Storm Data

Reproducible Research Course

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Impact of Severe Weather Events on Public Health and Economy in the United States

Synopsis

In this report, we aim to analyze the impact of different weather events on public health and economy based on the storm database collected from the U.S. National Oceanic and Atmospheric Administration's (NOAA) from 1950 - 2011. We will use the estimates of fatalities, injuries, property and crop damage to decide which types of event are most harmful to the population health and economy. From these data, we found that excessive heat and tornado are most harmful with respect to population health, while flood, drought, and hurricane/typhoon have the greatest economic consequences.

Data Processing

The data for this assignment come in the form of a comma-separated-value file compressed via the bzip2 algorithm to reduce its size. You can download the file from the course web site:

```
# first clean the environment and setup the working directory
rm(list= ls())
setwd("C:/Users/gabis/OneDrive/Documentos/Scribble/7mo Semestre/Actividad
Curricular Complementaria/Coursera/Reproducible Research/Semana 4")

# now download file
if (!file.exists("StormData.csv.bz2")) {
    fileURL <-
'https://d396qusza40orc.cloudfront.net/repdata%2Fdata%2FStormData.csv.bz2'
    download.file(fileURL, destfile='StormData.csv.bz2', method = 'curl')
}
noaaDF <- read.csv(bzfile('StormData.csv.bz2'),header=TRUE, stringsAsFactors
= FALSE)
# laad libraries for tidying - not all will be used in all this weeks
assignment
require(dplyr)

## Loading required package: dplyr
```

```
## Warning: package 'dplyr' was built under R version 3.6.3

## Error: package or namespace load failed for 'dplyr' in loadNamespace(i,
c(lib.loc, .libPaths()), versionCheck = vI[[i]]):
##  namespace 'rlang' 0.4.5 is already loaded, but >= 0.4.6 is required

require(tidyr)

## Loading required package: tidyr

## Warning: package 'tidyr' was built under R version 3.6.3

## Error: package or namespace load failed for 'tidyr' in loadNamespace(i,
c(lib.loc, .libPaths()), versionCheck = vI[[i]]):
##  namespace 'rlang' 0.4.5 is already loaded, but >= 0.4.7 is required

require(lubridate)

## Loading required package: lubridate

## Warning: package 'lubridate' was built under R version 3.6.3

##
## Attaching package: 'lubridate'

## The following object is masked from 'package:base':
##
##     date

require(ggplot2)

## Loading required package: ggplot2

## Warning: package 'ggplot2' was built under R version 3.6.3
```

Preliminary Analysis

First a summary of the NU.S. National Oceanic and Atmospheric Administration's (NOAA) storm database:

```
summary(noaaDF)

##     STATE__        BGN_DATE           BGN_TIME          TIME_ZONE
##  Min.   : 1.0   Length:902297      Length:902297      Length:902297
##  1st Qu.:19.0   Class :character   Class :character   Class :character
##  Median :30.0   Mode  :character   Mode  :character   Mode  :character
##  Mean   :31.2
##  3rd Qu.:45.0
##  Max.   :95.0
##
##      COUNTY       COUNTYNAME           STATE              EVTYPE
##  Min.   :  0.0   Length:902297      Length:902297      Length:902297
##  1st Qu.: 31.0   Class :character   Class :character   Class :character
```

```
##  Median : 75.0   Mode  :character   Mode  :character   Mode  :character
##  Mean   :100.6
##  3rd Qu.:131.0
##  Max.   :873.0
##
##    BGN_RANGE          BGN_AZI           BGN_LOCATI          END_DATE
##  Min.   :   0.000   Length:902297      Length:902297      Length:902297
##  1st Qu.:   0.000   Class :character   Class :character   Class :character
##  Median :   0.000   Mode  :character   Mode  :character   Mode  :character
##  Mean   :   1.484
##  3rd Qu.:   1.000
##  Max.   :3749.000
##
##    END_TIME           COUNTY_END COUNTYENDN       END_RANGE
##  Length:902297      Min.   :0    Mode:logical   Min.   :  0.0000
##  Class :character   1st Qu.:0    NA's:902297    1st Qu.:  0.0000
##  Mode  :character   Median :0                   Median :  0.0000
##                     Mean   :0                   Mean   :  0.9862
##                     3rd Qu.:0                   3rd Qu.:  0.0000
##                     Max.   :0                   Max.   :925.0000
##
##    END_AZI            END_LOCATI            LENGTH              WIDTH
##  Length:902297      Length:902297      Min.   :   0.0000   Min.   :
0.000
##  Class :character   Class :character   1st Qu.:   0.0000   1st Qu.:
0.000
##  Mode  :character   Mode  :character   Median :   0.0000   Median :
0.000
##                                        Mean   :   0.2301   Mean   :
7.503
##                                        3rd Qu.:   0.0000   3rd Qu.:
0.000
##                                        Max.   :2315.0000   Max.
:4400.000
##
##        F               MAG            FATALITIES          INJURIES
##  Min.   :0.0      Min.   :    0.0   Min.   :  0.0000   Min.   :   0.0000
##  1st Qu.:0.0      1st Qu.:    0.0   1st Qu.:  0.0000   1st Qu.:   0.0000
##  Median :1.0      Median :   50.0   Median :  0.0000   Median :   0.0000
##  Mean   :0.9      Mean   :   46.9   Mean   :  0.0168   Mean   :   0.1557
##  3rd Qu.:1.0      3rd Qu.:   75.0   3rd Qu.:  0.0000   3rd Qu.:   0.0000
##  Max.   :5.0      Max.   :22000.0   Max.   :583.0000   Max.   :1700.0000
##  NA's   :843563
##     PROPDMG          PROPDMGEXP           CROPDMG          CROPDMGEXP
##  Min.   :   0.00   Length:902297      Min.   :  0.000   Length:902297
##  1st Qu.:   0.00   Class :character   1st Qu.:  0.000   Class :character
##  Median :   0.00   Mode  :character   Median :  0.000   Mode  :character
##  Mean   :  12.06                      Mean   :  1.527
##  3rd Qu.:   0.50                      3rd Qu.:  0.000
##  Max.   :5000.00                      Max.   :990.000
```

```
##
##      WFO             STATEOFFIC         ZONENAMES            LATITUDE
##  Length:902297      Length:902297      Length:902297      Min.   :   0
##  Class :character   Class :character   Class :character   1st Qu.:2802
##  Mode  :character   Mode  :character   Mode  :character   Median :3540
##                                                           Mean   :2875
##                                                           3rd Qu.:4019
##                                                           Max.   :9706
##                                                           NA's   :47
##    LONGITUDE        LATITUDE_E     LONGITUDE_       REMARKS
##  Min.   :-14451   Min.   :   0   Min.   :-14455   Length:902297
##  1st Qu.:  7247   1st Qu.:   0   1st Qu.:     0   Class :character
##  Median :  8707   Median :   0   Median :     0   Mode  :character
##  Mean   :  6940   Mean   :1452   Mean   :  3509
##  3rd Qu.:  9605   3rd Qu.:3549   3rd Qu.:  8735
##  Max.   : 17124   Max.   :9706   Max.   :106220
##                   NA's   :40
##      REFNUM
##  Min.   :     1
##  1st Qu.:225575
##  Median :451149
##  Mean   :451149
##  3rd Qu.:676723
##  Max.   :902297
##
```

```
str(noaaDF)
```

```
## 'data.frame':    902297 obs. of  37 variables:
##  $ STATE__   : num  1 1 1 1 1 1 1 1 1 1 ...
##  $ BGN_DATE  : chr  "4/18/1950 0:00:00" "4/18/1950 0:00:00" "2/20/1951
0:00:00" "6/8/1951 0:00:00" ...
##  $ BGN_TIME  : chr  "0130" "0145" "1600" "0900" ...
##  $ TIME_ZONE : chr  "CST" "CST" "CST" "CST" ...
##  $ COUNTY    : num  97 3 57 89 43 77 9 123 125 57 ...
##  $ COUNTYNAME: chr  "MOBILE" "BALDWIN" "FAYETTE" "MADISON" ...
##  $ STATE     : chr  "AL" "AL" "AL" "AL" ...
##  $ EVTYPE    : chr  "TORNADO" "TORNADO" "TORNADO" "TORNADO" ...
##  $ BGN_RANGE : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ BGN_AZI   : chr  "" "" "" "" ...
##  $ BGN_LOCATI: chr  "" "" "" "" ...
##  $ END_DATE  : chr  "" "" "" "" ...
##  $ END_TIME  : chr  "" "" "" "" ...
##  $ COUNTY_END: num  0 0 0 0 0 0 0 0 0 0 ...
##  $ COUNTYENDN: logi  NA NA NA NA NA NA ...
##  $ END_RANGE : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ END_AZI   : chr  "" "" "" "" ...
##  $ END_LOCATI: chr  "" "" "" "" ...
##  $ LENGTH    : num  14 2 0.1 0 0 1.5 1.5 0 3.3 2.3 ...
##  $ WIDTH     : num  100 150 123 100 150 177 33 33 100 100 ...
```

```
##  $ F         : int  3 2 2 2 2 2 2 1 3 3 ...
##  $ MAG       : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ FATALITIES: num  0 0 0 0 0 0 0 0 1 0 ...
##  $ INJURIES  : num  15 0 2 2 2 6 1 0 14 0 ...
##  $ PROPDMG   : num  25 2.5 25 2.5 2.5 2.5 2.5 2.5 25 25 ...
##  $ PROPDMGEXP: chr  "K" "K" "K" "K" ...
##  $ CROPDMG   : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ CROPDMGEXP: chr  "" "" "" "" ...
##  $ WFO       : chr  "" "" "" "" ...
##  $ STATEOFFIC: chr  "" "" "" "" ...
##  $ ZONENAMES : chr  "" "" "" "" ...
##  $ LATITUDE  : num  3040 3042 3340 3458 3412 ...
##  $ LONGITUDE : num  8812 8755 8742 8626 8642 ...
##  $ LATITUDE_E: num  3051 0 0 0 0 ...
##  $ LONGITUDE_: num  8806 0 0 0 0 ...
##  $ REMARKS   : chr  "" "" "" "" ...
##  $ REFNUM    : num  1 2 3 4 5 6 7 8 9 10 ...
```

Results

1 Address the question of which types of events are most harmful to population health

Calculate the fatalities and injuries seperately.

```
#The fatalities:
totFatalities <- aggregate(noaaDF$FATALITIES, by = list(noaaDF$EVTYPE),
"sum")
names(totFatalities) <- c("Event", "Fatalities")
totFatalitiesSorted <- totFatalities[order(-totFatalities$Fatalities),
][1:20, ]
totFatalitiesSorted
```

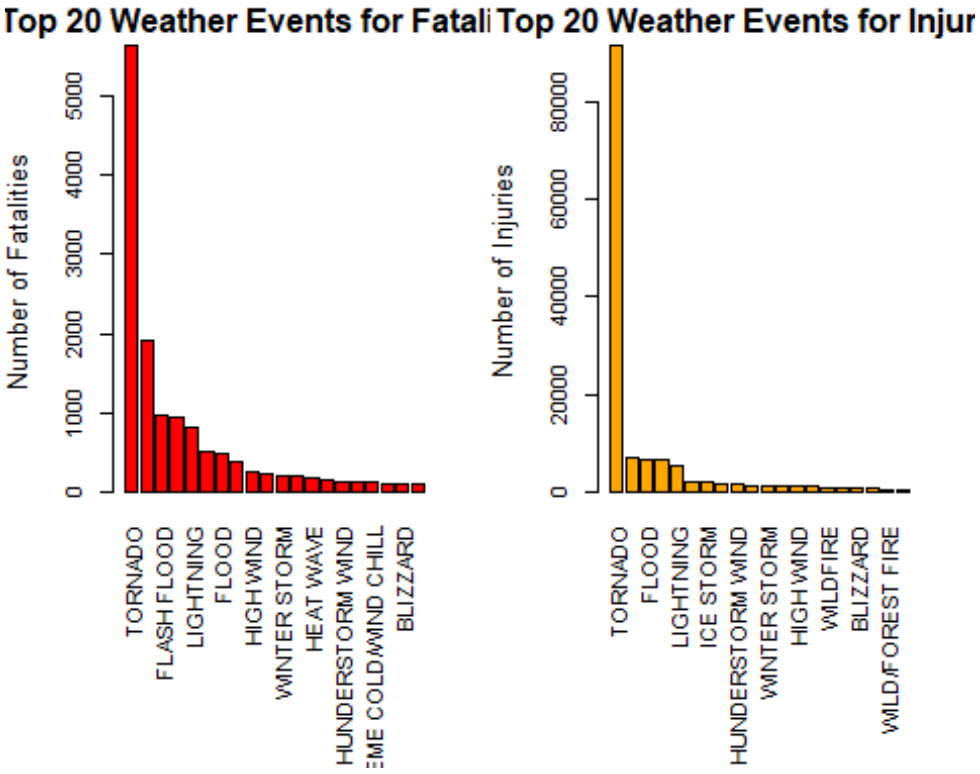
```
##                     Event Fatalities
## 834               TORNADO       5633
## 130        EXCESSIVE HEAT       1903
## 153           FLASH FLOOD        978
## 275                  HEAT        937
## 464             LIGHTNING        816
## 856             TSTM WIND        504
## 170                 FLOOD        470
## 585           RIP CURRENT        368
## 359             HIGH WIND        248
## 19              AVALANCHE        224
## 972          WINTER STORM        206
## 586          RIP CURRENTS        204
## 278             HEAT WAVE        172
## 140          EXTREME COLD        160
## 760     THUNDERSTORM WIND        133
## 310             HEAVY SNOW        127
```

```
## 141 EXTREME COLD/WIND CHILL        125
## 676             STRONG WIND        103
## 30                 BLIZZARD        101
## 350               HIGH SURF        101

#The injuries:
totInjuries <- aggregate(noaaDF$INJURIES, by = list(noaaDF$EVTYPE), "sum")
names(totInjuries) <- c("Event", "Injuries")
totInjuriesSorted <- totInjuries[order(-totInjuries$Injuries), ][1:20, ]
totInjuriesSorted

##                  Event Injuries
## 834            TORNADO    91346
## 856          TSTM WIND     6957
## 170              FLOOD     6789
## 130     EXCESSIVE HEAT     6525
## 464          LIGHTNING     5230
## 275               HEAT     2100
## 427          ICE STORM     1975
## 153        FLASH FLOOD     1777
## 760  THUNDERSTORM WIND     1488
## 244               HAIL     1361
## 972       WINTER STORM     1321
## 411  HURRICANE/TYPHOON     1275
## 359          HIGH WIND     1137
## 310         HEAVY SNOW     1021
## 957           WILDFIRE      911
## 786 THUNDERSTORM WINDS      908
## 30             BLIZZARD      805
## 188                  FOG      734
## 955   WILD/FOREST FIRE      545
## 117         DUST STORM      440

#Finally plot both the fatalities and injuries in a single plot:
par(mfrow = c(1, 2), mar = c(10, 4, 2, 2), las = 3, cex = 0.7, cex.main =
1.4, cex.lab = 1.2)
barplot(totFatalitiesSorted$Fatalities, names.arg =
totFatalitiesSorted$Event, col = 'red',
        main = 'Top 20 Weather Events for Fatalities', ylab = 'Number of
Fatalities')
barplot(totInjuriesSorted$Injuries, names.arg = totInjuriesSorted$Event, col
= 'orange',
        main = 'Top 20 Weather Events for Injuries', ylab = 'Number of
Injuries')
```



Thus we see that Tornados cause most deaths and injuries in the U.S. National Oceanic and Atmospheric Administration's (NOAA) storm database. But Excessive heat causes second most deaths, whereas as far as injuries are conserned second to fourth causes have very similar values.

2 Address the question of which types of events have the greatest economic consequences

Calculate the cost of property and crop damages seperately.

```
#The property:
totProperty <- aggregate(noaaDF$PROPDMG, by = list(noaaDF$EVTYPE), "sum")
names(totProperty) <- c("Event", "Property")
totPropertySorted <- totProperty[order(-totProperty$Property), ][1:20, ]
totPropertySorted
```

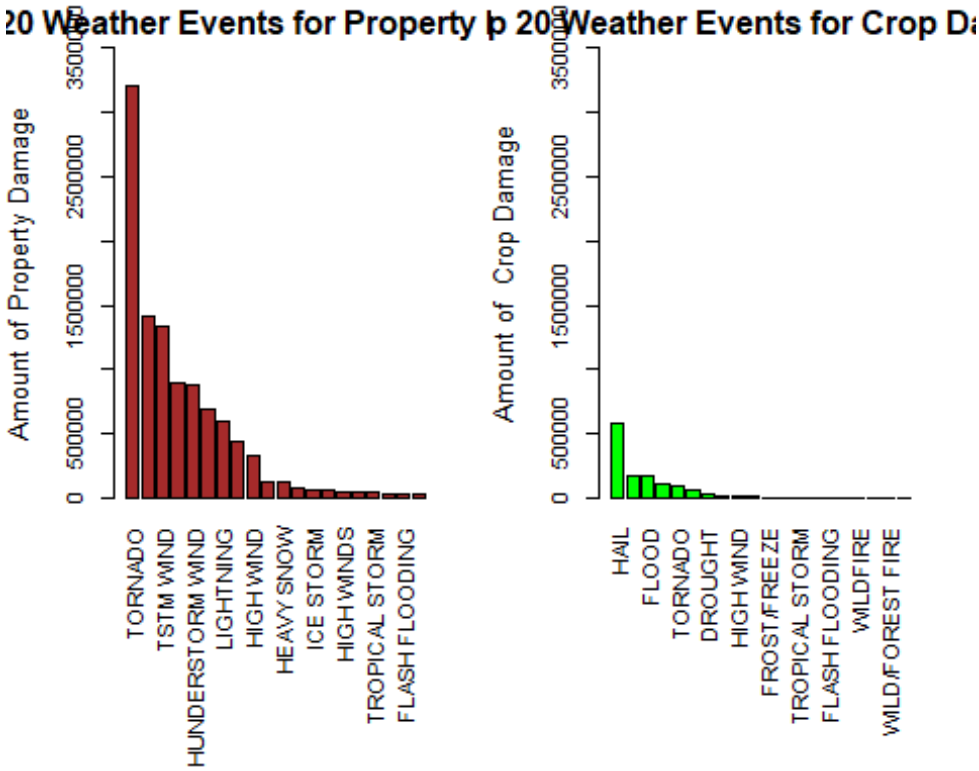
```
##                   Event   Property
## 834             TORNADO 3212258.16
## 153         FLASH FLOOD 1420124.59
## 856           TSTM WIND 1335965.61
## 170               FLOOD  899938.48
## 760  THUNDERSTORM WIND  876844.17
## 244                HAIL  688693.38
## 464           LIGHTNING  603351.78
## 786  THUNDERSTORM WINDS  446293.18
## 359           HIGH WIND  324731.56
```

```
## 972         WINTER STORM  132720.59
## 310           HEAVY SNOW  122251.99
## 957             WILDFIRE   84459.34
## 427            ICE STORM   66000.67
## 676          STRONG WIND   62993.81
## 376           HIGH WINDS   55625.00
## 290           HEAVY RAIN   50842.14
## 848       TROPICAL STORM   48423.68
## 955     WILD/FOREST FIRE   39344.95
## 164       FLASH FLOODING   28497.15
## 919 URBAN/SML STREAM FLD   26051.94
```

```
#The crop:
totCrop <- aggregate(noaaDF$CROPDMG, by = list(noaaDF$EVTYPE), "sum")
names(totCrop) <- c("Event", "Crop")
totCropSorted <- totCrop[order(-totCrop$Crop), ][1:20, ]
totCropSorted
```

```
##                  Event      Crop
## 244               HAIL 579596.28
## 153        FLASH FLOOD 179200.46
## 170              FLOOD 168037.88
## 856          TSTM WIND 109202.60
## 834            TORNADO 100018.52
## 760  THUNDERSTORM WIND  66791.45
## 95              DROUGHT  33898.62
## 786 THUNDERSTORM WINDS  18684.93
## 359          HIGH WIND  17283.21
## 290         HEAVY RAIN  11122.80
## 212       FROST/FREEZE   7034.14
## 140       EXTREME COLD   6121.14
## 848     TROPICAL STORM   5899.12
## 402          HURRICANE   5339.31
## 164     FLASH FLOODING   5126.05
## 411  HURRICANE/TYPHOON   4798.48
## 957           WILDFIRE   4364.20
## 873     TSTM WIND/HAIL   4356.65
## 955   WILD/FOREST FIRE   4189.54
## 464          LIGHTNING   3580.61
```

```
#Next plot both the cost of property and crop damages in a single plot:
par(mfrow = c(1, 2), mar = c(10, 4, 2, 2), las = 3, cex = 0.7, cex.main =
1.4, cex.lab = 1.2)
barplot(totPropertySorted$Property, names.arg = totPropertySorted$Event, col
= 'Brown',
        main = 'Top 20 Weather Events for Property Damage ', ylab = 'Amount
of Property Damage', ylim = c(0, 3500000))
barplot(totCropSorted$Crop, names.arg = totCropSorted$Event, col = 'Green',
        main = 'Top 20 Weather Events for Crop Damage', ylab = 'Amount of
Crop Damage', ylim = c(0, 3500000))
```

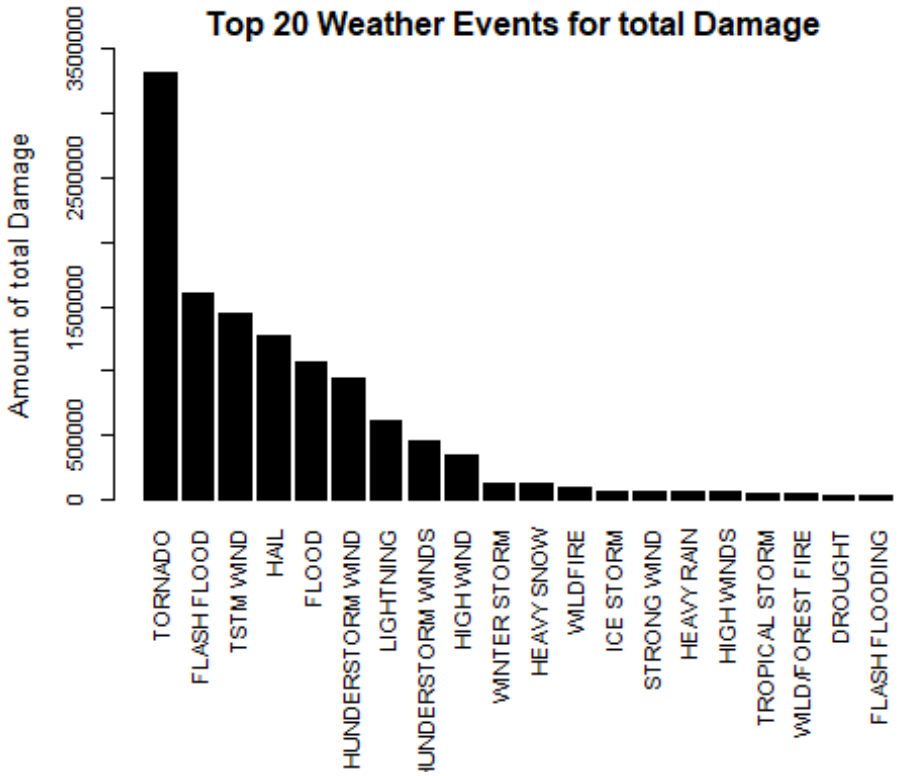



```
#Finally the total damage by adding both costs (property and crop damage)
totTotalCost <- aggregate(noaaDF$CROPDMG+noaaDF$PROPDMG, by =
list(noaaDF$EVTYPE), "sum")
names(totTotalCost) <- c("Event", "TotalCost")
totTotalCostSorted <- totTotalCost[order(-totTotalCost$TotalCost), ][1:20, ]
totTotalCostSorted
```

```
##                  Event  TotalCost
## 834            TORNADO 3312276.68
## 153        FLASH FLOOD 1599325.05
## 856          TSTM WIND 1445168.21
## 244               HAIL 1268289.66
## 170              FLOOD 1067976.36
## 760  THUNDERSTORM WIND  943635.62
## 464          LIGHTNING  606932.39
## 786 THUNDERSTORM WINDS  464978.11
## 359          HIGH WIND  342014.77
## 972       WINTER STORM  134699.58
## 310         HEAVY SNOW  124417.71
## 957           WILDFIRE   88823.54
## 427          ICE STORM   67689.62
## 676        STRONG WIND   64610.71
## 290         HEAVY RAIN   61964.94
## 376         HIGH WINDS   57384.60
## 848     TROPICAL STORM   54322.80
## 955   WILD/FOREST FIRE   43534.49
```

```
## 95              DROUGHT   37997.67
## 164     FLASH FLOODING   33623.20

#And a single plot
par(mfrow = c(1,1), mar = c(10, 4, 2, 2), las = 3, cex = 0.7, cex.main = 1.4,
cex.lab = 1.2)
barplot(totTotalCostSorted$TotalCost, names.arg = totTotalCostSorted$Event,
col = 'Black',
        main = 'Top 20 Weather Events for total Damage ', ylab = 'Amount of
total Damage', ylim = c(0, 3500000))
```



Thus we notice that tornadoes cause most total damage.

Results

As for the impact on public health, we have got two sorted lists of severe weather events below by the number of people badly affected.

```
totFatalitiesSorted
```

```
##                       Event Fatalities
## 834                 TORNADO       5633
## 130          EXCESSIVE HEAT       1903
## 153             FLASH FLOOD        978
## 275                    HEAT        937
## 464               LIGHTNING        816
## 856               TSTM WIND        504
```

```
## 170                   FLOOD        470
## 585             RIP CURRENT        368
## 359               HIGH WIND        248
## 19                AVALANCHE        224
## 972            WINTER STORM        206
## 586            RIP CURRENTS        204
## 278               HEAT WAVE        172
## 140            EXTREME COLD        160
## 760       THUNDERSTORM WIND        133
## 310               HEAVY SNOW        127
## 141 EXTREME COLD/WIND CHILL        125
## 676             STRONG WIND        103
## 30                 BLIZZARD        101
## 350               HIGH SURF        101
```

```
totInjuriesSorted
```

```
##                   Event Injuries
## 834             TORNADO    91346
## 856           TSTM WIND     6957
## 170               FLOOD     6789
## 130     EXCESSIVE HEAT     6525
## 464           LIGHTNING     5230
## 275                HEAT     2100
## 427           ICE STORM     1975
## 153         FLASH FLOOD     1777
## 760  THUNDERSTORM WIND     1488
## 244                HAIL     1361
## 972       WINTER STORM     1321
## 411  HURRICANE/TYPHOON     1275
## 359           HIGH WIND     1137
## 310          HEAVY SNOW     1021
## 957            WILDFIRE      911
## 786 THUNDERSTORM WINDS      908
## 30             BLIZZARD      805
## 188                  FOG      734
## 955   WILD/FOREST FIRE      545
## 117          DUST STORM      440
```

And the following is a pair of graphs of total fatalities and total injuries affected by these severe weather events.

Based on the above histograms, we find that **excessive heat** and **tornado** cause most fatalities; **tornato** causes most injuries in the United States from 1995 to 2011.

As for the impact on economy, we have got two sorted lists below by the amount of money cost by damages.

```
totPropertySorted
```

```
##                   Event   Property
## 834             TORNADO 3212258.16
## 153         FLASH FLOOD 1420124.59
## 856           TSTM WIND 1335965.61
## 170               FLOOD  899938.48
## 760  THUNDERSTORM WIND  876844.17
## 244                HAIL  688693.38
## 464           LIGHTNING  603351.78
## 786 THUNDERSTORM WINDS  446293.18
## 359           HIGH WIND  324731.56
## 972        WINTER STORM  132720.59
## 310          HEAVY SNOW  122251.99
## 957            WILDFIRE   84459.34
## 427           ICE STORM   66000.67
## 676         STRONG WIND   62993.81
## 376          HIGH WINDS   55625.00
## 290          HEAVY RAIN   50842.14
## 848      TROPICAL STORM   48423.68
## 955    WILD/FOREST FIRE   39344.95
## 164      FLASH FLOODING   28497.15
## 919 URBAN/SML STREAM FLD   26051.94

totCropSorted

##                   Event      Crop
## 244                HAIL 579596.28
## 153         FLASH FLOOD 179200.46
## 170               FLOOD 168037.88
## 856           TSTM WIND 109202.60
## 834             TORNADO 100018.52
## 760  THUNDERSTORM WIND  66791.45
## 95              DROUGHT  33898.62
## 786 THUNDERSTORM WINDS  18684.93
## 359           HIGH WIND  17283.21
## 290          HEAVY RAIN  11122.80
## 212       FROST/FREEZE   7034.14
## 140       EXTREME COLD   6121.14
## 848     TROPICAL STORM   5899.12
## 402           HURRICANE   5339.31
## 164     FLASH FLOODING   5126.05
## 411  HURRICANE/TYPHOON   4798.48
## 957            WILDFIRE   4364.20
## 873     TSTM WIND/HAIL   4356.65
## 955   WILD/FOREST FIRE   4189.54
## 464           LIGHTNING   3580.61
```

Based on the above histograms, we find that **flood** and **hurricane/typhoon** cause most property damage; **drought** and **flood** causes most crop damage in the United States from 1995 to 2011.

Conclusion

From these data, we found that **excessive heat** and **tornado** are most harmful with respect to population health, while **flood**, **drought**, and **hurricane/typhoon** have the greatest economic consequences.