Hurricane

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Introduction

This is a dataset about the public assistance funded projects provided by FEMA. FEMA is a agency that coordinate the local state to response to the disaster, such as provides the local government with experts in special fields or funding for rebuilding efforts. In this project, we used the doughnut map to show the proportion of all types of damage caused by hurricanes that hit the country from 2008 to 2019, and the frequency distribution of damage in different states. To better present the data, then we show the data in more detail in terms of years.

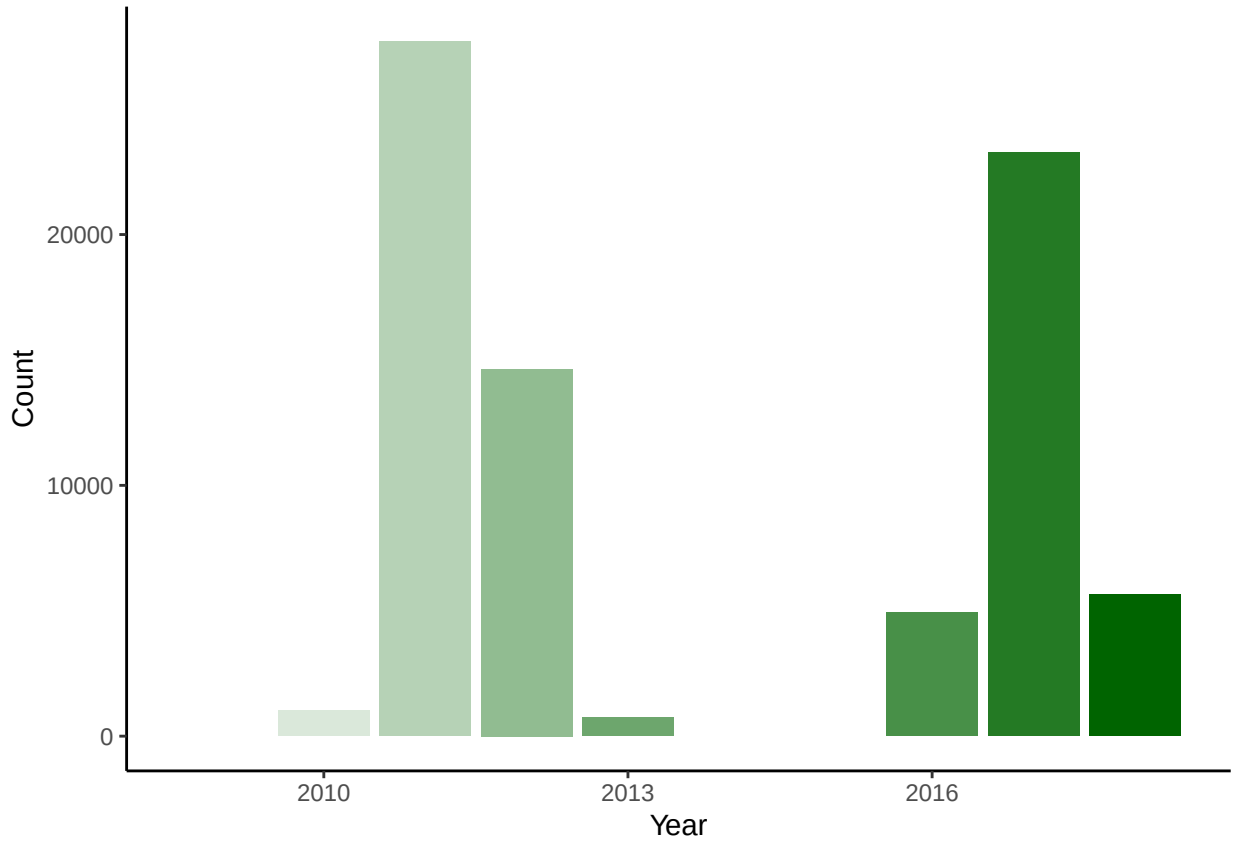
```
## data from Fema, select data which incident type being "Hurricane" and happened between 2009 to 2018
df <- read.csv("D:\\R project\\615\\Project-FEMA\\PublicAssistanceFundedProjectsDetails.csv", header = T
df <- subset(df, df$incidentType == "Hurricane")
#summary(df$projectAmount)
#summary(df$federalShareObligated)
## delete data which is negative
df <- subset(df, df$projectAmount > 0 & df$federalShareObligated > 0)
df$year <- as.numeric(substr(df$declarationDate, 1,4))
df <- subset(df, df$year>=2009 & df$year <= 2018)
df <- df %>% mutate(ID=str_c(state,county,sep = ","))
df$ID <- tolower(df$ID)
dy <- df # store the data frame for yearly figure
```

```
# unique(df$state)
counties_C <- c("alabama", "texas", "virgin islands of the U.S.", "north carolina", "massachusetts", "pu
state_CB <- map_data("state", counties_C)
counties_CB<- map_data("county", counties_C)
head(df)
```

```
##   disasterNumber          declarationDate incidentType pwNumber
## 1           1866 2009-12-22T05:00:00.000Z    Hurricane        2
## 2           1866 2009-12-22T05:00:00.000Z    Hurricane        4
## 3           1866 2009-12-22T05:00:00.000Z    Hurricane        5
## 4           1866 2009-12-22T05:00:00.000Z    Hurricane        6
## 5           1866 2009-12-22T05:00:00.000Z    Hurricane        7
## 6           1866 2009-12-22T05:00:00.000Z    Hurricane        8
##   applicationTitle  applicantId      damageCategoryCode dcc      damageCategory
## 1      DIW-097-01F 097-U15P3-00    F - Public Utilities   F    Public Utilities
## 2      DIW-097-04F 097-U15P3-00    F - Public Utilities   F    Public Utilities
## 3      DIW-097-01B 097-U15P3-00 B - Protective Measures   B Protective Measures
## 4          FOL-01B 003-26992-00 B - Protective Measures   B Protective Measures
## 5          BAL-01B 003-99003-00 B - Protective Measures   B Protective Measures
## 6         D102ADLR 097-19744-00      A - Debris Removal   A      Debris Removal
##   projectSize  county countyCode   state stateCode stateNumberCode
```

```
## 1       Large  Mobile         97 Alabama        AL               1
## 2       Small  Mobile         97 Alabama        AL               1
## 3       Small  Mobile         97 Alabama        AL               1
## 4       Small Baldwin          3 Alabama        AL               1
## 5       Small Baldwin          3 Alabama        AL               1
## 6       Small  Mobile         97 Alabama        AL               1
##   projectAmount federalShareObligated totalObligated           obligatedDate
## 1      58425.34              43819.01       43819.01 2010-01-28T03:33:40.000Z
## 2      12778.47               9583.85        9583.85 2010-01-28T03:33:40.000Z
## 3      15290.26              11467.70       11467.70 2010-01-28T03:33:40.000Z
## 4       9820.02               7365.02        7365.02 2010-01-28T03:33:40.000Z
## 5      22003.57              16502.68       16502.68 2010-01-28T03:33:40.000Z
## 6      32126.92              24095.19       24095.19 2010-01-28T03:33:40.000Z
##                                hash              lastRefresh
## 1 2208b99d98f3ad0858e5bfe615c63ccc 2020-06-15T11:33:48.983Z
## 2 81e4c0dcd9873684e927069be0274394 2020-06-15T11:33:48.985Z
## 3 2296b207e4b3118ec6a8ded1f11dcfd3 2020-06-15T11:33:48.986Z
## 4 ab0cd713b8357092a33c2564ebb4c083 2020-06-15T11:33:48.987Z
## 5 bc596df1be80e806d4496ccef7b568a1 2020-06-15T11:33:48.988Z
## 6 cf748f9cdef691f0168f5a6ef86c5706 2020-06-15T11:33:48.990Z
##                          id year              ID
## 1 5ee75c9c556129600ddb60c4 2009  alabama,mobile
## 2 5ee75c9c556129600ddb60c6 2009  alabama,mobile
## 3 5ee75c9c556129600ddb60c7 2009  alabama,mobile
## 4 5ee75c9c556129600ddb60c8 2009 alabama,baldwin
## 5 5ee75c9c556129600ddb60c9 2009 alabama,baldwin
## 6 5ee75c9c556129600ddb60ca 2009  alabama,mobile
```

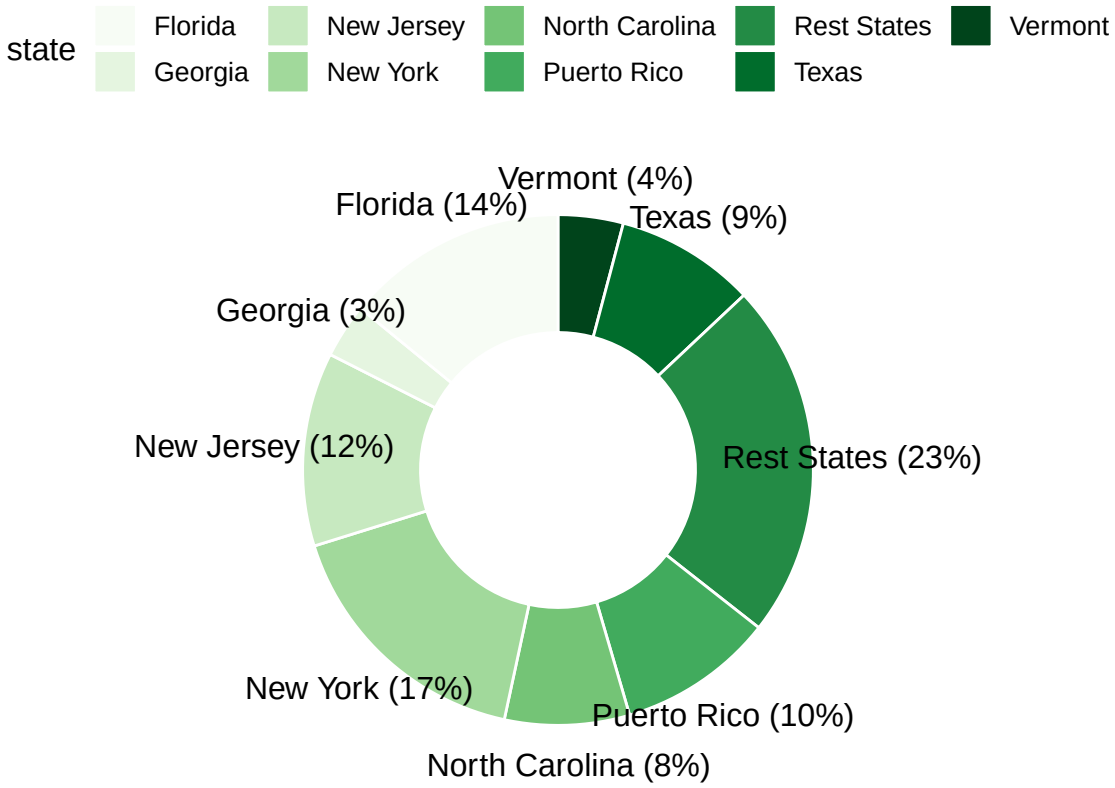
```r
## focus on the frequency distribution of diaster in terms of different years, using bar chart
du <- df
yearcount <- du %>% group_by(year) %>% summarize(count=sum(year!= "0"))
colors <- colorRampPalette(c("white","dark green"))(8)
ggplot(yearcount, mapping=aes(x=year, y=count)) +
  geom_bar(stat="identity",fill=colors)+
  labs(x="Year", y="Count") +
  theme_classic()
```



EDA

```
ds <- df
## calculate the frequency distribution of damage in different states
statecount <- ds %>% group_by(state) %>% summarize(count=sum(state!= "0"))
statecount <- statecount[order(statecount$count), ]
# Georgia 2692
# Vermont   3218
# North Carolina    6162
# Texas 6914
# Puerto Rico   7704
# New Jersey    9576
# Florida   10979
# New York  13115
## calculate the sum of frequency of rest of the states
topstate <- statecount[20:27,]
names(topstate) <- c("state","count")
restcount <- sum(statecount$count)-sum(topstate$count)
reststate <- data.frame("Rest States",restcount)
names(reststate)<-c("state","count")
newstate <- rbind(topstate, reststate)
newstate$percent_value = round(newstate$count/sum(newstate$count) * 100)
newstate$labs <- paste0(newstate$state, " (", newstate$percent_value, "%)")
ggdonutchart(newstate, "count",
             label = "labs",
             fill = "state",
             lab.adjust = 0,
             lab.font = c(4, "bold", "grey"),
```

```
            color = "white",
            palette = "Greens" ) +
    coord_polar(theta = "y", start = 0, clip = "off")
```




```
head(ds)
```

```
##   disasterNumber          declarationDate incidentType pwNumber
## 1           1866 2009-12-22T05:00:00.000Z    Hurricane        2
## 2           1866 2009-12-22T05:00:00.000Z    Hurricane        4
## 3           1866 2009-12-22T05:00:00.000Z    Hurricane        5
## 4           1866 2009-12-22T05:00:00.000Z    Hurricane        6
## 5           1866 2009-12-22T05:00:00.000Z    Hurricane        7
## 6           1866 2009-12-22T05:00:00.000Z    Hurricane        8
##   applicationTitle  applicantId      damageCategoryCode dcc      damageCategory
## 1      DIW-097-01F 097-U15P3-00    F - Public Utilities   F    Public Utilities
## 2      DIW-097-04F 097-U15P3-00    F - Public Utilities   F    Public Utilities
## 3      DIW-097-01B 097-U15P3-00 B - Protective Measures   B Protective Measures
## 4          FOL-01B 003-26992-00 B - Protective Measures   B Protective Measures
## 5          BAL-01B 003-99003-00 B - Protective Measures   B Protective Measures
## 6         D102ADLR 097-19744-00      A - Debris Removal   A      Debris Removal
##   projectSize  county countyCode   state stateCode stateNumberCode
## 1       Large  Mobile         97 Alabama        AL               1
## 2       Small  Mobile         97 Alabama        AL               1
## 3       Small  Mobile         97 Alabama        AL               1
## 4       Small Baldwin          3 Alabama        AL               1
## 5       Small Baldwin          3 Alabama        AL               1
```

```
## 6       Small  Mobile         97 Alabama        AL               1
##   projectAmount federalShareObligated totalObligated           obligatedDate
## 1      58425.34              43819.01       43819.01 2010-01-28T03:33:40.000Z
## 2      12778.47               9583.85        9583.85 2010-01-28T03:33:40.000Z
## 3      15290.26              11467.70       11467.70 2010-01-28T03:33:40.000Z
## 4       9820.02               7365.02        7365.02 2010-01-28T03:33:40.000Z
## 5      22003.57              16502.68       16502.68 2010-01-28T03:33:40.000Z
## 6      32126.92              24095.19       24095.19 2010-01-28T03:33:40.000Z
##                                 hash              lastRefresh
## 1 2208b99d98f3ad0858e5bfe615c63ccc 2020-06-15T11:33:48.983Z
## 2 81e4c0dcd9873684e927069be0274394 2020-06-15T11:33:48.985Z
## 3 2296b207e4b3118ec6a8ded1f11dcfd3 2020-06-15T11:33:48.986Z
## 4 ab0cd713b8357092a33c2564ebb4c083 2020-06-15T11:33:48.987Z
## 5 bc596df1be80e806d4496ccef7b568a1 2020-06-15T11:33:48.988Z
## 6 cf748f9cdef691f0168f5a6ef86c5706 2020-06-15T11:33:48.990Z
##                          id year              ID
## 1 5ee75c9c556129600ddb60c4 2009  alabama,mobile
## 2 5ee75c9c556129600ddb60c6 2009  alabama,mobile
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## 4 5ee75c9c556129600ddb60c8 2009 alabama,baldwin
## 5 5ee75c9c556129600ddb60c9 2009 alabama,baldwin
## 6 5ee75c9c556129600ddb60ca 2009  alabama,mobile
```
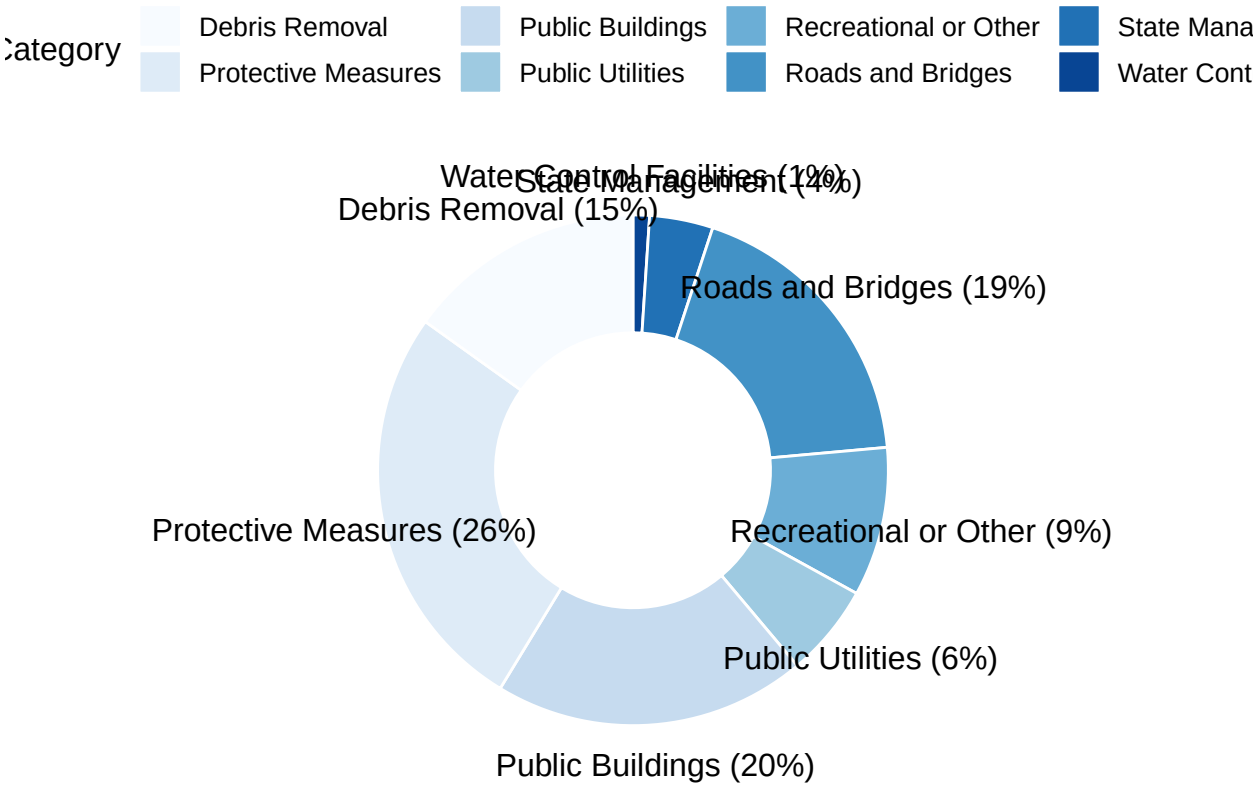

```r
## Focus on the distribution of damage category
dd <- df
damagecategorycount <- dd %>% group_by(damageCategory) %>%     summarize(count=sum(damageCategory!= "0")
damagecategorycount <- damagecategorycount[order(damagecategorycount$count), ]
damagecategorycount$percent_value = round(damagecategorycount$count/sum(damagecategorycount$count) * 10
damagecategorycount$labs <- paste0(damagecategorycount$damageCategory, " (", damagecategorycount$percen
ggdonutchart(damagecategorycount, "count",
             label = "labs",
             fill = "damageCategory",
             lab.adjust = 0,
             lab.font = c(2, "bold", "grey"),
             color = "white",
             palette = "Blues" ) +
    coord_polar(theta = "y", start = 0, clip = "off")
```




```
head(dd)
```

```
##   disasterNumber          declarationDate incidentType pwNumber
## 1           1866 2009-12-22T05:00:00.000Z    Hurricane        2
## 2           1866 2009-12-22T05:00:00.000Z    Hurricane        4
## 3           1866 2009-12-22T05:00:00.000Z    Hurricane        5
## 4           1866 2009-12-22T05:00:00.000Z    Hurricane        6
## 5           1866 2009-12-22T05:00:00.000Z    Hurricane        7
## 6           1866 2009-12-22T05:00:00.000Z    Hurricane        8
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##   projectSize  county countyCode   state stateCode stateNumberCode
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## 5       Small Baldwin          3 Alabama        AL               1
## 6       Small  Mobile         97 Alabama        AL               1
##   projectAmount federalShareObligated totalObligated            obligatedDate
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## 2      12778.47               9583.85        9583.85 2010-01-28T03:33:40.000Z
```

```
## 3      15290.26              11467.70       11467.70 2010-01-28T03:33:40.000Z
## 4       9820.02               7365.02        7365.02 2010-01-28T03:33:40.000Z
## 5      22003.57              16502.68       16502.68 2010-01-28T03:33:40.000Z
## 6      32126.92              24095.19       24095.19 2010-01-28T03:33:40.000Z
##                                 hash             lastRefresh
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## 2 81e4c0dcd9873684e927069be0274394 2020-06-15T11:33:48.985Z
## 3 2296b207e4b3118ec6a8ded1f11dcfd3 2020-06-15T11:33:48.986Z
## 4 ab0cd713b8357092a33c2564ebb4c083 2020-06-15T11:33:48.987Z
## 5 bc596df1be80e806d4496ccef7b568a1 2020-06-15T11:33:48.988Z
## 6 cf748f9cdef691f0168f5a6ef86c5706 2020-06-15T11:33:48.990Z
##                          id year              ID
## 1 5ee75c9c556129600ddb60c4 2009  alabama,mobile
## 2 5ee75c9c556129600ddb60c6 2009  alabama,mobile
## 3 5ee75c9c556129600ddb60c7 2009  alabama,mobile
## 4 5ee75c9c556129600ddb60c8 2009 alabama,baldwin
## 5 5ee75c9c556129600ddb60c9 2009 alabama,baldwin
## 6 5ee75c9c556129600ddb60ca 2009  alabama,mobile
```

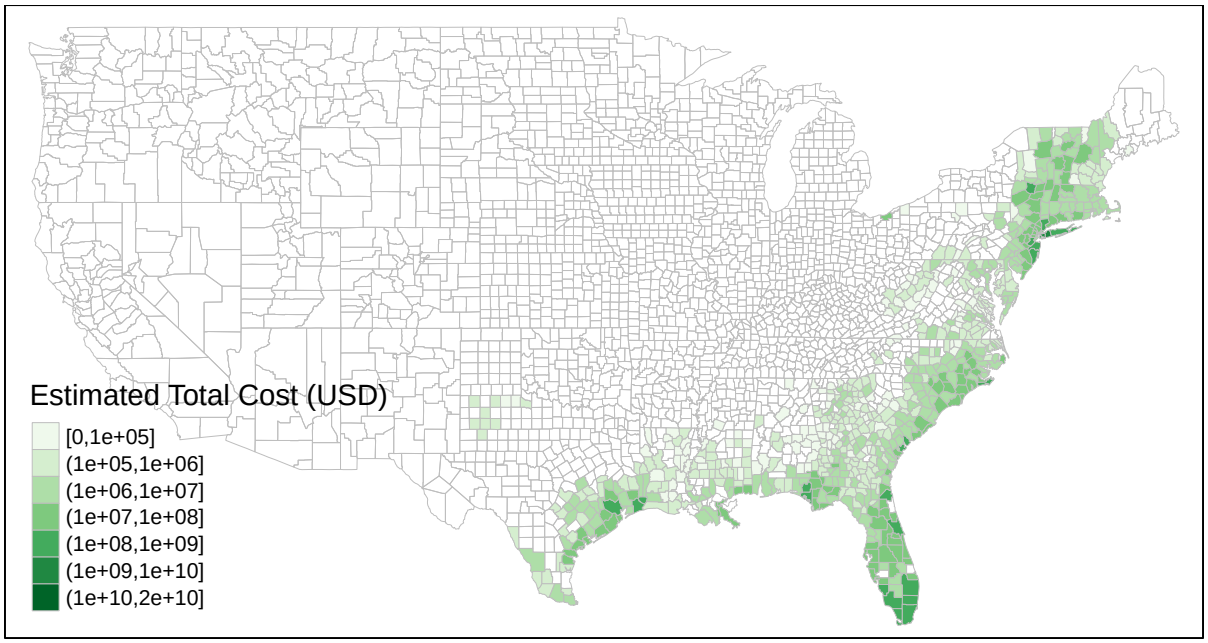
Mapping

Focus on "Project Amount"

The estimated total cost of the Public Assistance grant project in dollars, without administrative costs. This amount is based on the damage survey.

```r
## the estimated total cost of Public Assistance grant project from 2009 to 2018
df_c <- df %>%
  group_by(ID) %>%
  summarize(projectAmount = sum(projectAmount))
df_c <- df_c %>%
  mutate(`Estimated Total Cost (USD)` = cut(df_c$projectAmount,
                      breaks=c(0,100000,1000000,10000000,100000000,1000000000,10000000000,20000000000),
                      include.lowest = TRUE))
ttMap <- st_as_sf(maps::map("county",plot=FALSE,fill=TRUE))
df_c <- left_join(ttMap,df_c,by="ID")
df_c %<>% select(-projectAmount)
```

```r
# Mapping
tm_shape(df_c)+
  tm_polygons("Estimated Total Cost (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Estimated Total Cost (USD)",
              palette = "Greens") +
  tm_layout(main.title = 'Project_Amount 2009-2018',main.title.position="center")
```



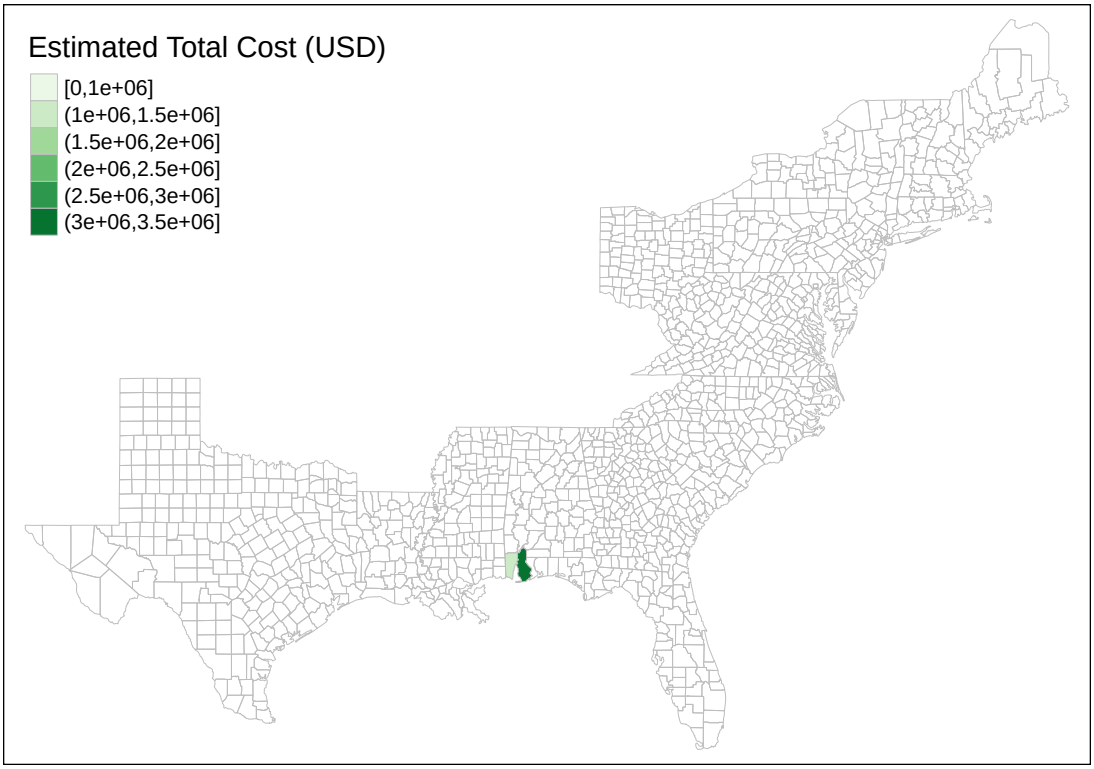
2009

```
## the estimated total cost of Public Assistance grant project for 2009
dy_2009 <- subset(dy, dy$year==2009)
dy_2009 <- dy_2009 %>%
  group_by(ID) %>%
  summarize(projectAmount = sum(projectAmount))
summary(dy_2009$projectAmount)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 1184470 1240211 1295953 1849006 2181274 3066595
```

```
dy_2009 <- dy_2009 %>%
  mutate(`Estimated Total Cost (USD)` = cut(dy_2009$projectAmount,
                    breaks=c(0,1000000,1500000,2000000,2500000,3000000,3500000),
                    include.lowest = TRUE))
tMap <- st_as_sf(map("county",counties_C ,plot=F,fill=T))
dy_2009 <- left_join(tMap,dy_2009,by="ID")
dy_2009 %<>% select(-projectAmount)
## Mapping
tm_shape(dy_2009)+
  tm_polygons("Estimated Total Cost (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Estimated Total Cost (USD)",
              palette = "Greens") +
  tm_layout(main.title = 'Project_Amount 2009',main.title.position="center")
```

Project_Amount 2009



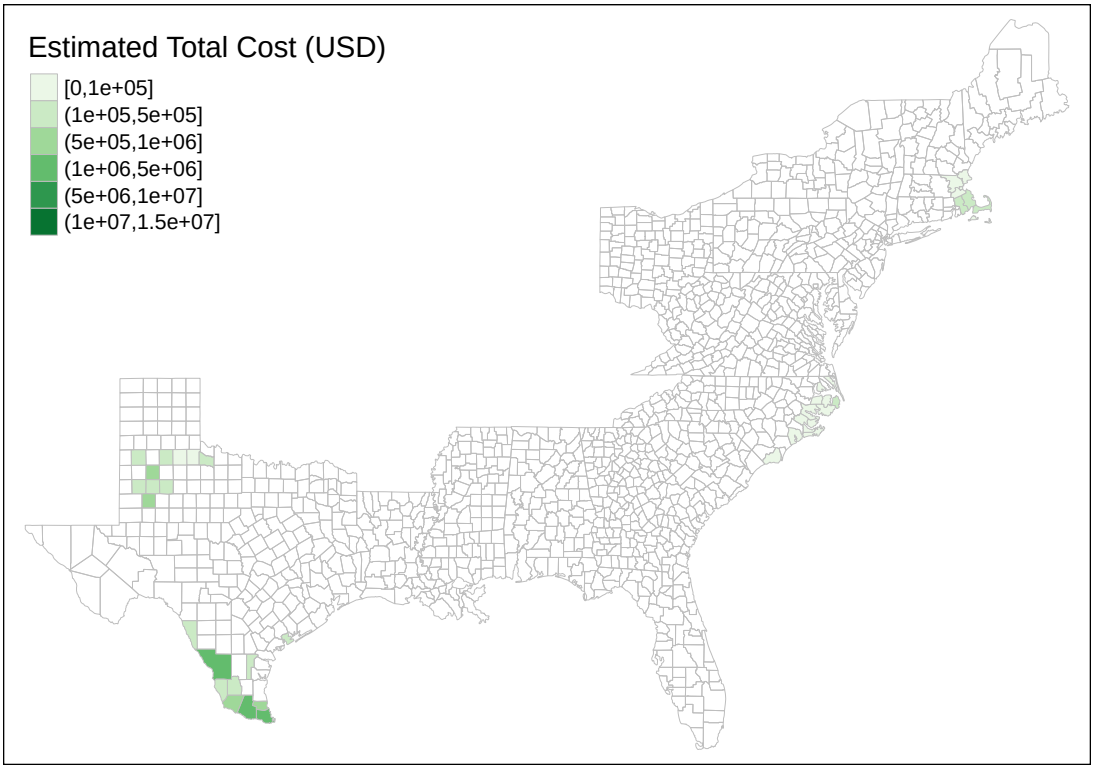
2010

```
## the estimated total cost of Public Assistance grant project for 2010
dy_2010 <- subset(dy, dy$year==2010)
dy_2010 <- dy_2010 %>%
  group_by(ID) %>%
  summarize(projectAmount = sum(projectAmount))
summary(dy_2010$projectAmount)
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
##     1837    17011   122852   704908   398640 10946933
```

```
dy_2010 <- dy_2010 %>%
  mutate(`Estimated Total Cost (USD)` = cut(dy_2010$projectAmount,
                    breaks=c(0,100000,500000,1000000,5000000,10000000,15000000),
                    include.lowest = TRUE))
dy_2010 <- left_join(tMap,dy_2010,by="ID")
dy_2010 %<>% select(-projectAmount)
## Mapping
tm_shape(dy_2010)+
  tm_polygons("Estimated Total Cost (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Estimated Total Cost (USD)",
              palette = "Greens") +
  tm_layout(main.title = 'Project_Amount 2010',main.title.position="center")
```

Project_Amount 2010



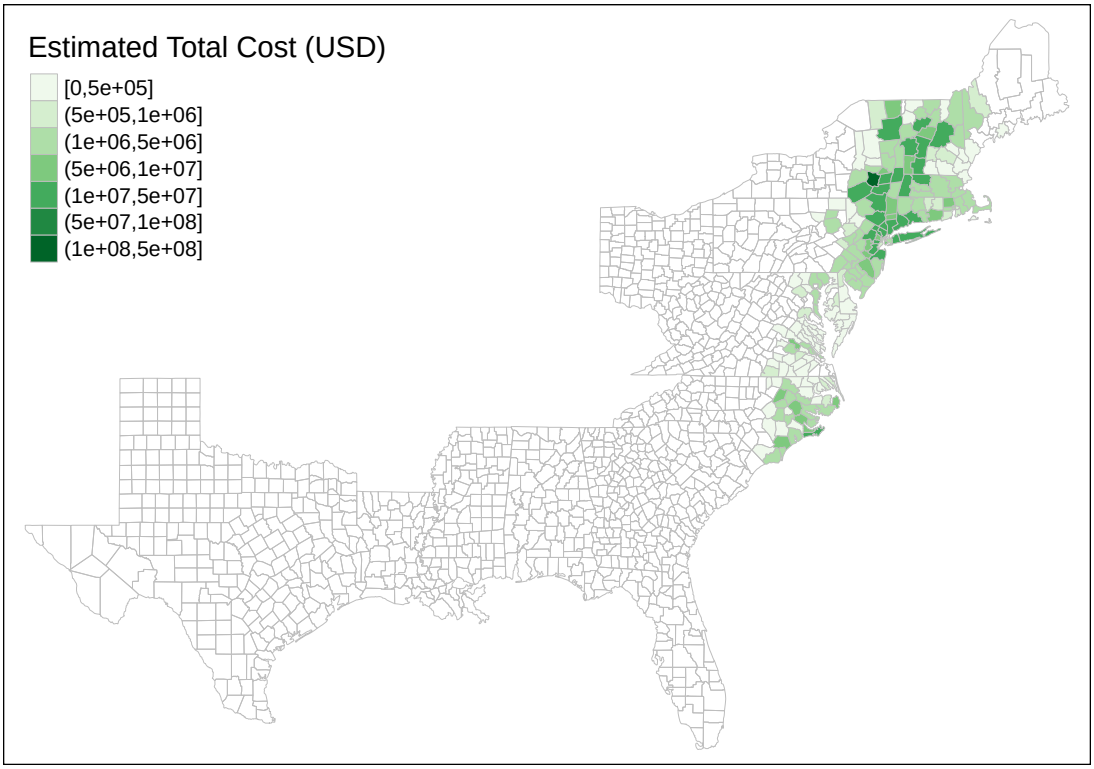
2011

```
## the estimated total cost of Public Assistance grant project for 2011
dy_2011 <- subset(dy, dy$year==2011)
dy_2011 <- dy_2011 %>%
  group_by(ID) %>%
  summarize(projectAmount = sum(projectAmount))
summary(dy_2011$projectAmount)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
##      3751    307015   1002479   5224165   3357525 233833258
```

```
dy_2011 <- dy_2011 %>%
  mutate(`Estimated Total Cost (USD)` = cut(dy_2011$projectAmount,
                    breaks=c(0,500000,1000000,5000000,10000000,50000000,100000000,500000000),
                    include.lowest = TRUE))
dy_2011 <- left_join(tMap,dy_2011,by="ID")
dy_2011 %<>% select(-projectAmount)
## Mapping
tm_shape(dy_2011)+
  tm_polygons("Estimated Total Cost (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Estimated Total Cost (USD)",
              palette = "Greens") +
  tm_layout(main.title = 'Project_Amount 2011',main.title.position="center")
```

Project_Amount 2011



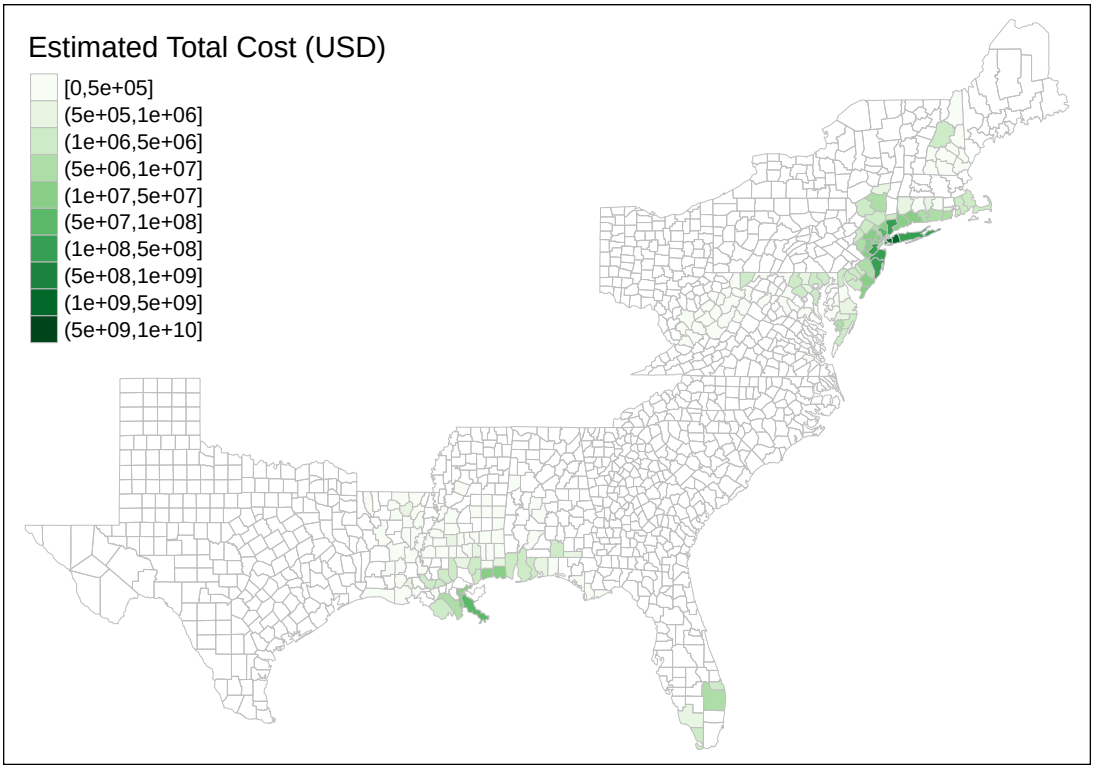
2012

```
## the estimated total cost of Public Assistance grant project for 2012
dy_2012<- subset(dy, dy$year==2012)
dy_2012 <- dy_2012 %>%
  group_by(ID) %>%
  summarize(projectAmount = sum(projectAmount))
summary(dy_2012$projectAmount)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
## 1.356e+03 1.260e+05 4.781e+05 7.910e+07 3.786e+06 9.724e+09
```

```
dy_2012 <- dy_2012 %>%
  mutate(`Estimated Total Cost (USD)` = cut(dy_2012$projectAmount,
                      breaks=c(0,500000,1000000,5000000,10000000,50000000,100000000,500000000,1000000000
                      include.lowest = TRUE))
dy_2012 <- left_join(tMap,dy_2012,by="ID")
dy_2012 %<>% select(-projectAmount)
## Mapping
tm_shape(dy_2012)+
  tm_polygons("Estimated Total Cost (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Estimated Total Cost (USD)",
              palette = "Greens") +
  tm_layout(main.title = 'Project_Amount 2012',main.title.position="center")
```

Project_Amount 2012



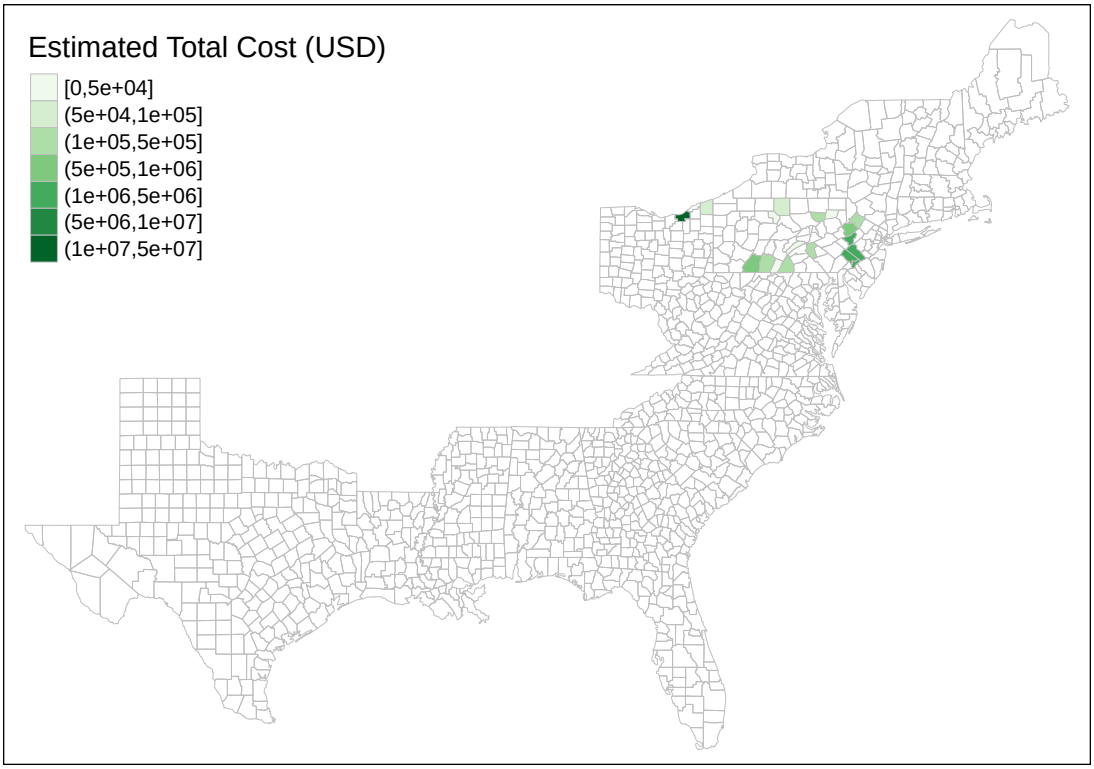
2013

```
## the estimated total cost of Public Assistance grant project for 2013
dy_2013<- subset(dy, dy$year==2013)
dy_2013 <- dy_2013 %>%
  group_by(ID) %>%
  summarize(projectAmount = sum(projectAmount))
summary(dy_2013$projectAmount)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
##      6829     78559    216434   2011744   3002384  16217372
```

```
dy_2013 <- dy_2013 %>%
  mutate(`Estimated Total Cost (USD)` = cut(dy_2013$projectAmount,
                    breaks=c(0,50000,100000,500000,1000000,5000000,10000000,50000000),
                    include.lowest = TRUE))
dy_2013 <- left_join(tMap,dy_2013,by="ID")
dy_2013 %<>% select(-projectAmount)
## Mapping
tm_shape(dy_2013)+
  tm_polygons("Estimated Total Cost (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Estimated Total Cost (USD)",
              palette = "Greens") +
  tm_layout(main.title = 'Project_Amount 2013',main.title.position="center")
```

Project_Amount 2013



2014

2015

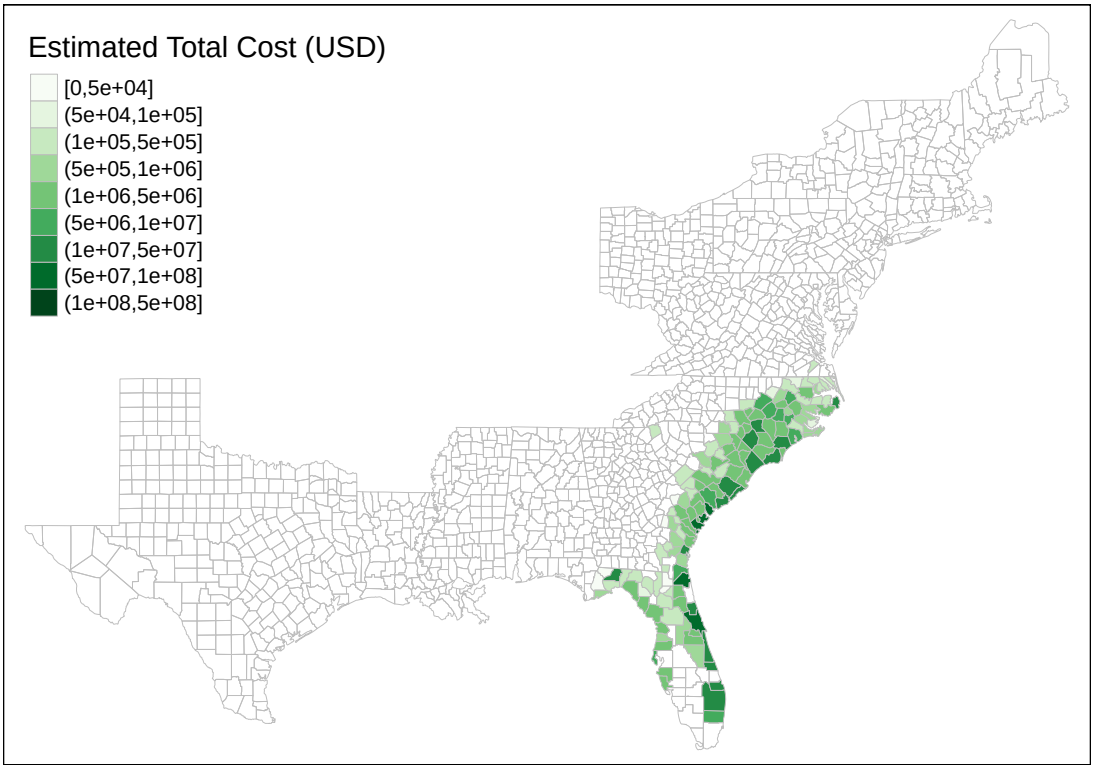
2016

```
## the estimated total cost of Public Assistance grant project for 2016
dy_2016<- subset(dy, dy$year==2016)
dy_2016 <- dy_2016 %>%
  group_by(ID) %>%
  summarize(projectAmount = sum(projectAmount))
summary(dy_2016$projectAmount)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
##      7621    286603   1528748   9343455   4805146 159800082
```

```
dy_2016 <- dy_2016 %>%
  mutate(`Estimated Total Cost (USD)` = cut(dy_2016$projectAmount,
                    breaks=c(0,50000,100000,500000,1000000,5000000,10000000,50000000,100000000,5000000
                    include.lowest = TRUE))
dy_2016 <- left_join(tMap,dy_2016,by="ID")
dy_2016 %<>% select(-projectAmount)
## Mapping
tm_shape(dy_2016)+
  tm_polygons("Estimated Total Cost (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
```

```
              title = "Estimated Total Cost (USD)",
              palette = "Greens") +
  tm_layout(main.title = 'Project_Amount 2016',main.title.position="center")
```



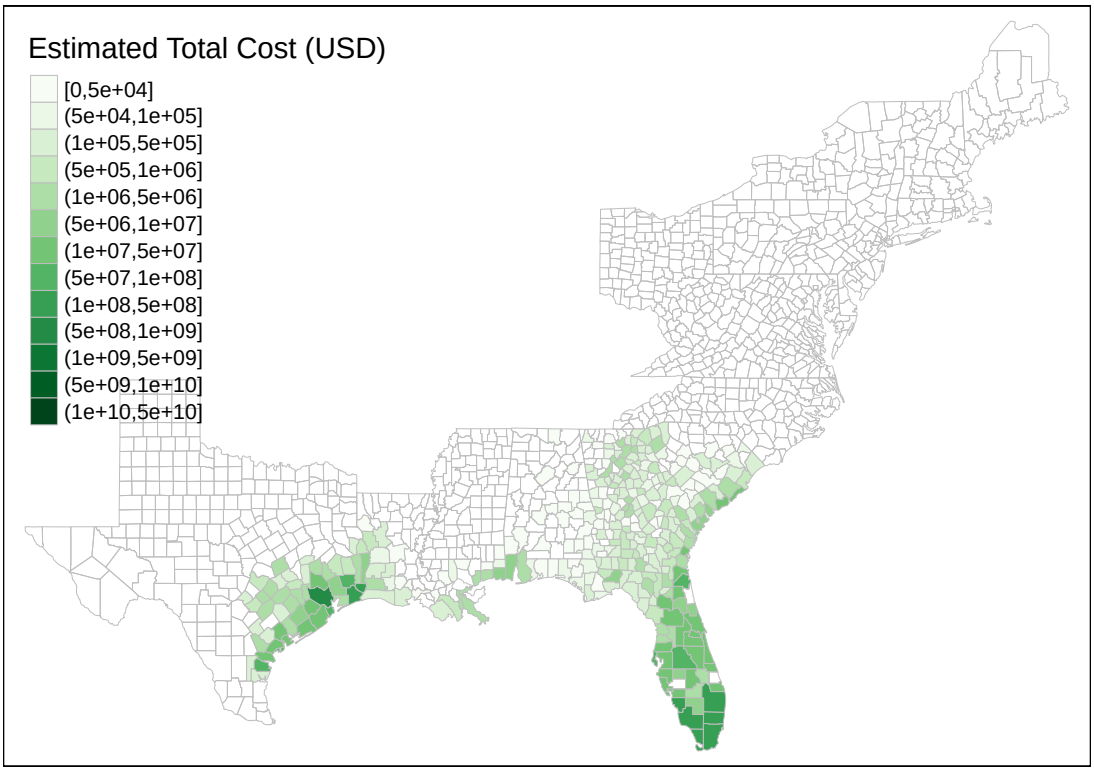
2017

```
## the estimated total cost of Public Assistance grant project for 2017
dy_2017<- subset(dy, dy$year==2017)
dy_2017 <- dy_2017 %>%
  group_by(ID) %>%
  summarize(projectAmount = sum(projectAmount))
summary(dy_2017$projectAmount)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
## 3.399e+03 9.809e+04 5.866e+05 6.492e+07 1.047e+07 1.894e+10
```

```
dy_2017 <- dy_2017 %>%
  mutate(`Estimated Total Cost (USD)` = cut(dy_2017$projectAmount,
                    breaks=c(0,50000,100000,500000,1000000,5000000,10000000,50000000,100000000,5000000
                    include.lowest = TRUE))
dy_2017 <- left_join(tMap,dy_2017,by="ID")
dy_2017 %<>% select(-projectAmount)
## Mapping
tm_shape(dy_2017)+
  tm_polygons("Estimated Total Cost (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Estimated Total Cost (USD)",
              palette = "Greens") +
```

```
  tm_layout(main.title = 'Project_Amount 2017',main.title.position="center")
```

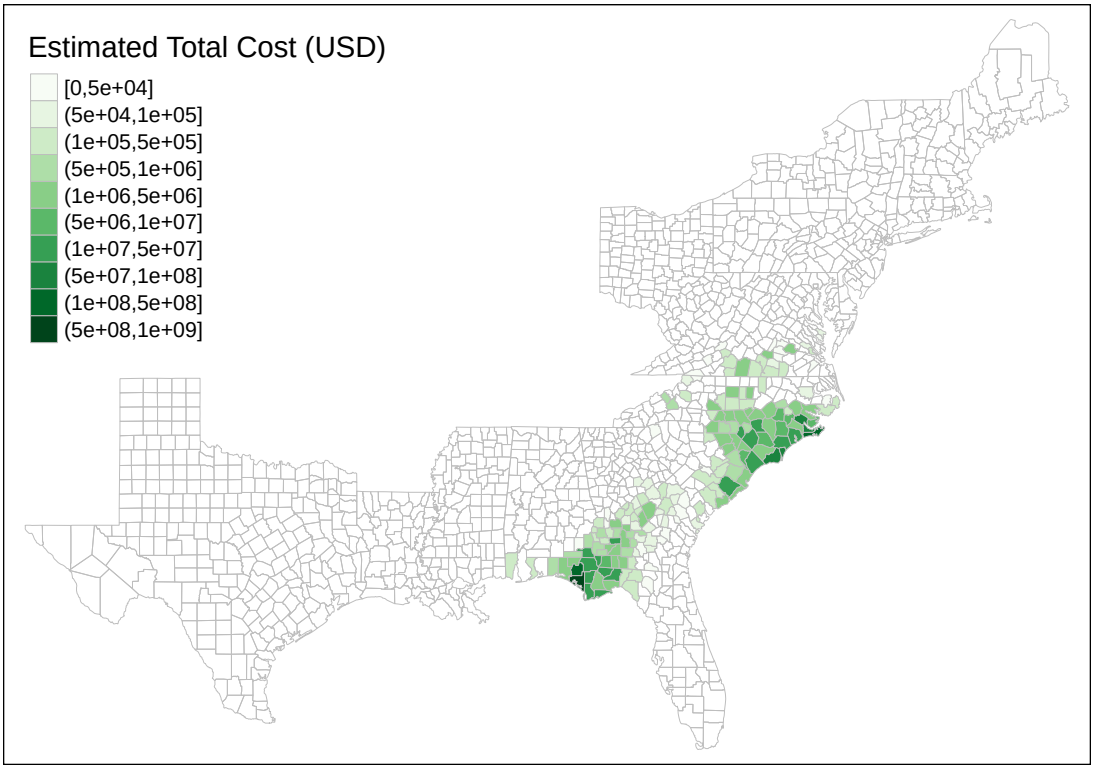


2018

```
## the estimated total cost of Public Assistance grant project for 2018
dy_2018<- subset(dy, dy$year==2018)
dy_2018 <- dy_2018 %>%
  group_by(ID) %>%
  summarize(projectAmount = sum(projectAmount))
summary(dy_2018$projectAmount)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
##      4376    100725    510967  14145725   2657303 696062983
```

```
dy_2018 <- dy_2018 %>%
  mutate(`Estimated Total Cost (USD)` = cut(dy_2018$projectAmount,
                      breaks=c(0,50000,100000,500000,1000000,5000000,10000000,50000000,100000000,5000000
                      include.lowest = TRUE))
dy_2018 <- left_join(tMap,dy_2018,by="ID")
dy_2018 %<>% select(-projectAmount)
## Mapping
tm_shape(dy_2018)+
  tm_polygons("Estimated Total Cost (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Estimated Total Cost (USD)",
              palette = "Greens") +
  tm_layout(main.title = 'Project_Amount 2018',main.title.position="center")
```

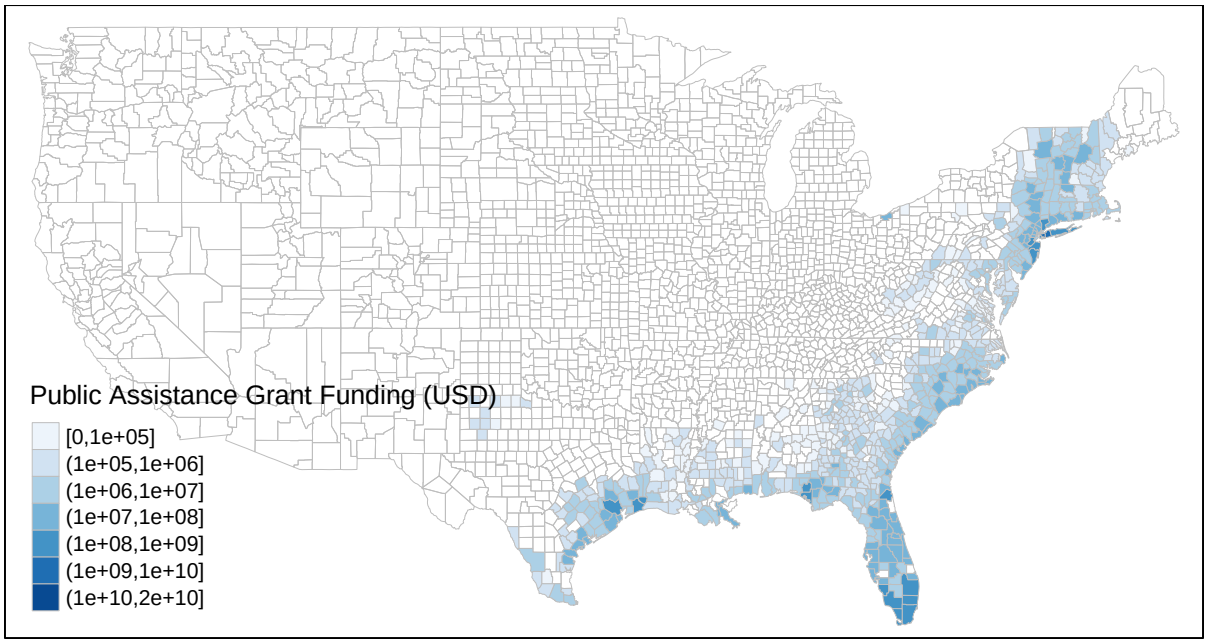


Focus on "Federal Share Obligated"

The Public Assistance grant funding available to the grantee (State) in dollars, for sub-grantee's approved Project Worksheets.

```
df_d <- df %>%
  group_by(ID) %>%
  summarize(federalShareObligated = sum(federalShareObligated))
df_d <- df_d %>%
  mutate(`Public Assistance Grant Funding (USD)` = cut(df_d$federalShareObligated,
                      breaks=c(0,100000,1000000,10000000,100000000,1000000000,10000000000,20000000000),
                      include.lowest = TRUE))
ttMap <- st_as_sf(map("county",plot=F,fill=T))
df_d <- left_join(ttMap,df_d,by="ID")
df_d %<>% select(-federalShareObligated)
```

```
# Mapping
tm_shape(df_d)+
  tm_polygons("Public Assistance Grant Funding (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Public Assistance Grant Funding (USD)",
              palette = "Blues") +
  tm_layout(main.title = 'Federal_Share_Obligated 2009-2018',main.title.position="center")
```



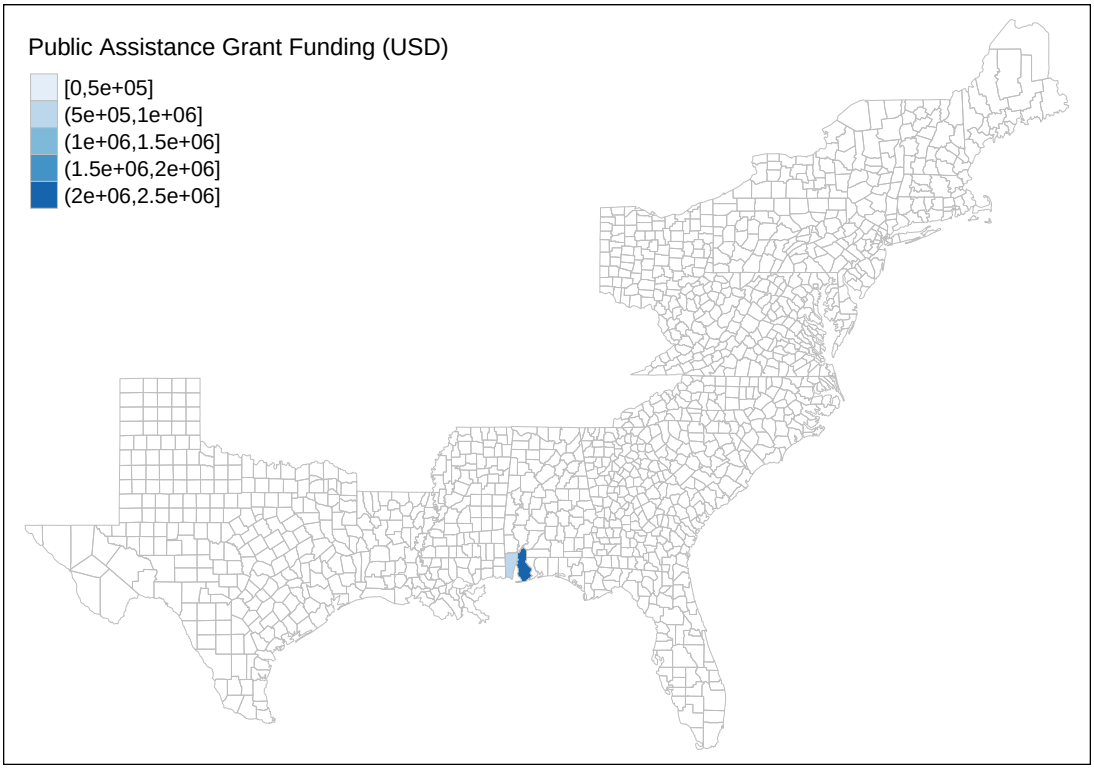
2009

```
## the estimated Public Assistance grant funding available to the grantee (State) for 2009
dp_2009 <- subset(dy, dy$year==2009)
dp_2009 <- dp_2009 %>%
  group_by(ID) %>%
  summarize(federalShareObligated = sum(federalShareObligated))
summary(dp_2009$federalShareObligated)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  888353  964497 1040641 1409647 1670294 2299946
```

```
dp_2009 <- dp_2009 %>%
  mutate(`Public Assistance Grant Funding (USD)` = cut(dp_2009$federalShareObligated,
                      breaks=c(0,500000,1000000,1500000,2000000,2500000),
                      include.lowest = TRUE))
tMap <- st_as_sf(map("county",counties_C ,plot=F,fill=T))
dp_2009 <- left_join(tMap,dp_2009,by="ID")
dp_2009 %<>% select(-federalShareObligated)
## Mapping
tm_shape(dp_2009)+
  tm_polygons("Public Assistance Grant Funding (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Public Assistance Grant Funding (USD)",
              palette = "Blues") +
  tm_layout(main.title = 'Federal_Share_Obligated 2009',main.title.position="center")
```

Federal_Share_Obligated 2009



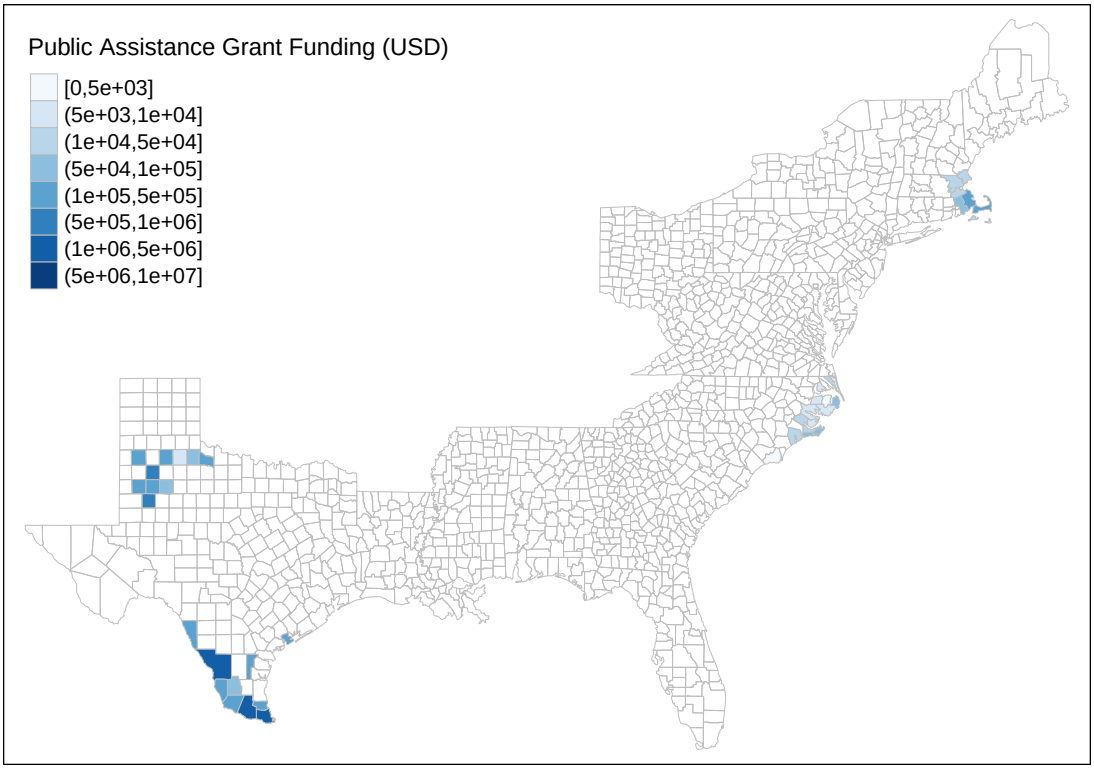
2010

```
## the estimated Public Assistance grant funding available to the grantee (State) for 2010
dp_2010 <- subset(dy, dy$year==2010)
dp_2010 <- dp_2010 %>%
  group_by(ID) %>%
  summarize(federalShareObligated = sum(federalShareObligated))
summary(dp_2010$federalShareObligated)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1378   12759   92139  533081  298980 8386170
```

```
dp_2010 <- dp_2010 %>%
  mutate(`Public Assistance Grant Funding (USD)` = cut(dp_2010$federalShareObligated,
                    breaks=c(0,5000,10000,50000,100000,500000,1000000,5000000,10000000),
                    include.lowest = TRUE))
dp_2010 <- left_join(tMap,dp_2010,by="ID")
dp_2010 %<>% select(-federalShareObligated)
## Mapping
tm_shape(dp_2010)+
  tm_polygons("Public Assistance Grant Funding (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Public Assistance Grant Funding (USD)",
              palette = "Blues") +
  tm_layout(main.title = 'Federal_Share_Obligated 2010',main.title.position="center")
```

Federal_Share_Obligated 2010



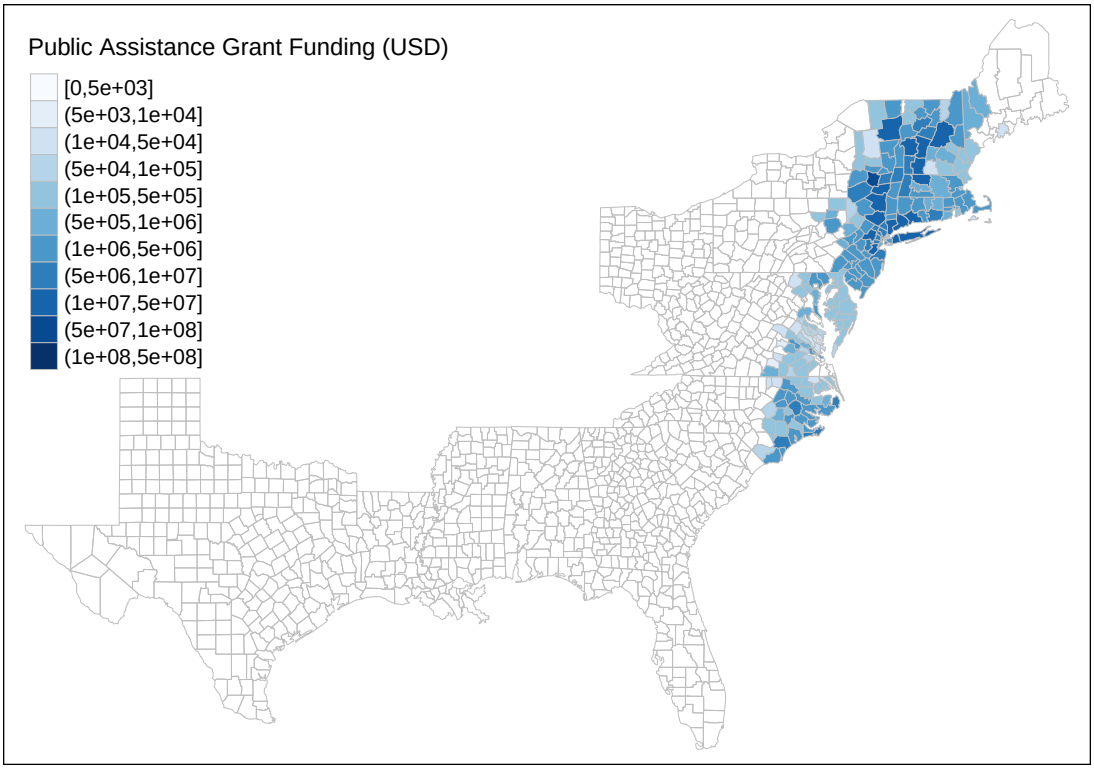
2011

```
## the estimated Public Assistance grant funding available to the grantee (State) for 2011
dp_2011 <- subset(dy, dy$year==2011)
dp_2011 <- dp_2011 %>%
  group_by(ID) %>%
  summarize(federalShareObligated = sum(federalShareObligated))
summary(dp_2011$federalShareObligated)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
##      2813    230261    751859   4040172   2572351 175447538
```

```
dp_2011 <- dp_2011 %>%
  mutate(`Public Assistance Grant Funding (USD)` = cut(dp_2011$federalShareObligated,
                      breaks=c(0,5000,10000,50000,100000,500000,1000000,5000000,10000000,50000000,100000
                      include.lowest = TRUE))
dp_2011 <- left_join(tMap,dp_2011,by="ID")
dp_2011 %<>% select(-federalShareObligated)
## Mapping
tm_shape(dp_2011)+
  tm_polygons("Public Assistance Grant Funding (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Public Assistance Grant Funding (USD)",
              palette = "Blues") +
  tm_layout(main.title = 'Federal_Share_Obligated 2011',main.title.position="center")
```

Federal_Share_Obligated 2011



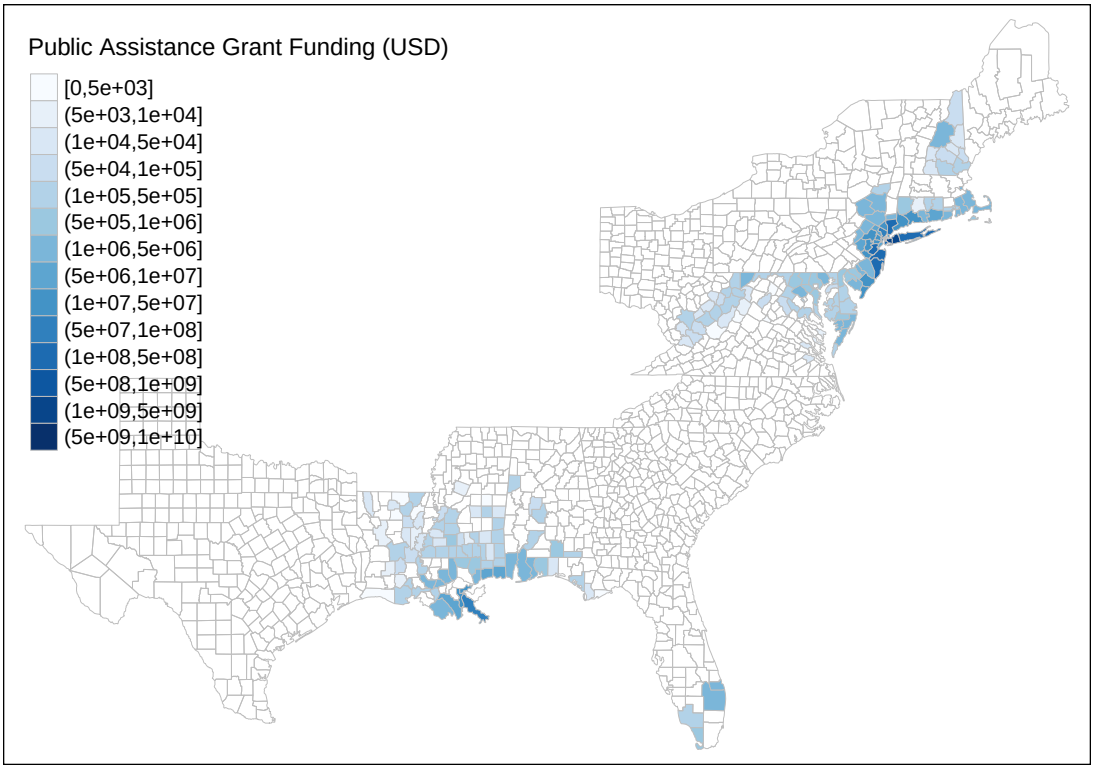
2012

```
## the estimated Public Assistance grant funding available to the grantee (State) for 2012
dp_2012 <- subset(dy, dy$year==2012)
dp_2012 <- dp_2012 %>%
  group_by(ID) %>%
  summarize(federalShareObligated = sum(federalShareObligated))
summary(dp_2012$federalShareObligated)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
## 1.017e+03 9.426e+04 3.576e+05 7.083e+07 2.929e+06 8.751e+09
```

```
dp_2012 <- dp_2012 %>%
  mutate(`Public Assistance Grant Funding (USD)` = cut(dp_2012$federalShareObligated,
                      breaks=c(0,5000,10000,50000,100000,500000,1000000,5000000,10000000,50000000,100000
                      include.lowest = TRUE))
dp_2012 <- left_join(tMap,dp_2012,by="ID")
dp_2012 %<>% select(-federalShareObligated)
## Mapping
tm_shape(dp_2012)+
  tm_polygons("Public Assistance Grant Funding (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Public Assistance Grant Funding (USD)",
              palette = "Blues") +
  tm_layout(main.title = 'Federal_Share_Obligated 2012',main.title.position="center")
```

Federal_Share_Obligated 2012

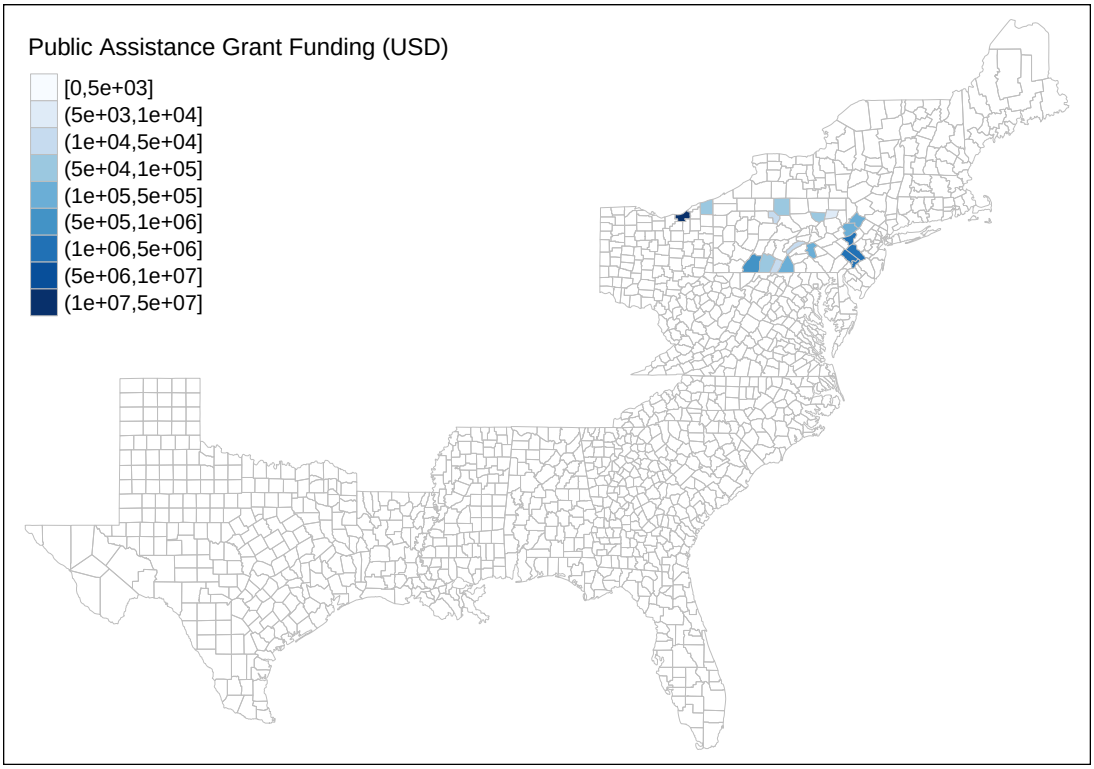


2013

```
## the estimated Public Assistance grant funding available to the grantee (State) for 2013
dp_2013 <- subset(dy, dy$year==2013)
dp_2013 <- dp_2013 %>%
  group_by(ID) %>%
  summarize(federalShareObligated = sum(federalShareObligated))
summary(dp_2013$federalShareObligated)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
##      5122     58919    162325   1513826   2251788  12163029
```

```
dp_2013 <- dp_2013 %>%
  mutate(`Public Assistance Grant Funding (USD)` = cut(dp_2013$federalShareObligated,
                      breaks=c(0,5000,10000,50000,100000,500000,1000000,5000000,10000000,50000000),
                      include.lowest = TRUE))
dp_2013 <- left_join(tMap,dp_2013,by="ID")
dp_2013 %<>% select(-federalShareObligated)
## Mapping
tm_shape(dp_2013)+
  tm_polygons("Public Assistance Grant Funding (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Public Assistance Grant Funding (USD)",
              palette = "Blues") +
  tm_layout(main.title = 'Federal_Share_Obligated 2013',main.title.position="center")
```



2014

2015

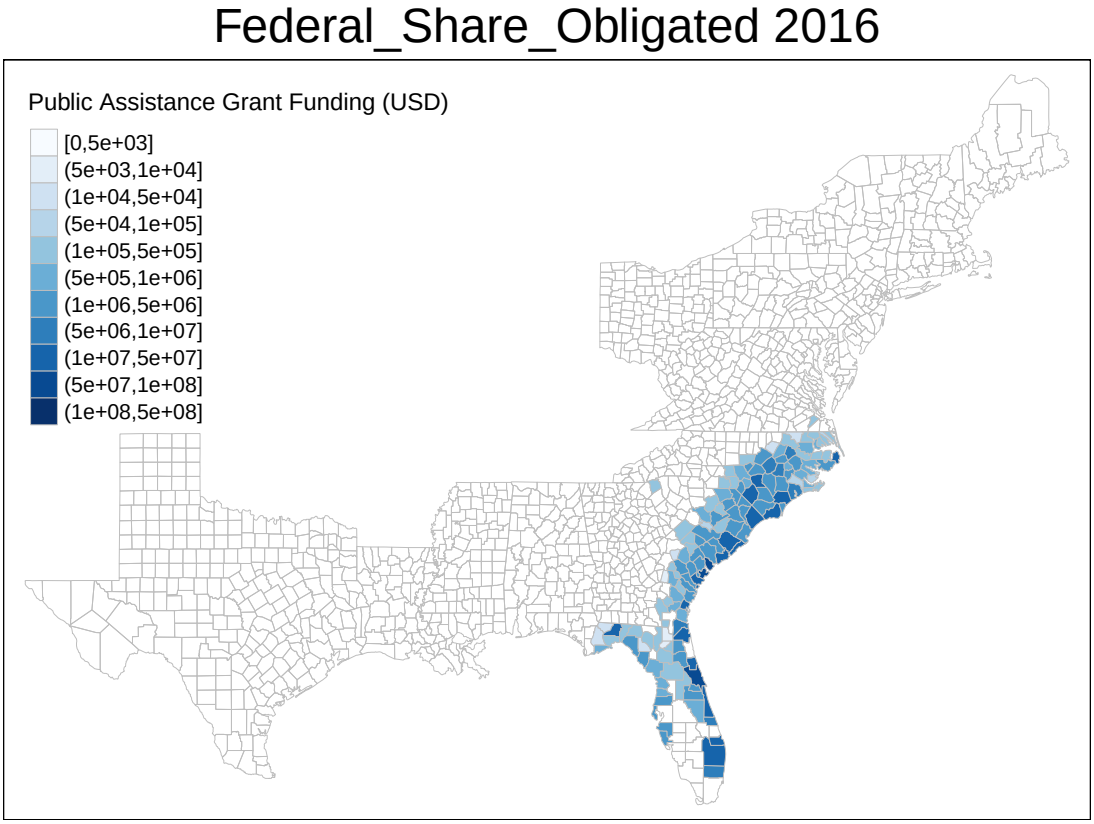
2016

```
## the estimated Public Assistance grant funding available to the grantee (State) for 2016
dp_2016 <- subset(dy, dy$year==2016)
dp_2016 <- dp_2016 %>%
  group_by(ID) %>%
  summarize(federalShareObligated = sum(federalShareObligated))
summary(dp_2016$federalShareObligated)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
##      6478    224222   1163009   7255198   3708394 124560548
```

```
dp_2016 <- dp_2016 %>%
  mutate(`Public Assistance Grant Funding (USD)` = cut(dp_2016$federalShareObligated,
                      breaks=c(0,5000,10000,50000,100000,500000,1000000,5000000,10000000,50000000,100000
                      include.lowest = TRUE))
dp_2016 <- left_join(tMap,dp_2016,by="ID")
dp_2016 %<>% select(-federalShareObligated)
## Mapping
tm_shape(dp_2016)+
  tm_polygons("Public Assistance Grant Funding (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
```

```
              title = "Public Assistance Grant Funding (USD)",
              palette = "Blues") +
  tm_layout(main.title = 'Federal_Share_Obligated 2016',main.title.position="center")
```



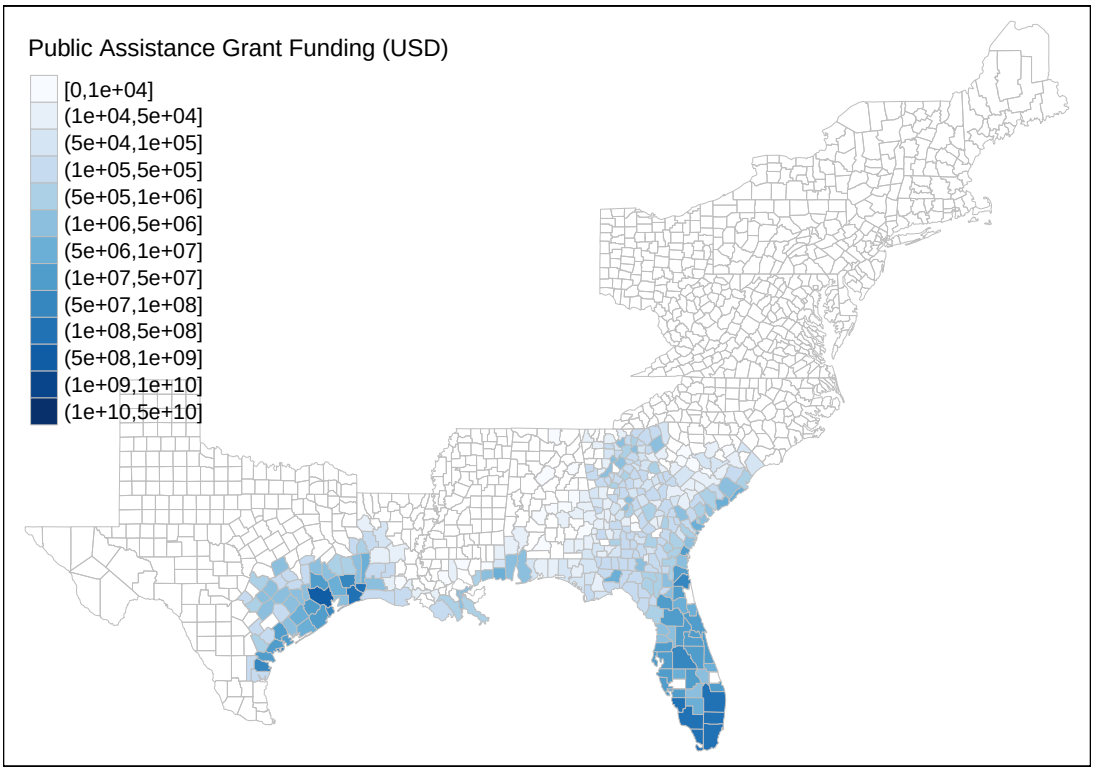
2017

```
## the estimated Public Assistance grant funding available to the grantee (State) for 2017
dp_2017 <- subset(dy, dy$year==2017)
dp_2017 <- dp_2017 %>%
  group_by(ID) %>%
  summarize(federalShareObligated = sum(federalShareObligated))
summary(dp_2017$federalShareObligated)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
## 2.549e+03 8.125e+04 4.899e+05 6.010e+07 9.480e+06 1.749e+10
```

```
dp_2017 <- dp_2017 %>%
  mutate(`Public Assistance Grant Funding (USD)` = cut(dp_2017$federalShareObligated,
                      breaks=c(0,10000,50000,100000,500000,1000000,5000000,10000000,50000000,100000000,5
                      include.lowest = TRUE))
dp_2017 <- left_join(tMap,dp_2017,by="ID")
dp_2017 %<>% select(-federalShareObligated)
## Mapping
tm_shape(dp_2017)+
  tm_polygons("Public Assistance Grant Funding (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Public Assistance Grant Funding (USD)",
              palette = "Blues") +
```

```
  tm_layout(main.title = 'Federal_Share_Obligated 2017',main.title.position="center")
```

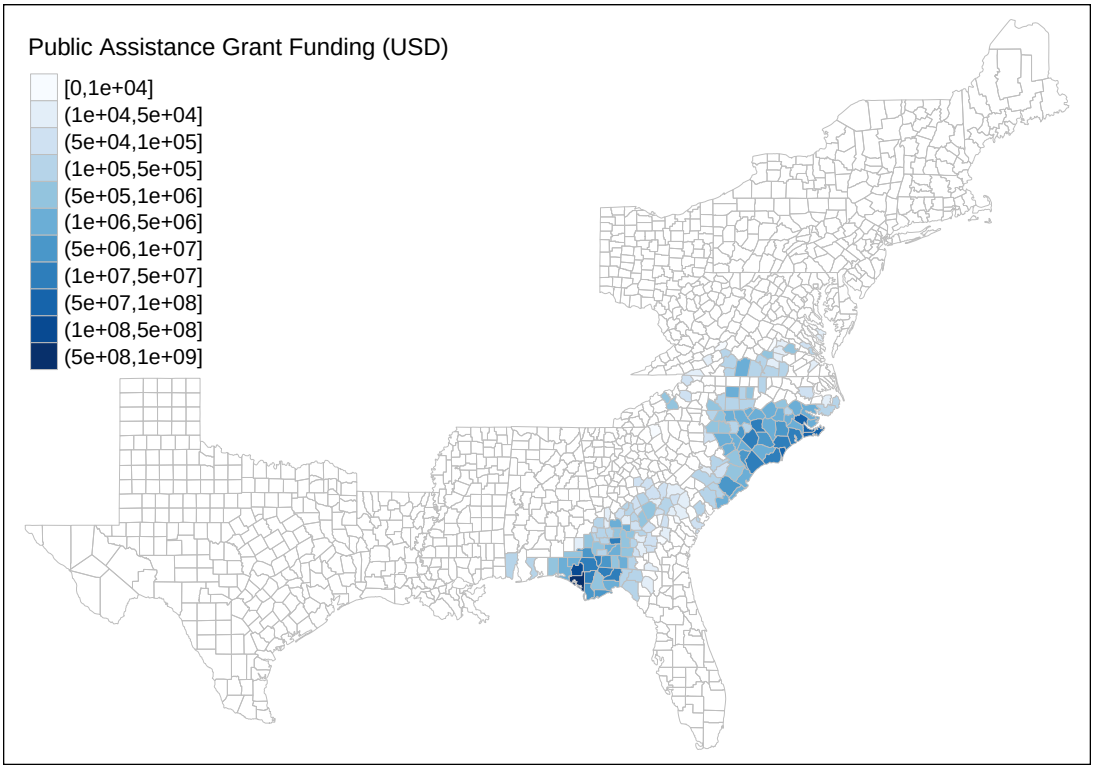


2018

```
## the estimated Public Assistance grant funding available to the grantee (State) for 2018
dp_2018 <- subset(dy, dy$year==2018)
dp_2018 <- dp_2018 %>%
  group_by(ID) %>%
  summarize(federalShareObligated = sum(federalShareObligated))
summary(dp_2018$federalShareObligated)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
##      3279     75689    382067  11849140   2003729 624918780
```

```
dp_2018 <- dp_2018 %>%
  mutate(`Public Assistance Grant Funding (USD)` = cut(dp_2018$federalShareObligated,
                      breaks=c(0,10000,50000,100000,500000,1000000,5000000,10000000,50000000,100000000,5
                      include.lowest = TRUE))
dp_2018 <- left_join(tMap,dp_2018,by="ID")
dp_2018 %<>% select(-federalShareObligated)
## Mapping
tm_shape(dp_2018)+
  tm_polygons("Public Assistance Grant Funding (USD)",  border.col = "grey",
              lwd = 0.1, colorNA = NULL, style="cont",
              title = "Public Assistance Grant Funding (USD)",
              palette = "Blues") +
  tm_layout(main.title = 'Federal_Share_Obligated 2018',main.title.position="center")
```



Summary

We can roughly see that in those 11 years, protective measures, public buildings, roads and Bridges suffered the most damage in the hurricanes. Between 2009 and 2019, New York suffered the most hurricanes, accounting for 17% of the country's total. The second is Florida and New jersey. Besides, 2011 and 2017 were the worst years for hurricanes in the United States.

In general, we can find that the cities that are hardest hit by hurricanes are those on the east coast, and they receive more aid each year.