Assignment 10: Data Scraping

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OVERVIEW

This exercise accompanies the lessons in Environmental Data Analytics on data scraping.

Directions

1. Rename this file `<FirstLast>_A10_DataScraping.Rmd` (replacing `<FirstLast>` with your first and last name).
2. Change "Student Name" on line 3 (above) with your name.
3. Work through the steps, **creating code and output** that fulfill each instruction.
4. Be sure your code is tidy; use line breaks to ensure your code fits in the knitted output.
5. Be sure to **answer the questions** in this assignment document.
6. When you have completed the assignment, **Knit** the text and code into a single PDF file.

Set up

1. Set up your session:

- Load the packages `tidyverse`, `rvest`, and any others you end up using.
- Check your working directory

```
#1
library(tidyverse)
library(rvest)
library(lubridate)
```

2. We will be scraping data from the NC DEQs Local Water Supply Planning website, specifically the Durham's 2022 Municipal Local Water Supply Plan (LWSP):

- Navigate to https://www.ncwater.org/WUDC/app/LWSP/search.php
- Scroll down and select the LWSP link next to Durham Municipality.
- Note the web address: https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=03-32-010&year=2022

Indicate this website as the as the URL to be scraped. (In other words, read the contents into an `rvest` webpage object.)

```
#2 Set the URL
webpage <-read_html('https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=03-32-010&year=2022')

webpage
```

```
## {html_document}
## <html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
## [1] <head>\n<title>DWR :: Local Water Supply Planning</title>\n<meta http-equ ...
## [2] <body id="plan">\r\n<!--<div id="division-header">\r\n<a name="top" href= ...
```

3. The data we want to collect are listed below:

- From the "1. System Information" section:
- Water system name
- PWSID
- Ownership
- From the "3. Water Supply Sources" section:
- Maximum Day Use (MGD) - for each month

In the code chunk below scrape these values, assigning them to four separate variables.

> HINT: The first value should be "Durham", the second "03-32-010", the third "Municipality", and the last should be a vector of 12 numeric values (represented as strings)".

```
#3
Water_System_Name <-webpage %>%
  html_nodes('div+ table tr:nth-child(1) td:nth-child(2)')%>% html_text()

PWSID <-webpage %>%
  html_nodes('td tr:nth-child(1) td:nth-child(5)')%>% html_text()

Ownership <-webpage %>%
  html_nodes('div+ table tr:nth-child(2) td:nth-child(4)')%>% html_text()

Max_Day_Use <-webpage %>%
  html_nodes('th~ td+ td') %>% html_text()
```

4. Convert your scraped data into a dataframe. This dataframe should have a column for each of the 4 variables scraped and a row for the month corresponding to the withdrawal data. Also add a Date column that includes your month and year in data format. (Feel free to add a Year column too, if you wish.)

   TIP: Use `rep()` to repeat a value when creating a dataframe.

   NOTE: It's likely you won't be able to scrape the monthly widthrawal data in chronological order. You can overcome this by creating a month column manually assigning values in the order the data are scraped: "Jan", "May", "Sept", "Feb", etc... Or, you could scrape month values from the web page...

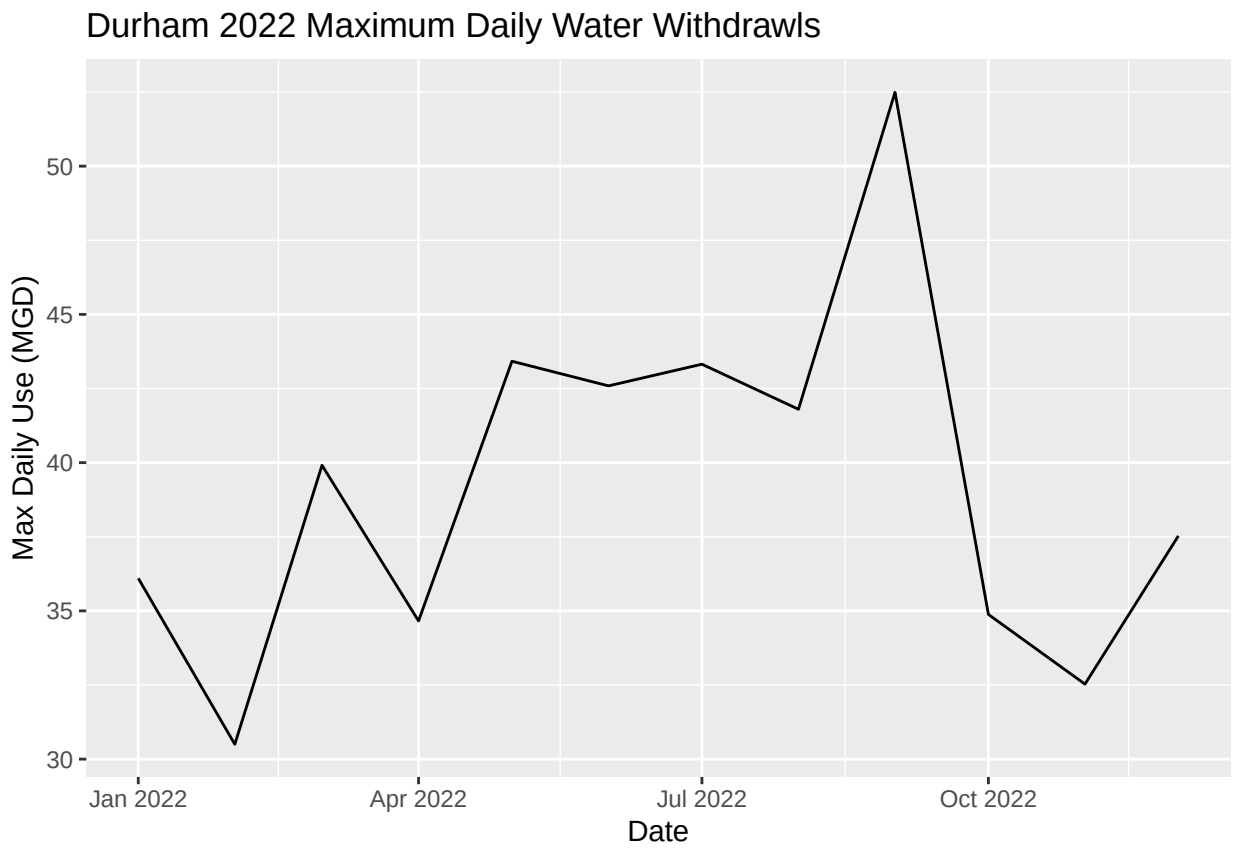
5. Create a line plot of the maximum daily withdrawals across the months for 2022

```
#4
max_daily_22_df <- data.frame("Water_System_Name" = rep(Water_System_Name,12),
                              "PWSID" = rep(PWSID,12),
                              "Ownership"= rep(Ownership,12),
                              "Month" = c('Jan','May','Sep','Feb','Jun','Oct',
                                          'Mar','Jul','Nov','Apr','Aug','Dec'),
                              "Year" = rep(2022,12),
                              "Max_Daily_Use_mgd" = as.numeric(Max_Day_Use)) %>%
  mutate(Month = recode(Month,
  Jan = 1,
  Feb = 2,
  Mar = 3,
  Apr = 4,
  May = 5,
  Jun = 6,
  Jul = 7,
```

```
  Aug = 8,
  Sep = 9,
  Oct = 10,
  Nov = 11,
  Dec = 12
)) %>%
  mutate(Date = my(paste(Month,Year)))
max_daily_22_df %>%
    arrange(ydm(Date))
```

```
##    Water_System_Name     PWSID    Ownership Month Year Max_Daily_Use_mgd
## 1             Durham 03-32-010 Municipality     1 2022              36.10
## 2             Durham 03-32-010 Municipality     2 2022              30.50
## 3             Durham 03-32-010 Municipality     3 2022              39.91
## 4             Durham 03-32-010 Municipality     4 2022              34.66
## 5             Durham 03-32-010 Municipality     5 2022              43.42
## 6             Durham 03-32-010 Municipality     6 2022              42.59
## 7             Durham 03-32-010 Municipality     7 2022              43.32
## 8             Durham 03-32-010 Municipality     8 2022              41.80
## 9             Durham 03-32-010 Municipality     9 2022              52.49
## 10            Durham 03-32-010 Municipality    10 2022              34.88
## 11            Durham 03-32-010 Municipality    11 2022              32.53
## 12            Durham 03-32-010 Municipality    12 2022              37.53
##          Date
## 1  2022-01-01
## 2  2022-02-01
## 3  2022-03-01
## 4  2022-04-01
## 5  2022-05-01
## 6  2022-06-01
## 7  2022-07-01
## 8  2022-08-01
## 9  2022-09-01
## 10 2022-10-01
## 11 2022-11-01
## 12 2022-12-01
```

```
#5
max_daily_22_plot <- ggplot(max_daily_22_df,
                            aes(x=Date,
                                y=Max_Daily_Use_mgd))+
  geom_line()+
  labs(y="Max Daily Use (MGD)",
       title="Durham 2022 Maximum Daily Water Withdrawls")

max_daily_22_plot
```



6. Note that the PWSID and the year appear in the web address for the page we scraped. Construct a function using your code above that can scrape data for any PWSID and year for which the NC DEQ has data. **Be sure to modify the code to reflect the year and site (pwsid) scraped**.

```
#6.
#Create scraping function
Scrape_NC_DEQ <-function(year,PWSID){
  #Retrieve the website contents
  website <- read_html(paste0('https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=',
                              PWSID,'&year=',year))
  #Create element variables and scrape the webpage
  the_water_system_name <-website %>%
    html_nodes('div+ table tr:nth-child(1) td:nth-child(2)')%>%
    html_text()
  the_PWSID_code <-website %>%
    html_nodes('td tr:nth-child(1) td:nth-child(5)')%>%
    html_text()
  the_ownership <-website %>%
    html_nodes('div+ table tr:nth-child(2) td:nth-child(4)')%>%
    html_text()
  the_max_day_use <-website %>%
    html_nodes('th~ td+ td') %>%
    html_text()
  #Convert to a dataframe and tidy the date columns
  max_daily_df_year <- data.frame("Water_System_Name" = rep(the_water_system_name,12),
                              "PWSID" = rep(the_PWSID_code,12),
                              "Ownership" = rep(the_ownership,12),
```

```
                            "Month" =c('Jan','May','Sep','Feb','Jun','Oct',
                                       'Mar','Jul','Nov','Apr','Aug','Dec'),
                            "Year" = rep(year,12),
                            "Max_Daily_Use_mgd" = as.numeric(the_max_day_use))%>%
    mutate(Month = recode(Month,
                          Jan = 1,
                          Feb = 2,
                          Mar = 3,
                          Apr = 4,
                          May = 5,
                          Jun = 6,
                          Jul = 7,
                          Aug = 8,
                          Sep = 9,
                          Oct = 10,
                          Nov = 11,
                          Dec = 12
                          )) %>%
    mutate(Date = my(paste(Month,year))) %>%
    arrange(ydm(Date))
}
```

7. Use the function above to extract and plot max daily withdrawals for Durham (PWSID='03-32-010') for each month in 2015

```
#7
#Fetch Durham 2015
Durham_2015 <- Scrape_NC_DEQ('2015','03-32-010')

Durham_2015
```

```
##    Water_System_Name     PWSID    Ownership Month Year Max_Daily_Use_mgd
## 1             Durham 03-32-010 Municipality     1 2015             40.25
## 2             Durham 03-32-010 Municipality     2 2015             43.50
## 3             Durham 03-32-010 Municipality     3 2015             43.10
## 4             Durham 03-32-010 Municipality     4 2015             49.68
## 5             Durham 03-32-010 Municipality     5 2015             53.17
## 6             Durham 03-32-010 Municipality     6 2015             57.02
## 7             Durham 03-32-010 Municipality     7 2015             41.65
## 8             Durham 03-32-010 Municipality     8 2015             44.70
## 9             Durham 03-32-010 Municipality     9 2015             40.03
## 10            Durham 03-32-010 Municipality    10 2015             38.72
## 11            Durham 03-32-010 Municipality    11 2015             43.55
## 12            Durham 03-32-010 Municipality    12 2015             48.75
##          Date
## 1  2015-01-01
## 2  2015-02-01
## 3  2015-03-01
## 4  2015-04-01
## 5  2015-05-01
## 6  2015-06-01
## 7  2015-07-01
## 8  2015-08-01
## 9  2015-09-01
## 10 2015-10-01
```

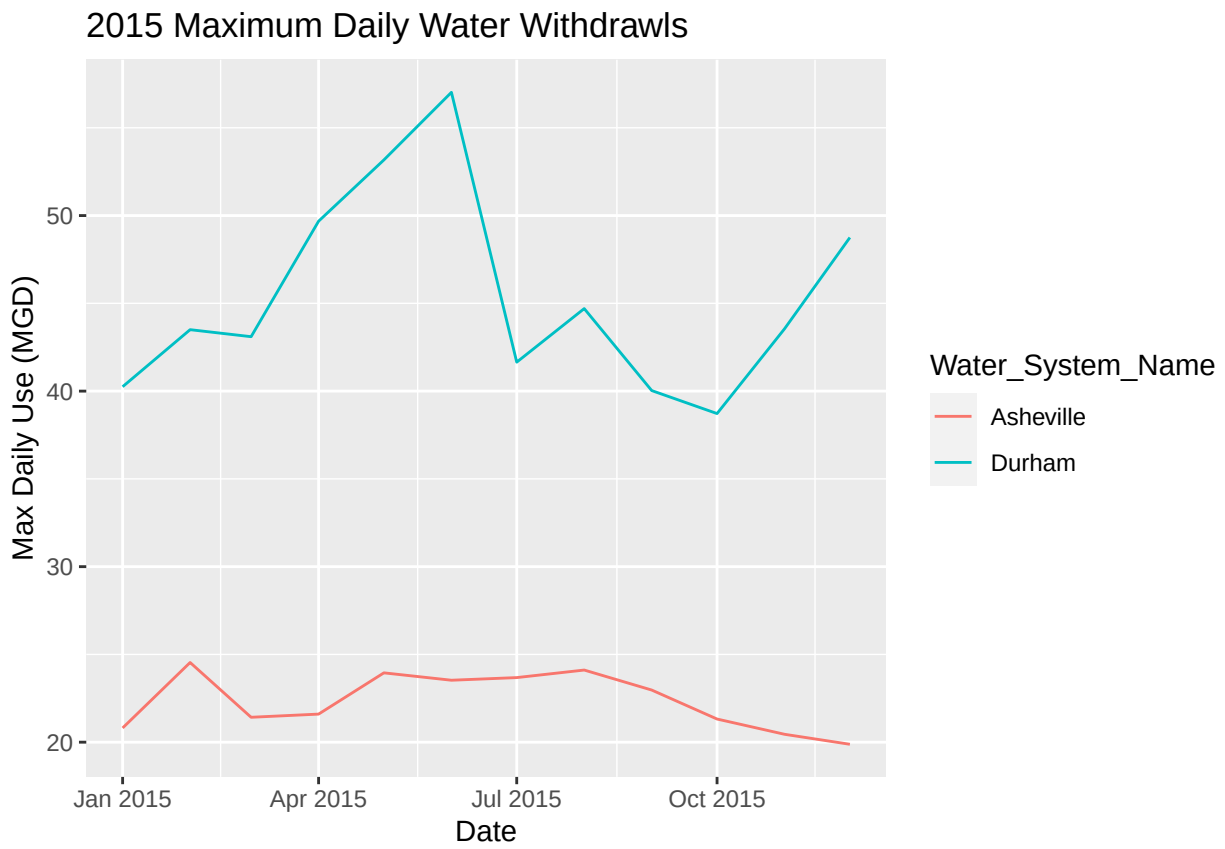
```
## 11 2015-11-01
## 12 2015-12-01
```

8. Use the function above to extract data for Asheville (PWSID = 01-11-010) in 2015. Combine this data with the Durham data collected above and create a plot that compares Asheville's to Durham's water withdrawals.

```
#8
#Fetch Asheville 2015
Asheville_2015 <- Scrape_NC_DEQ('2015','01-11-010')

Asheville_2015
```

```
##    Water_System_Name     PWSID    Ownership Month Year Max_Daily_Use_mgd
## 1          Asheville 01-11-010 Municipality     1 2015              20.81
## 2          Asheville 01-11-010 Municipality     2 2015              24.54
## 3          Asheville 01-11-010 Municipality     3 2015              21.42
## 4          Asheville 01-11-010 Municipality     4 2015              21.60
## 5          Asheville 01-11-010 Municipality     5 2015              23.95
## 6          Asheville 01-11-010 Municipality     6 2015              23.53
## 7          Asheville 01-11-010 Municipality     7 2015              23.68
## 8          Asheville 01-11-010 Municipality     8 2015              24.11
## 9          Asheville 01-11-010 Municipality     9 2015              22.97
## 10         Asheville 01-11-010 Municipality    10 2015              21.32
## 11         Asheville 01-11-010 Municipality    11 2015              20.45
## 12         Asheville 01-11-010 Municipality    12 2015              19.88
##          Date
## 1  2015-01-01
## 2  2015-02-01
## 3  2015-03-01
## 4  2015-04-01
## 5  2015-05-01
## 6  2015-06-01
## 7  2015-07-01
## 8  2015-08-01
## 9  2015-09-01
## 10 2015-10-01
## 11 2015-11-01
## 12 2015-12-01
```

```
#Create joint dataframe
Withdrawls_2015_df <-rbind(Durham_2015,Asheville_2015)

#Create joint plot
Withdrawls_2015_plot <-ggplot(Withdrawls_2015_df,
                              aes(x=Date,
                                  y=Max_Daily_Use_mgd,
                                  color=Water_System_Name))+
  geom_line()+
  labs(y="Max Daily Use (MGD)",
       title="2015 Maximum Daily Water Withdrawls")

Withdrawls_2015_plot
```



9. Use the code & function you created above to plot Asheville's max daily withdrawal by months for the years 2010 thru 2021.Add a smoothed line to the plot (method = 'loess').

   TIP: See Section 3.2 in the "10_Data_Scraping.Rmd" where we apply "map2()" to iteratively run a function over two inputs. Pipe the output of the map2() function to `bindrows()` to combine the dataframes into a single one.

```
#9
#Subset the Asheville years
the_years <-  rep(2010:2021)

#Create a list of the PWSID we want, the same length as the vector above
the_PWSID <- rep.int('01-11-010',length(the_years))

#"Map" the "scrape.it" function to retrieve data for all these
Asheville_Max_Daily_DF <- map2(the_years,the_PWSID,Scrape_NC_DEQ) %>% bind_rows()

Asheville_Max_Daily_DF
```

```
##     Water_System_Name     PWSID    Ownership Month Year Max_Daily_Use_mgd
## 1           Asheville 01-11-010 Municipality     1 2010             21.89
## 2           Asheville 01-11-010 Municipality     2 2010             19.95
## 3           Asheville 01-11-010 Municipality     3 2010             19.74
## 4           Asheville 01-11-010 Municipality     4 2010             21.25
## 5           Asheville 01-11-010 Municipality     5 2010             20.99
## 6           Asheville 01-11-010 Municipality     6 2010             22.53
## 7           Asheville 01-11-010 Municipality     7 2010             24.01
```

```
## 8          Asheville 01-11-010 Municipality     8 2010            22.50
## 9          Asheville 01-11-010 Municipality     9 2010            22.45
## 10         Asheville 01-11-010 Municipality    10 2010            21.49
## 11         Asheville 01-11-010 Municipality    11 2010            21.23
## 12         Asheville 01-11-010 Municipality    12 2010            24.43
## 13         Asheville 01-11-010 Municipality     1 2011            21.44
## 14         Asheville 01-11-010 Municipality     2 2011            23.87
## 15         Asheville 01-11-010 Municipality     3 2011            20.20
## 16         Asheville 01-11-010 Municipality     4 2011            20.58
## 17         Asheville 01-11-010 Municipality     5 2011            23.33
## 18         Asheville 01-11-010 Municipality     6 2011            23.73
## 19         Asheville 01-11-010 Municipality     7 2011            24.04
## 20         Asheville 01-11-010 Municipality     8 2011            24.18
## 21         Asheville 01-11-010 Municipality     9 2011            23.54
## 22         Asheville 01-11-010 Municipality    10 2011            22.55
## 23         Asheville 01-11-010 Municipality    11 2011            21.53
## 24         Asheville 01-11-010 Municipality    12 2011            21.51
## 25         Asheville 01-11-010 Municipality     1 2012            22.17
## 26         Asheville 01-11-010 Municipality     2 2012            21.90
## 27         Asheville 01-11-010 Municipality     3 2012            21.06
## 28         Asheville 01-11-010 Municipality     4 2012            21.57
## 29         Asheville 01-11-010 Municipality     5 2012            22.63
## 30         Asheville 01-11-010 Municipality     6 2012            24.82
## 31         Asheville 01-11-010 Municipality     7 2012            23.82
## 32         Asheville 01-11-010 Municipality     8 2012            23.00
## 33         Asheville 01-11-010 Municipality     9 2012            21.69
## 34         Asheville 01-11-010 Municipality    10 2012            21.67
## 35         Asheville 01-11-010 Municipality    11 2012            20.85
## 36         Asheville 01-11-010 Municipality    12 2012            20.43
## 37         Asheville 01-11-010 Municipality     1 2013            20.84
## 38         Asheville 01-11-010 Municipality     2 2013            20.53
## 39         Asheville 01-11-010 Municipality     3 2013            20.28
## 40         Asheville 01-11-010 Municipality     4 2013            20.93
## 41         Asheville 01-11-010 Municipality     5 2013            21.95
## 42         Asheville 01-11-010 Municipality     6 2013            21.46
## 43         Asheville 01-11-010 Municipality     7 2013            21.42
## 44         Asheville 01-11-010 Municipality     8 2013            21.25
## 45         Asheville 01-11-010 Municipality     9 2013            21.04
## 46         Asheville 01-11-010 Municipality    10 2013            20.34
## 47         Asheville 01-11-010 Municipality    11 2013            19.81
## 48         Asheville 01-11-010 Municipality    12 2013            19.66
## 49         Asheville 01-11-010 Municipality     1 2014            22.64
## 50         Asheville 01-11-010 Municipality     2 2014            21.22
## 51         Asheville 01-11-010 Municipality     3 2014            19.81
## 52         Asheville 01-11-010 Municipality     4 2014            20.08
## 53         Asheville 01-11-010 Municipality     5 2014            21.39
## 54         Asheville 01-11-010 Municipality     6 2014            21.83
## 55         Asheville 01-11-010 Municipality     7 2014            22.20
## 56         Asheville 01-11-010 Municipality     8 2014            21.66
## 57         Asheville 01-11-010 Municipality     9 2014            20.98
## 58         Asheville 01-11-010 Municipality    10 2014            20.73
## 59         Asheville 01-11-010 Municipality    11 2014            20.33
## 60         Asheville 01-11-010 Municipality    12 2014            20.78
## 61         Asheville 01-11-010 Municipality     1 2015            20.81
```

```
## 62          Asheville 01-11-010 Municipality     2 2015            24.54
## 63          Asheville 01-11-010 Municipality     3 2015            21.42
## 64          Asheville 01-11-010 Municipality     4 2015            21.60
## 65          Asheville 01-11-010 Municipality     5 2015            23.95
## 66          Asheville 01-11-010 Municipality     6 2015            23.53
## 67          Asheville 01-11-010 Municipality     7 2015            23.68
## 68          Asheville 01-11-010 Municipality     8 2015            24.11
## 69          Asheville 01-11-010 Municipality     9 2015            22.97
## 70          Asheville 01-11-010 Municipality    10 2015            21.32
## 71          Asheville 01-11-010 Municipality    11 2015            20.45
## 72          Asheville 01-11-010 Municipality    12 2015            19.88
## 73          Asheville 01-11-010 Municipality     1 2016            20.43
## 74          Asheville 01-11-010 Municipality     2 2016            20.87
## 75          Asheville 01-11-010 Municipality     3 2016            19.35
## 76          Asheville 01-11-010 Municipality     4 2016            21.07
## 77          Asheville 01-11-010 Municipality     5 2016            21.99
## 78          Asheville 01-11-010 Municipality     6 2016            24.08
## 79          Asheville 01-11-010 Municipality     7 2016            22.85
## 80          Asheville 01-11-010 Municipality     8 2016            22.34
## 81          Asheville 01-11-010 Municipality     9 2016            22.95
## 82          Asheville 01-11-010 Municipality    10 2016            22.62
## 83          Asheville 01-11-010 Municipality    11 2016            22.43
## 84          Asheville 01-11-010 Municipality    12 2016            21.97
## 85          Asheville 01-11-010 Municipality     1 2017            21.31
## 86          Asheville 01-11-010 Municipality     2 2017            20.28
## 87          Asheville 01-11-010 Municipality     3 2017            19.80
## 88          Asheville 01-11-010 Municipality     4 2017            20.43
## 89          Asheville 01-11-010 Municipality     5 2017            21.62
## 90          Asheville 01-11-010 Municipality     6 2017            21.85
## 91          Asheville 01-11-010 Municipality     7 2017            22.50
## 92          Asheville 01-11-010 Municipality     8 2017            22.89
## 93          Asheville 01-11-010 Municipality     9 2017            21.87
## 94          Asheville 01-11-010 Municipality    10 2017            21.57
## 95          Asheville 01-11-010 Municipality    11 2017            20.00
## 96          Asheville 01-11-010 Municipality    12 2017            20.55
## 97          Asheville 01-11-010 Municipality     1 2018            23.89
## 98          Asheville 01-11-010 Municipality     2 2018            20.07
## 99          Asheville 01-11-010 Municipality     3 2018            19.78
## 100         Asheville 01-11-010 Municipality     4 2018            20.31
## 101         Asheville 01-11-010 Municipality     5 2018            21.97
## 102         Asheville 01-11-010 Municipality     6 2018            22.47
## 103         Asheville 01-11-010 Municipality     7 2018            22.54
## 104         Asheville 01-11-010 Municipality     8 2018            22.47
## 105         Asheville 01-11-010 Municipality     9 2018            23.87
## 106         Asheville 01-11-010 Municipality    10 2018            21.61
## 107         Asheville 01-11-010 Municipality    11 2018            21.05
## 108         Asheville 01-11-010 Municipality    12 2018            21.62
## 109         Asheville 01-11-010 Municipality     1 2019            24.51
## 110         Asheville 01-11-010 Municipality     2 2019            22.46
## 111         Asheville 01-11-010 Municipality     3 2019            24.25
## 112         Asheville 01-11-010 Municipality     4 2019            25.26
## 113         Asheville 01-11-010 Municipality     5 2019            27.09
## 114         Asheville 01-11-010 Municipality     6 2019            26.10
## 115         Asheville 01-11-010 Municipality     7 2019            26.10
```

```
## 116         Asheville 01-11-010 Municipality     8 2019            26.21
## 117         Asheville 01-11-010 Municipality     9 2019            28.45
## 118         Asheville 01-11-010 Municipality    10 2019            24.99
## 119         Asheville 01-11-010 Municipality    11 2019            25.06
## 120         Asheville 01-11-010 Municipality    12 2019            24.16
## 121         Asheville 01-11-010 Municipality     1 2020            23.76
## 122         Asheville 01-11-010 Municipality     2 2020            22.03
## 123         Asheville 01-11-010 Municipality     3 2020            21.96
## 124         Asheville 01-11-010 Municipality     4 2020            20.84
## 125         Asheville 01-11-010 Municipality     5 2020            23.28
## 126         Asheville 01-11-010 Municipality     6 2020            23.42
## 127         Asheville 01-11-010 Municipality     7 2020            24.15
## 128         Asheville 01-11-010 Municipality     8 2020            24.27
## 129         Asheville 01-11-010 Municipality     9 2020            23.81
## 130         Asheville 01-11-010 Municipality    10 2020            22.76
## 131         Asheville 01-11-010 Municipality    11 2020            21.75
## 132         Asheville 01-11-010 Municipality    12 2020            22.96
## 133         Asheville 01-11-010 Municipality     1 2021            22.29
## 134         Asheville 01-11-010 Municipality     2 2021            21.84
## 135         Asheville 01-11-010 Municipality     3 2021            21.75
## 136         Asheville 01-11-010 Municipality     4 2021            22.81
## 137         Asheville 01-11-010 Municipality     5 2021            24.27
## 138         Asheville 01-11-010 Municipality     6 2021            26.04
## 139         Asheville 01-11-010 Municipality     7 2021            25.29
## 140         Asheville 01-11-010 Municipality     8 2021            25.42
## 141         Asheville 01-11-010 Municipality     9 2021            24.76
## 142         Asheville 01-11-010 Municipality    10 2021            24.39
## 143         Asheville 01-11-010 Municipality    11 2021            23.40
## 144         Asheville 01-11-010 Municipality    12 2021            23.11
##           Date
## 1   2010-01-01
## 2   2010-02-01
## 3   2010-03-01
## 4   2010-04-01
## 5   2010-05-01
## 6   2010-06-01
## 7   2010-07-01
## 8   2010-08-01
## 9   2010-09-01
## 10  2010-10-01
## 11  2010-11-01
## 12  2010-12-01
## 13  2011-01-01
## 14  2011-02-01
## 15  2011-03-01
## 16  2011-04-01
## 17  2011-05-01
## 18  2011-06-01
## 19  2011-07-01
## 20  2011-08-01
## 21  2011-09-01
## 22  2011-10-01
## 23  2011-11-01
## 24  2011-12-01
```

```
## 25  2012-01-01
## 26  2012-02-01
## 27  2012-03-01
## 28  2012-04-01
## 29  2012-05-01
## 30  2012-06-01
## 31  2012-07-01
## 32  2012-08-01
## 33  2012-09-01
## 34  2012-10-01
## 35  2012-11-01
## 36  2012-12-01
## 37  2013-01-01
## 38  2013-02-01
## 39  2013-03-01
## 40  2013-04-01
## 41  2013-05-01
## 42  2013-06-01
## 43  2013-07-01
## 44  2013-08-01
## 45  2013-09-01
## 46  2013-10-01
## 47  2013-11-01
## 48  2013-12-01
## 49  2014-01-01
## 50  2014-02-01
## 51  2014-03-01
## 52  2014-04-01
## 53  2014-05-01
## 54  2014-06-01
## 55  2014-07-01
## 56  2014-08-01
## 57  2014-09-01
## 58  2014-10-01
## 59  2014-11-01
## 60  2014-12-01
## 61  2015-01-01
## 62  2015-02-01
## 63  2015-03-01
## 64  2015-04-01
## 65  2015-05-01
## 66  2015-06-01
## 67  2015-07-01
## 68  2015-08-01
## 69  2015-09-01
## 70  2015-10-01
## 71  2015-11-01
## 72  2015-12-01
## 73  2016-01-01
## 74  2016-02-01
## 75  2016-03-01
## 76  2016-04-01
## 77  2016-05-01
## 78  2016-06-01
```

```
## 79  2016-07-01
## 80  2016-08-01
## 81  2016-09-01
## 82  2016-10-01
## 83  2016-11-01
## 84  2016-12-01
## 85  2017-01-01
## 86  2017-02-01
## 87  2017-03-01
## 88  2017-04-01
## 89  2017-05-01
## 90  2017-06-01
## 91  2017-07-01
## 92  2017-08-01
## 93  2017-09-01
## 94  2017-10-01
## 95  2017-11-01
## 96  2017-12-01
## 97  2018-01-01
## 98  2018-02-01
## 99  2018-03-01
## 100 2018-04-01
## 101 2018-05-01
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## 105 2018-09-01
## 106 2018-10-01
## 107 2018-11-01
## 108 2018-12-01
## 109 2019-01-01
## 110 2019-02-01
## 111 2019-03-01
## 112 2019-04-01
## 113 2019-05-01
## 114 2019-06-01
## 115 2019-07-01
## 116 2019-08-01
## 117 2019-09-01
## 118 2019-10-01
## 119 2019-11-01
## 120 2019-12-01
## 121 2020-01-01
## 122 2020-02-01
## 123 2020-03-01
## 124 2020-04-01
## 125 2020-05-01
## 126 2020-06-01
## 127 2020-07-01
## 128 2020-08-01
## 129 2020-09-01
## 130 2020-10-01
## 131 2020-11-01
## 132 2020-12-01
```
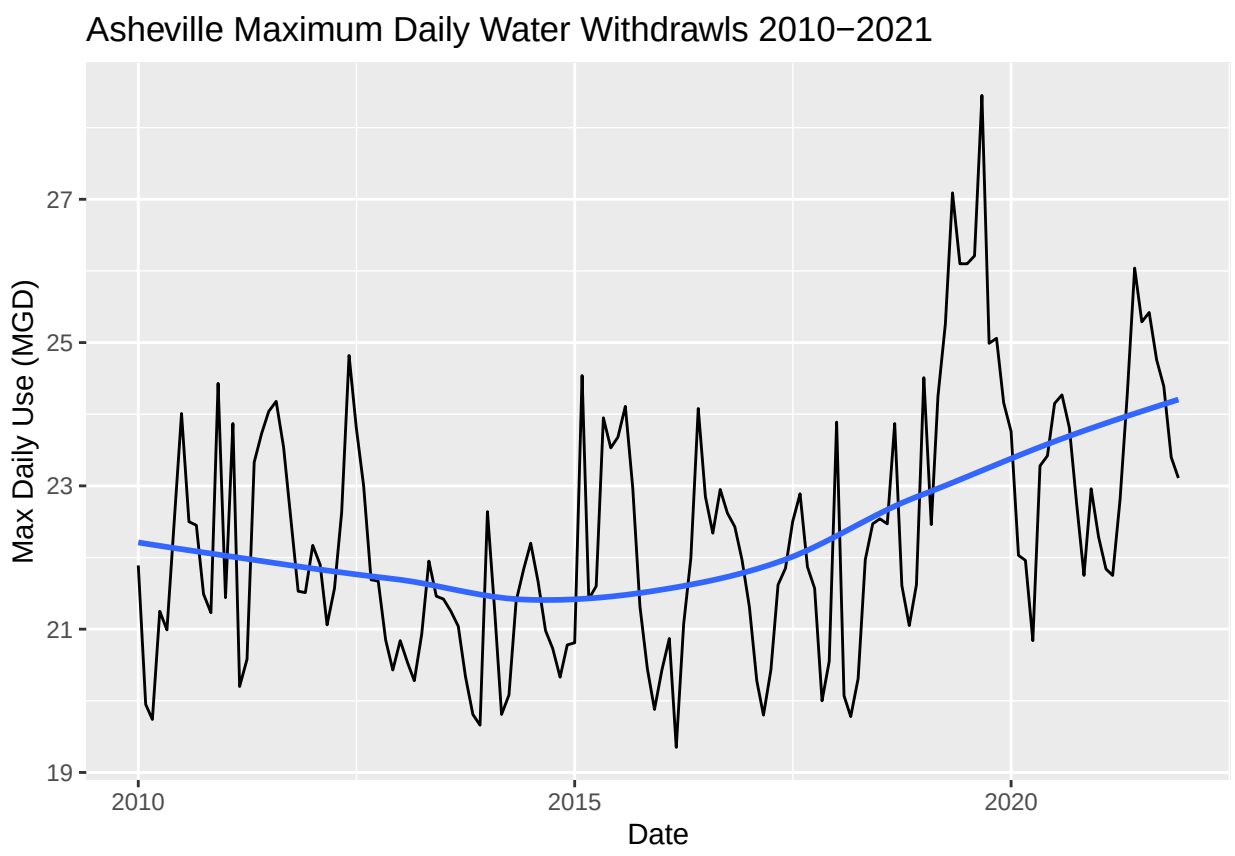

```
## 133 2021-01-01
## 134 2021-02-01
## 135 2021-03-01
## 136 2021-04-01
## 137 2021-05-01
## 138 2021-06-01
## 139 2021-07-01
## 140 2021-08-01
## 141 2021-09-01
## 142 2021-10-01
## 143 2021-11-01
## 144 2021-12-01
```

```
#Plot
Asheville_Max_Daily_Plot <-ggplot(Asheville_Max_Daily_DF,
                                  aes(x=Date,
                                      y=Max_Daily_Use_mgd))+
  geom_line()+
  geom_smooth(method="loess",
              se=FALSE)+
  labs(y="Max Daily Use (MGD)",
       title="Asheville Maximum Daily Water Withdrawls 2010-2021")

Asheville_Max_Daily_Plot
```

```
## `geom_smooth()` using formula = 'y ~ x'
```



Question: Just by looking at the plot (i.e. not running statistics), does Asheville have a trend in water usage over time? > Answer: Asheville had a negative trend in water withdrawls between 2010-2015 but beginning in 2015 has a positive trend. This means they were using progressively less water between 2010-2015 but have been using an increasing amount between 2015-2021. >