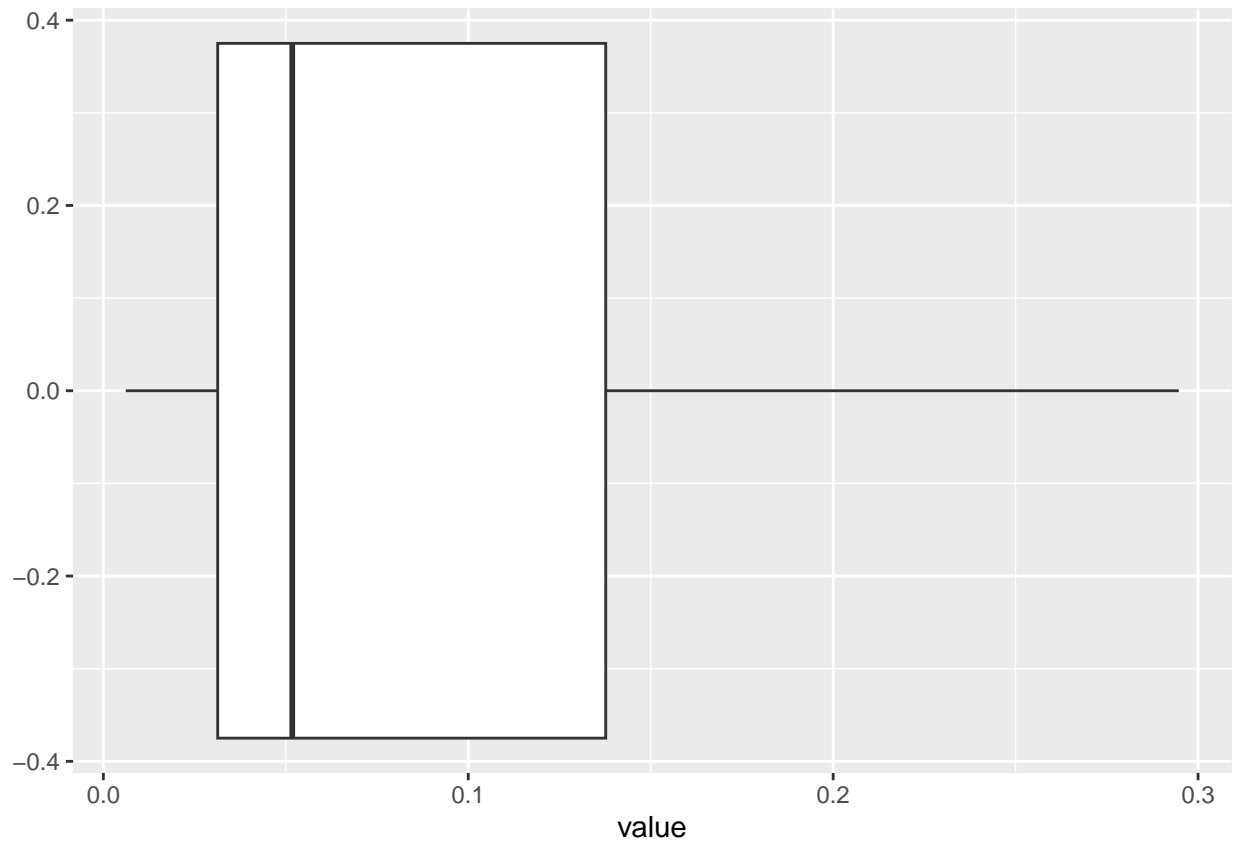
The Breusch-Pagan test to assess homoscedasticity

```
ncvTest(mod)
```

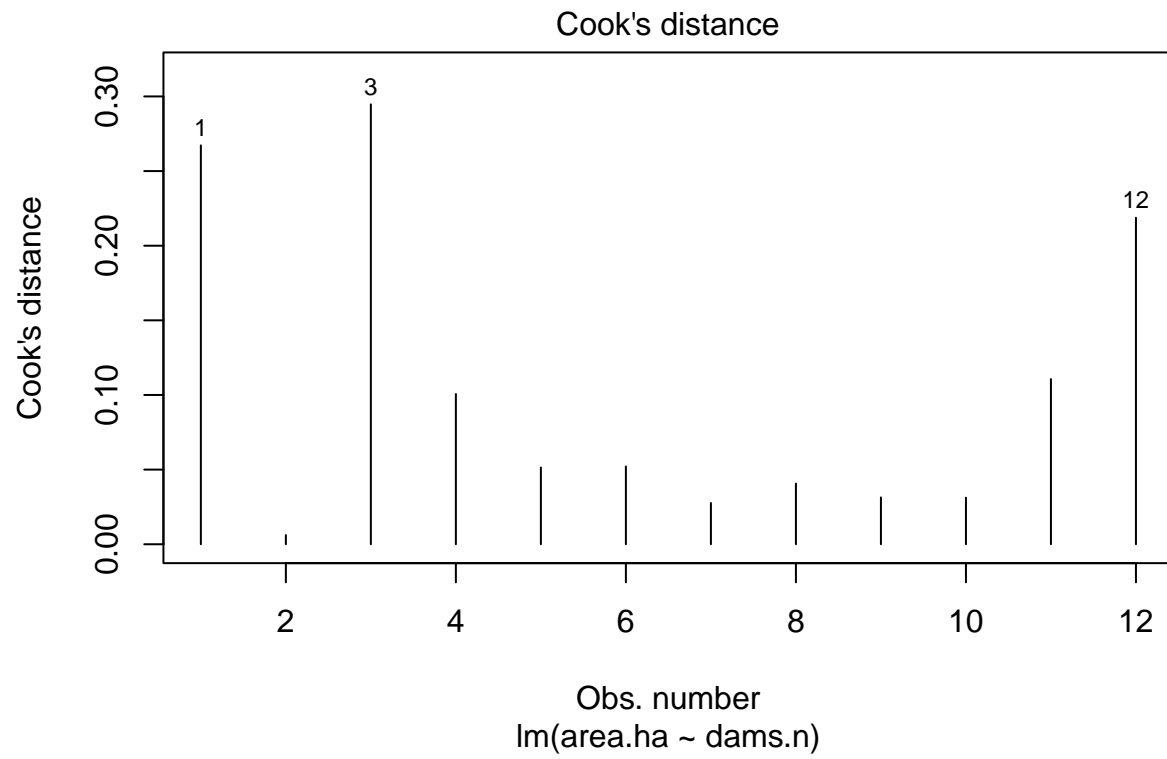
```
## Non-constant Variance Score Test
## Variance formula: ~ fitted.values
## Chisquare = 1.054123, Df = 1, p = 0.30456
```

```
#Cooks D
```

```
ggplot(as_tibble(cooks.distance(mod)), aes(value)) + geom_boxplot()
```

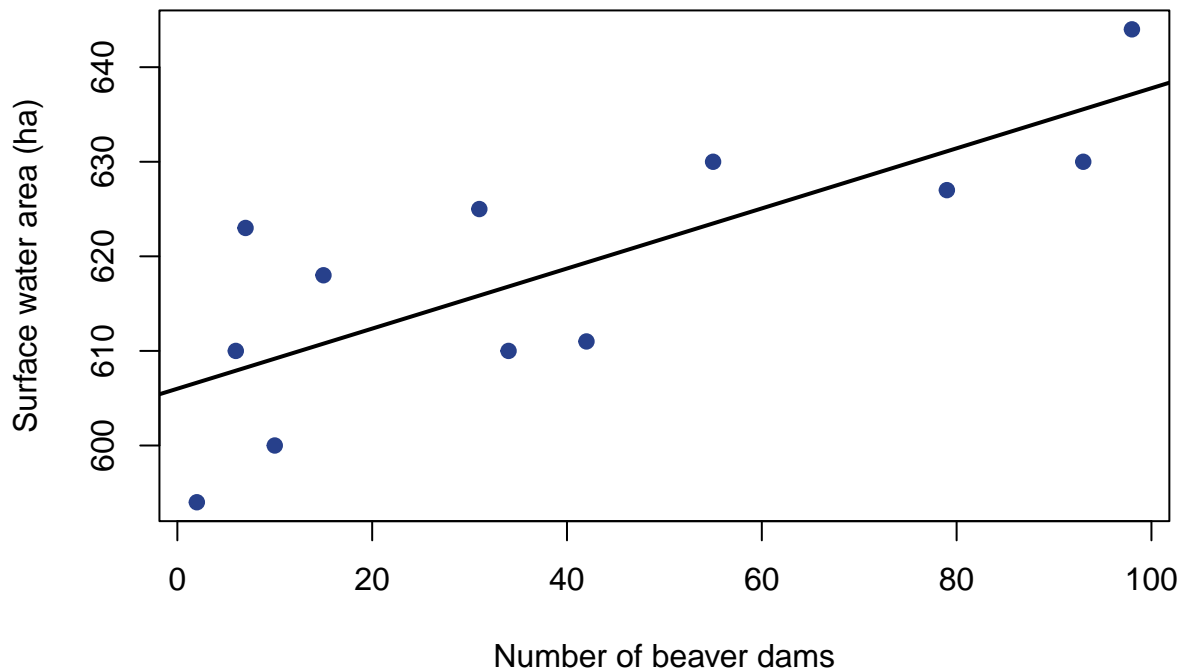


```
plot(mod,which=4)
```



Make plot of beaver dams and surface water

```
plot(area.ha ~ dams.n, data,
     pch = 19,
     col = "royalblue4",
     ylab = "Surface water area (ha)",
     xlab = "Number of beaver dams")
#add regression line
#make line width thicker
abline(mod, lwd=2)
```



References:

<https://bookdown.org/kroppheather/IntEnvData/introduction-to-linear-regression.html> https://github.com/kroppheather/Intro_Enviro_Data/blob/main/IntroEnvData/data/tutorial_5/beaver_dam.csv

Response Key:

Hypothesis (3 pts): We tested whether the presence of beaver dams is significantly associated with an increase in surface water area in the Arctic tundra.

Test (considering assumptions) (8 pts): We used a linear regression to assess the relationship between the number of beaver dams and surface water area. Assumptions for linear regression, including linearity and homoscedasticity, were considered reasonable based on visual inspection of residuals.

correct values (5 pts): slope = slope = 0.318, $p = 0.0027$, $r^2 = 0.610$

Description (2 pts): The relationship between beaver dams and surface water area is statistically significant and positive. For each additional beaver dam, surface water area increases by approximately 0.318 hectares on average.

Interpretation/Conclusions (2 pts): The findings suggest that beaver activity, indicated by the number of dams, contributes to an increase in surface water area in the Arctic tundra. This supports the hypothesis that beaver dams influence hydrology in this region, potentially affecting broader ecological processes such as carbon cycling.