

DATA 481 02_EDA

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Read the data

Data sourced from Github repository [rfordatascience/tidytuesday](https://github.com/rfordatascience/tidytuesday)
(<https://github.com/rfordatascience/tidytuesday/blob/main/data/2021/2021-07-20/readme.md>)

Data Reference:

“The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Map courtesy of NDMC.”

This data contains weekly recorded (mapped) drought levels, from 2001 to 2021, across the 50 U.S. states, U.S. Capital (DC), and Puerto Rico (PR).

Included in these records are categorical levels of drought, as well as statistics of the land and populations affected within each drought category.

Schema

map_date: Date map released

state_abb: State abbreviation

valid_start: Start date of weekly data

valid_end: End date of weekly data

stat_fmt: Statistic format (2 for “categorical”, 1 for “cumulative” “)

drought_lvl: Drought level (None, DO, D1, D2, D3, D4) which corresponds to no drought, abnormally dry, moderate drought, severe drought, extreme drought or exceptional drought.

area_pct: Percent of state currently in that drought category

area_total: Total land area (sq miles) of state currently in that drought category

pop_pct: Population percent of total state population in that drought category

pop_total: Population total of that state in that drought category

Preview of dataset

```
drought <- read.csv("../RData/Drought_data/drought.csv")
head(drought)
```

```
##   map_date state_abb valid_start valid_end stat_fmt drought_lvl area_pct
## 1 20210713      AK  2021-07-13 2021-07-19      2      None    74.35
## 2 20210713      AK  2021-07-13 2021-07-19      2       D0    25.65
## 3 20210713      AK  2021-07-13 2021-07-19      2       D1     0.00
## 4 20210713      AK  2021-07-13 2021-07-19      2       D2     0.00
## 5 20210713      AK  2021-07-13 2021-07-19      2       D3     0.00
## 6 20210713      AK  2021-07-13 2021-07-19      2       D4     0.00
##   area_total pop_pct pop_total
## 1  433133.2   33.91  240644.2
## 2  149435.1   66.09  468985.8
## 3      0.0    0.00      0.0
## 4      0.0    0.00      0.0
## 5      0.0    0.00      0.0
## 6      0.0    0.00      0.0
```

Dimensions of dataset

```
#size of data frame:
cat("The drought dataset has:", dim(drought)[1], "rows and", dim(drought)[2], "columns")
```

```
## The drought dataset has: 325728 rows and 10 columns
```

Check for any missing values

```
sum(is.na(drought))
```

```
## [1] 0
```

There are no missing values within the dataset

Clean the Data

First, observe the types and names of the variables

```
str(drought)
```

```
## 'data.frame': 325728 obs. of 10 variables:
## $ map_date : int 20210713 20210713 20210713 20210713 20210713 20210713 20210713 20210706 20210706 20210706 ...
## $ state_abb : chr "AK" "AK" "AK" "AK" ...
## $ valid_start: chr "2021-07-13" "2021-07-13" "2021-07-13" "2021-07-13" ...
## $ valid_end : chr "2021-07-19" "2021-07-19" "2021-07-19" "2021-07-19" ...
## $ stat_fmt : int 2 2 2 2 2 2 2 2 2 2 ...
## $ drought_lvl: chr "None" "D0" "D1" "D2" ...
## $ area_pct : num 74.3 25.6 0 0 0 ...
## $ area_total : num 433133 149435 0 0 0 ...
## $ pop_pct : num 33.9 66.1 0 0 0 ...
## $ pop_total : num 240644 468986 0 0 0 ...
```

Generally, it is good practice to change date variables such as `map_date`, `valid_start` and `valid_end` dates to numeric types

```
drought$map_date <- as.numeric(gsub("-", "", drought$map_date))
drought$valid_start <- as.numeric(gsub("-", "", drought$valid_start))
drought$valid_end <- as.numeric(gsub("-", "", drought$valid_end))
```

```
## num [1:325728] 20210713 20210713 20210713 20210713 20210713 ...
## num [1:325728] 20210713 20210713 20210713 20210713 20210713 ...
## num [1:325728] 20210719 20210719 20210719 20210719 20210719 ...
```

— Remove redundant columns —

Out of curiosity, I'd like to investigate `stat_fmt` since `drought_lvl`

```
cat("Unique values in stat_fmt: ", unique(drought$stat_fmt))
```

```
## Unique values in stat_fmt: 2
```

The only unique value within `stat_fmt` is 2, let's observe how many rows hold values of 2 and 1

```
nrows_sf1 <- nrow(drought[drought$stat_fmt == 1,])
nrows_sf2 <- nrow(drought[drought$stat_fmt == 2,])
cat("Number of rows where stat_fmt = 1:", nrows_sf1,
    "; Number of rows where stat_fmt = 2:", nrows_sf2, "\n")
```

```
## Number of rows where stat_fmt = 1: 0 ; Number of rows where stat_fmt = 2: 325728
```

```
## Number of rows in drought.csv: 325728
```

As the `stat_fmt` column does not provide any useful information I will remove it from the dataset.

```
drought <- drought %>%  
  select(-c("stat_fmt"))  
names(drought)
```

```
## [1] "map_date"      "state_abb"     "valid_start"  "valid_end"    "drought_lvl"  
## [6] "area_pct"      "area_total"    "pop_pct"      "pop_total"
```

— Reorganize dataset —

Reorder `map_date` in ascending value for each state; just my personal preference

```
drought_ordered <- drought[order(drought$state_abb, drought$valid_start),]  
head(drought_ordered)
```

```
##      map_date state_abb valid_start valid_end drought_lvl area_pct area_total  
## 6259 20010717      AK    20010717  20010723      None    97.92  570476.56  
## 6260 20010717      AK    20010717  20010723       D0     2.08   12091.73  
## 6261 20010717      AK    20010717  20010723       D1     0.00     0.00  
## 6262 20010717      AK    20010717  20010723       D2     0.00     0.00  
## 6263 20010717      AK    20010717  20010723       D3     0.00     0.00  
## 6264 20010717      AK    20010717  20010723       D4     0.00     0.00  
##      pop_pct pop_total  
## 6259    92.71 657899.35  
## 6260     7.29  51730.64  
## 6261     0.00     0.00  
## 6262     0.00     0.00  
## 6263     0.00     0.00  
## 6264     0.00     0.00
```

We may observe that there is a lot of redundancy in rows per date. As each state has 6 rows for the single week. The 6 separate rows are the statistics for each drought category.

— Split the Data —

To prepare for smoother data visualization, I will split the organized dataset for different purposes. The goal is to have separate datasets for Area Percentage, Area Total, Population Percentage, and Population Total.

Each new dataset will each have a more organized view of each respective quantity;

That is the Area Percentage dataset will have columns for each drought level, which will hold their respective `area_pct` statistics. The Area Total dataset will also have columns for each drought level, which will hold their respective `area_total` statistics, and so forth.

This way, it will be easier to reference the different data sets for different visualizations. We may visualize trends among drought levels for separate statistics.

To prepare, I will first split the organized dataset by drought level

Drought level None. Rename variable names to avoid confusion when joining later.

```
drought_none <- drought_ordered %>%  
  filter(drought_lvl=="None") %>%  
  rename(None = drought_lvl,  
         None.area_pct = area_pct,  
         None.area_total = area_total,  
         None.pop_pct = pop_pct,  
         None.pop_total = pop_total)  
  
head(drought_none)
```

```
##   map_date state_abb valid_start valid_end None None.area_pct None.area_total  
## 1 20010717      AK    20010717  20010723 None          97.92        570476.6  
## 2 20010724      AK    20010724  20010730 None          97.92        570476.6  
## 3 20010731      AK    20010731  20010806 None         100.00        582568.3  
## 4 20010807      AK    20010807  20010813 None         100.00        582568.3  
## 5 20010814      AK    20010814  20010820 None         100.00        582568.3  
## 6 20010821      AK    20010821  20010827 None         100.00        582568.3  
##   None.pop_pct None.pop_total  
## 1           92.71        657899.4  
## 2           92.71        657899.4  
## 3          100.00        709630.0  
## 4          100.00        709630.0  
## 5          100.00        709630.0  
## 6          100.00        709630.0
```

Drought level D0. Rename variable names to avoid confusion when joining later.

```
drought_D0 <- drought_ordered %>%  
  filter(drought_lvl == "D0") %>%  
  rename(D0 = drought_lvl,  
         D0.area_pct = area_pct,  
         D0.area_total = area_total,  
         D0.pop_pct = pop_pct,  
         D0.pop_total = pop_total)  
  
head(drought_D0)
```

```
##   map_date state_abb valid_start valid_end D0 D0.area_pct D0.area_total  
## 1 20010717      AK    20010717  20010723 D0           2.08        12091.73  
## 2 20010724      AK    20010724  20010730 D0           2.08        12091.73  
## 3 20010731      AK    20010731  20010806 D0           0.00           0.00  
## 4 20010807      AK    20010807  20010813 D0           0.00           0.00  
## 5 20010814      AK    20010814  20010820 D0           0.00           0.00  
## 6 20010821      AK    20010821  20010827 D0           0.00           0.00  
##   D0.pop_pct D0.pop_total  
## 1           7.29        51730.64  
## 2           7.29        51730.64  
## 3           0.00           0.00  
## 4           0.00           0.00  
## 5           0.00           0.00  
## 6           0.00           0.00
```

Drought level D1. Rename variable names to avoid confusion when joining later.

```
drought_D1 <- drought_ordered %>%  
  filter(drought_lvl == "D1") %>%  
  rename(D1 = drought_lvl,  
         D1.area_pct = area_pct,  
         D1.area_total = area_total,  
         D1.pop_pct = pop_pct,  
         D1.pop_total = pop_total)  
head(drought_D1)
```

```
##   map_date state_abb valid_start valid_end D1 D1.area_pct D1.area_total  
## 1 20010717      AK    20010717  20010723 D1          0          0  
## 2 20010724      AK    20010724  20010730 D1          0          0  
## 3 20010731      AK    20010731  20010806 D1          0          0  
## 4 20010807      AK    20010807  20010813 D1          0          0  
## 5 20010814      AK    20010814  20010820 D1          0          0  
## 6 20010821      AK    20010821  20010827 D1          0          0  
##   D1.pop_pct D1.pop_total  
## 1          0          0  
## 2          0          0  
## 3          0          0  
## 4          0          0  
## 5          0          0  
## 6          0          0
```

Drought level D2. Rename variable names to avoid confusion when joining later.

```
drought_D2 <- drought_ordered %>%  
  filter(drought_lvl == "D2") %>%  
  rename(D2 = drought_lvl,  
         D2.area_pct = area_pct,  
         D2.area_total = area_total,  
         D2.pop_pct = pop_pct,  
         D2.pop_total = pop_total)  
head(drought_D2)
```

```
##   map_date state_abb valid_start valid_end D2 D2.area_pct D2.area_total  
## 1 20010717      AK    20010717  20010723 D2          0          0  
## 2 20010724      AK    20010724  20010730 D2          0          0  
## 3 20010731      AK    20010731  20010806 D2          0          0  
## 4 20010807      AK    20010807  20010813 D2          0          0  
## 5 20010814      AK    20010814  20010820 D2          0          0  
## 6 20010821      AK    20010821  20010827 D2          0          0  
##   D2.pop_pct D2.pop_total  
## 1          0          0  
## 2          0          0  
## 3          0          0  
## 4          0          0  
## 5          0          0  
## 6          0          0
```

Drought level D3. Rename variable names to avoid confusion when joining later.

```
drought_D3 <- drought_ordered %>%  
  filter(drought_lvl == "D3") %>%  
  rename(D3 = drought_lvl,  
         D3.area_pct = area_pct,  
         D3.area_total = area_total,  
         D3.pop_pct = pop_pct,  
         D3.pop_total = pop_total)  
head(drought_D3)
```

```
##   map_date state_abb valid_start valid_end D3 D3.area_pct D3.area_total  
## 1 20010717      AK    20010717  20010723 D3          0          0  
## 2 20010724      AK    20010724  20010730 D3          0          0  
## 3 20010731      AK    20010731  20010806 D3          0          0  
## 4 20010807      AK    20010807  20010813 D3          0          0  
## 5 20010814      AK    20010814  20010820 D3          0          0  
## 6 20010821      AK    20010821  20010827 D3          0          0  
##   D3.pop_pct D3.pop_total  
## 1          0          0  
## 2          0          0  
## 3          0          0  
## 4          0          0  
## 5          0          0  
## 6          0          0
```

Drought level D4. Rename variable names to avoid confusion when joining later.

```
drought_D4 <- drought_ordered %>%  
  filter(drought_lvl == "D4") %>%  
  rename(D4 = drought_lvl,  
         D4.area_pct = area_pct,  
         D4.area_total = area_total,  
         D4.pop_pct = pop_pct,  
         D4.pop_total = pop_total)  
head(drought_D4)
```

```
##   map_date state_abb valid_start valid_end D4 D4.area_pct D4.area_total  
## 1 20010717      AK    20010717  20010723 D4          0          0  
## 2 20010724      AK    20010724  20010730 D4          0          0  
## 3 20010731      AK    20010731  20010806 D4          0          0  
## 4 20010807      AK    20010807  20010813 D4          0          0  
## 5 20010814      AK    20010814  20010820 D4          0          0  
## 6 20010821      AK    20010821  20010827 D4          0          0  
##   D4.pop_pct D4.pop_total  
## 1          0          0  
## 2          0          0  
## 3          0          0  
## 4          0          0  
## 5          0          0  
## 6          0          0
```


— Create the new split datasets —

To avoid repeatedly creating new empty datasets, I will create an empty dataframe that will act as a base for easy data insertion.

```
#dimensions
numcols <- ncol(drought_none) + 1
numrows <- nrow(drought_none)

#create a matrix with placeholder columns and convert to a data frame
empty_template <- data.frame(
  matrix(ncol = numcols,
        nrow = numRows))
```

The only difference between the new datasets will be their respective statistic values for each drought level. Therefore I will go ahead and rename the *constant* placeholder columns.

```
template_cnames <- c("map_date", "state_abb", "valid_start", "valid_end",
                    "None", "D0", "D1", "D2", "D3", "D4")
colnames(empty_template) <- template_cnames
```

drought_area_pct: new dataset which will hold area_pct statistics from the separate drought level datasets.

```
drought_area_pct <- empty_template %>%
  #insert correct data
  mutate(
    map_date = drought_none$map_date,
    state_abb = drought_none$state_abb,
    valid_start = drought_none$valid_start,
    valid_end = drought_none$valid_end,
    None = drought_none$None.area_pct,
    D0 = drought_D0$D0.area_pct,
    D1 = drought_D1$D1.area_pct,
    D2 = drought_D2$D2.area_pct,
    D3 = drought_D3$D3.area_pct,
    D4 = drought_D4$D4.area_pct
  )

head(drought_area_pct)
```

```
##   map_date state_abb valid_start valid_end   None   D0 D1 D2 D3 D4
## 1 20010717      AK   20010717  20010723  97.92 2.08 0 0 0 0
## 2 20010724      AK   20010724  20010730  97.92 2.08 0 0 0 0
## 3 20010731      AK   20010731  20010806 100.00 0.00 0 0 0 0
## 4 20010807      AK   20010807  20010813 100.00 0.00 0 0 0 0
## 5 20010814      AK   20010814  20010820 100.00 0.00 0 0 0 0
## 6 20010821      AK   20010821  20010827 100.00 0.00 0 0 0 0
```

drought_area_total: new dataset which will hold area_total statistics from the separate drought level datasets.

```
drought_area_total <- empty_template %>%
  #insert correct data
  mutate(
    map_date = drought_D0$map_date,
    state_abb = drought_D0$state_abb,
    valid_start = drought_D0$valid_start,
    valid_end = drought_D0$valid_end,
    None = drought_none$None.area_total,
    D0 = drought_D0$D0.area_total,
    D1 = drought_D1$D1.area_total,
    D2 = drought_D2$D2.area_total,
    D3 = drought_D3$D3.area_total,
    D4 = drought_D4$D4.area_total
  )

head(drought_area_total)
```

##	map_date	state_abb	valid_start	valid_end	None	D0	D1	D2	D3	D4
## 1	20010717	AK	20010717	20010723	570476.6	12091.73	0	0	0	0
## 2	20010724	AK	20010724	20010730	570476.6	12091.73	0	0	0	0
## 3	20010731	AK	20010731	20010806	582568.3	0.00	0	0	0	0
## 4	20010807	AK	20010807	20010813	582568.3	0.00	0	0	0	0
## 5	20010814	AK	20010814	20010820	582568.3	0.00	0	0	0	0
## 6	20010821	AK	20010821	20010827	582568.3	0.00	0	0	0	0

drought_pop_pct: new dataset which will hold pop_pct statistics from the separate drought level datasets.

```
drought_pop_pct <- empty_template %>%
  #insert correct data
  mutate(
    map_date = drought_D1$map_date,
    state_abb = drought_D1$state_abb,
    valid_start = drought_D1$valid_start,
    valid_end = drought_D1$valid_end,
    None = drought_none$None.pop_pct,
    D0 = drought_D0$D0.pop_pct,
    D1 = drought_D1$D1.pop_pct,
    D2 = drought_D2$D2.pop_pct,
    D3 = drought_D3$D3.pop_pct,
    D4 = drought_D4$D4.pop_pct
  )

head(drought_pop_pct)
```

##	map_date	state_abb	valid_start	valid_end	None	D0	D1	D2	D3	D4
## 1	20010717	AK	20010717	20010723	92.71	7.29	0	0	0	0
## 2	20010724	AK	20010724	20010730	92.71	7.29	0	0	0	0
## 3	20010731	AK	20010731	20010806	100.00	0.00	0	0	0	0
## 4	20010807	AK	20010807	20010813	100.00	0.00	0	0	0	0
## 5	20010814	AK	20010814	20010820	100.00	0.00	0	0	0	0
## 6	20010821	AK	20010821	20010827	100.00	0.00	0	0	0	0

drought_pop_total: new dataset which will hold pop_total statistics from the separate drought level datasets.

```
drought_pop_total <- empty_template %>%  
  #insert correct data  
  mutate(  
    map_date = drought_D2$map_date,  
    state_abb = drought_D2$state_abb,  
    valid_start = drought_D2$valid_start,  
    valid_end = drought_D2$valid_end,  
    None = drought_none$None.pop_pct,  
    D0 = drought_D0$D0.pop_total,  
    D1 = drought_D1$D1.pop_total,  
    D2 = drought_D2$D2.pop_total,  
    D3 = drought_D3$D3.pop_total,  
    D4 = drought_D4$D4.pop_total  
  )  
  
head(drought_pop_total)
```

##	map_date	state_abb	valid_start	valid_end	None	D0	D1	D2	D3	D4
## 1	20010717	AK	20010717	20010723	92.71	51730.64	0	0	0	0
## 2	20010724	AK	20010724	20010730	92.71	51730.64	0	0	0	0
## 3	20010731	AK	20010731	20010806	100.00	0.00	0	0	0	0
## 4	20010807	AK	20010807	20010813	100.00	0.00	0	0	0	0
## 5	20010814	AK	20010814	20010820	100.00	0.00	0	0	0	0
## 6	20010821	AK	20010821	20010827	100.00	0.00	0	0	0	0

Exploratory Data Analysis

Visualization: heatmap for drought scales summed by state from drought_pop_total

```
drought_categories <- c("D0", "D1", "D2", "D3", "D4")

state_summary_pt <- drought_pop_total %>%
  group_by(state_abb) %>% summarise(across(all_of(drought_categories), sum, na.rm = TRUE))
```

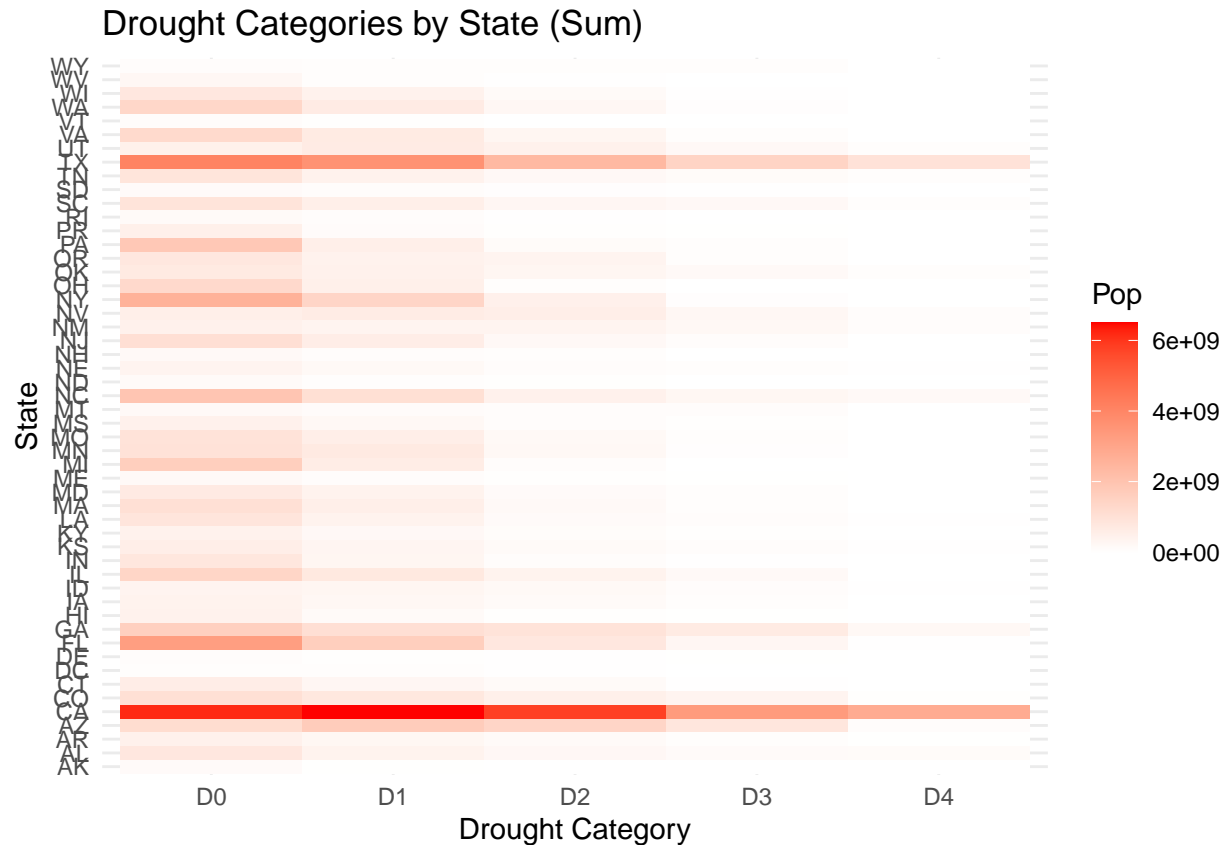
```
## Warning: There was 1 warning in 'summarise()'.
## i In argument: 'across(all_of(drought_categories), sum, na.rm = TRUE)'.
## i In group 1: 'state_abb = "AK"'.
## Caused by warning:
## ! The '...' argument of 'across()' is deprecated as of dplyr 1.1.0.
## Supply arguments directly to '.fns' through an anonymous function instead.
##
## # Previously
##   across(a:b, mean, na.rm = TRUE)
##
## # Now
##   across(a:b, \(x) mean(x, na.rm = TRUE))
```

```
state_summary_pt[1:10,]
```

```
## # A tibble: 10 x 6
##   state_abb      D0      D1      D2      D3      D4
##   <chr>      <dbl>    <dbl>    <dbl>    <dbl>    <dbl>
## 1 AK        157387100.  15366979.  2976425.  726274.    0
## 2 AL        803709762.  417723844.  260759919.  156726827.  136751121.
## 3 AR        473496609.  288524453.  162688805.  62429838.  14452802.
## 4 AZ        1175352142.  1728834137.  1422830343.  851384913.  102420372.
## 5 CA        6187507992.  6506120260.  5809135815.  3360040370.  2819950088.
## 6 CO        1065891313.  789374210.  526108996.  378947531.  50763254.
## 7 CT        600304377.  298549078.  163987224.  29993311.    0
## 8 DC        75627490.  66545943.  19965853.  5983698.    0
## 9 DE        110186886.  47118087.  30365223.  13413725.  1087418.
## 10 FL       3263070029.  1635841745.  804472334.  302432239.  33127878.
```

```
state_summary_long_pt <- state_summary_pt %>%
  pivot_longer(cols = all_of(drought_categories), names_to = "Category", values_to = "Pop")

ggplot(state_summary_long_pt, aes(x = Category, y = state_abb, fill = Pop)) +
  geom_tile() +
  scale_fill_gradient(low = "white", high = "red") +
  labs(title = "Drought Categories by State (Sum)",
       x = "Drought Category",
       y = "State") +
  theme_minimal()
```



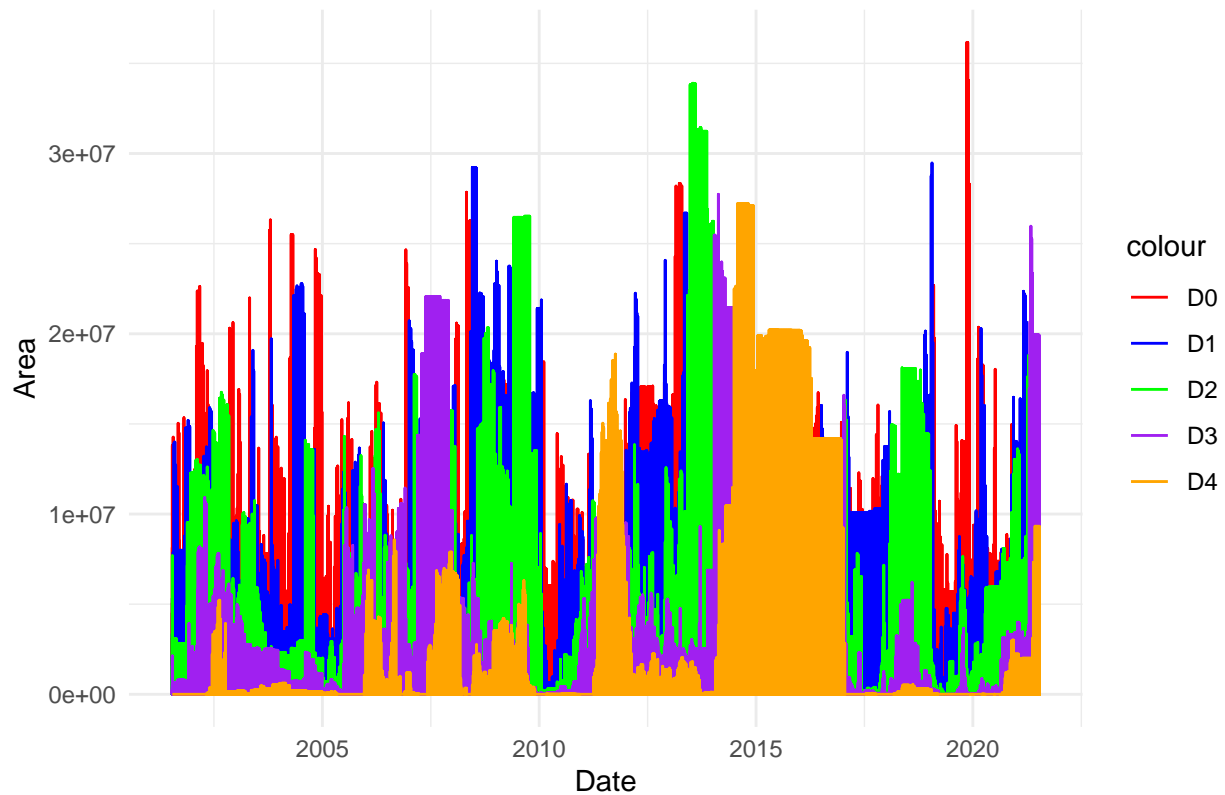
As the heat map shows, it is not very surprising that the populations of California and Texas have been reported to be highly affected by drought. California is highly populated. Both California and Texas are among hot, dry weather conditions that often receive droughts.

Visualization: reported state population affected by each drought category over time

```
drought_pop_total$map_date <- as.Date(as.character(drought_pop_total$map_date), format="%Y%m%d")
```

```
ggplot(drought_pop_total, aes(x=map_date)) +
  geom_line(aes(y=D0, color="D0")) +
  geom_line(aes(y=D1, color="D1")) +
  geom_line(aes(y=D2, color="D2")) +
  geom_line(aes(y=D3, color="D3")) +
  geom_line(aes(y=D4, color="D4")) +
  labs(title="Drought Categories Effect on Population Over Time",
        x="Date",
        y = "Area") +
  scale_color_manual(values = c("red", "blue", "green", "purple", "orange")) + theme_minimal()
```

Drought Categories Effect on Population Over Time



From `drought_area_total` let's observe a State-level summary of how much total land area has been affected by each drought category

```
drought_categories <- c("D0", "D1", "D2", "D3", "D4")
state_summary_at <- drought_area_total %>%
  group_by(state_abb) %>%
  summarise(across(all_of(drought_categories), sum, na.rm = TRUE))
state_summary_at[1:10,]
```

```
## # A tibble: 10 x 6
##   state_abb      D0      D1      D2      D3      D4
##   <chr>      <dbl>    <dbl>    <dbl>    <dbl>    <dbl>
## 1 AK      99949965.  6327434.  875942.  124286.     0
## 2 AL      9002530.  4742872.  2941230. 1756565. 1117915.
## 3 AR      8373619.  5188830.  3146306. 1195528.  247864.
## 4 AZ      22782473. 28316155. 24714273. 15353312. 4151144.
## 5 CA      26239845. 28697838. 26435571. 14384897. 9348866.
## 6 CO      22585843. 15472701. 14313591. 11635585. 2959151.
## 7 CT       851493.  438609.  212229.  39263.     0
## 8 DC        7567.   6659.   1998.    599.     0
## 9 DE       257745.  138726.  84844.  24481.   2790.
## 10 FL     10132823.  5270176. 2733205. 1068337. 107694.
```

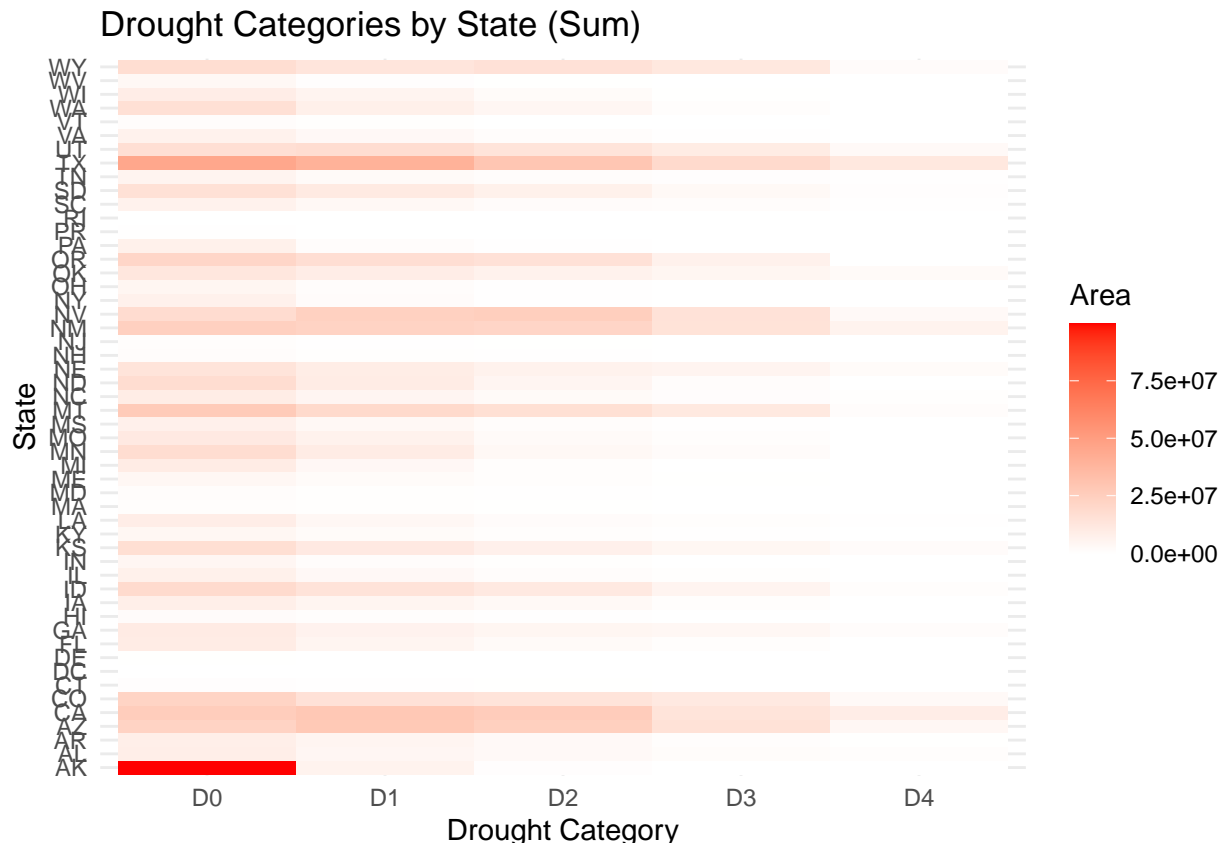
Visualization: heatmap for total land area by state affected by each drought category, from `drought_area_total`

```

state_summary_long_at <- state_summary_at %>%
pivot_longer(cols = all_of(drought_categories), names_to = "Category", values_to = "Area")

ggplot(state_summary_long_at, aes(x = Category, y = state_abb, fill = Area)) +
  geom_tile() +
  scale_fill_gradient(low = "white", high = "red") +
  labs(title = "Drought Categories by State (Sum)",
       x = "Drought Category",
       y = "State") +
  theme_minimal()

```



As we can see, Arkansas' total land area mostly experiences drought at the milder D0 category. States such as Texas, Nevada, New Mexico, Colorado, California, and Arizona have a fairly even, extensive spread of land that has been affected up to drought levels of D3. Some even reach D4. This may be likely a sign of a steady increase in climate change and its effects increase yearly.

```

drought_area_total$map_date <- as.Date(as.character(drought_area_total$map_date), format="%Y%m%d")

```

```

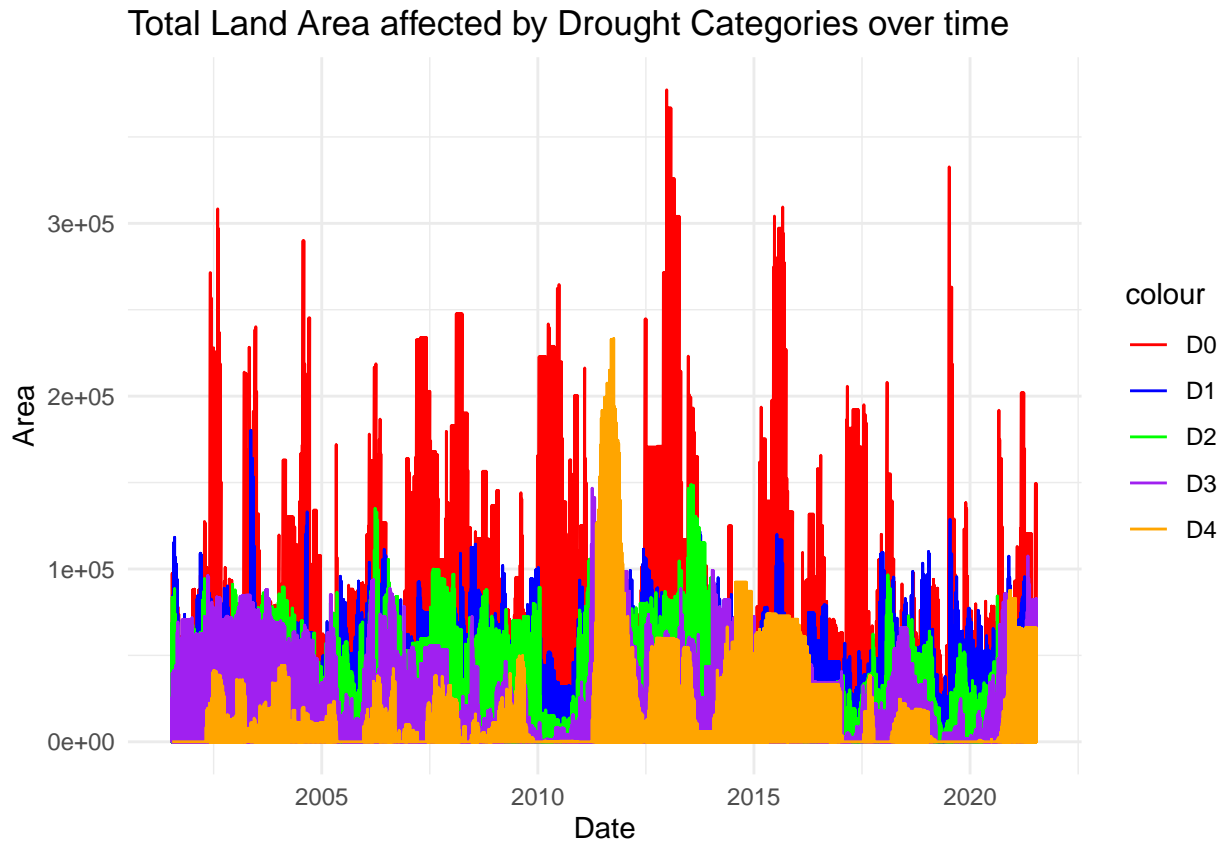
ggplot(drought_area_total, aes(x=map_date)) +
  geom_line(aes(y=D0, color="D0")) +
  geom_line(aes(y=D1, color="D1")) +
  geom_line(aes(y=D2, color="D2")) +
  geom_line(aes(y=D3, color="D3")) +
  geom_line(aes(y=D4, color="D4")) +
  labs(title="Total Land Area affected by Drought Categories over time",
       x="Date",

```

```

y = "Area") +
scale_x_date(limits = c(as.Date("2001-07-10"),
                        as.Date("2021-07-30")),
            date_labels = "%Y") +
scale_color_manual(values = c("red", "blue", "green", "purple", "orange")) +
theme_minimal()

```



We may observe there still steady spikes in D0-level droughts, as well as higher amounts of land affected by D4-level droughts. The D4-level droughts's effects more land over time and have much longer durations prior to ~2011. Among each drought category, there is a notable dip around the late 2010s, which is likely when the effects of icecaps and glaciers melting cooled the weather and alleviated land area affected by drought. Then we see a spike and increase in duration again entering 2021, which may represent the cyclical nature of regular seasonal changes or even that of climate change.