How severe weather events can cause public health and economic problems

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Synopsis - Summary

Storms and severe weather can have big health and economic consequences. The understanding of the specific types of events associated with the greatest consequences can help inform disaster preparedness policies that can potentially mitigate damages and help target limited resources. The purpose of the current study is to identify the specific weather-related events that are associated witht the greatest amount of economic and health consequence. Data for this analysis come from the U.S. National Oceanic and Atmospheric Administration's (NOAA) storm database. Based on an exploratory analysis of the NOAA storm database, the storm related events associated with the greatest number of fatalities were tornados and heat. The greatest amount of economic damage was due to winds (e.g., tropical storm, storm surge, hurricane, and typhoons) and flooding.

Phase 1 - Data Processing

Read Data

```
rawdata <- read.csv(bzfile("C:/Users/hsofoian/Desktop/DataScience/Course 5 - Reproducible Re
```

Relevant fields + Homogenous

```
data <- rawdata[, c("STATE", "EVTYPE", "FATALITIES", "INJURIES", "PROPDMG",
    "PROPDMGEXP", "CROPDMG", "CROPDMGEXP")]
colnames(data) <- tolower(colnames(data))
```

```
data$evtype <- factor(toupper(data$evtype))
data$propdmgexp <- factor(toupper(data$propdmgexp))
data$cropdmgexp <- factor(toupper(data$cropdmgexp))
```

Convert the values of the columns propdmg

```
exponents <- data.frame(c("", "0", "H", "K", "M", "B"), c(1, 1, 10^2, 10^3,
    10^6, 10^9))
colnames(exponents) <- c("validexp", "multiplier")

data <- subset(data, (cropdmgexp %in% exponents$validexp) & (propdmgexp %in%
    exponents$validexp))

# convert damage values in number
colnames(exponents) <- c("validexp", "propdmgmultiplier")
data <- merge(data, exponents, by.x = "propdmgexp", by.y = "validexp")
data$propdmg <- (data$propdmg * data$propdmgmultiplier)

colnames(exponents) <- c("validexp", "cropdmgmultiplier")
data <- merge(data, exponents, by.x = "cropdmgexp", by.y = "validexp")
data$cropdmg <- (data$cropdmg * data$cropdmgmultiplier)
```

A - Calculation of economic impact

Calculation of the **economic impact** of different weather events.

```
data$totalCost <- data$propdmg + data$cropdmg  #define total cost
economicData <- subset(data, totalCost > 0)  #select only events with cost > 0

economicData <- economicData[, c("state", "evtype", "totalCost")]

library(reshape2)
library(plyr)
economicData <- dcast(economicData, state ~ evtype, fun.aggregate = sum, value.var = "totalC
economicData <- melt(economicData, id = "state")
economicData <- arrange(economicData, state, desc(value))
```

The event that generated the higher **totalCost**:

```
economicData <- split(economicData, economicData$state)
economicData <- lapply(economicData, function(x) x[1, ])
economicData <- melt(economicData, id = "state", id.vars = "variable", measure.vars = "value
```

B - Calculation of health impact

Calculation of the **health impact** of fatalities and injuries caused by each event.

```
# define total health cost through pca
pca <- data[, c("fatalities", "injuries")]
pca <- princomp(pca)
summary(pca)
```

```
## Importance of components:
##                         Comp.1  Comp.2
## Standard deviation     5.4379 0.72389
## Proportion of Variance 0.9826 0.01741
## Cumulative Proportion  0.9826 1.00000
```

```
data$totalHealthCost <- pca$scores[, 1]
healthData <- subset(data, totalHealthCost > 0)  #select only events with cost > 0
healthData <- healthData[, c("state", "evtype", "totalHealthCost")]
```

```
# sum over states by type of event and arrange for decreasing costs
healthData <- dcast(healthData, state ~ evtype, fun.aggregate = sum, value.var = "totalHealt
healthData <- melt(healthData, id = "state")
healthData <- arrange(healthData, state, desc(value))
healthData <- split(healthData, healthData$state)
healthData <- lapply(healthData, function(x) x[1, ])
healthData <- melt(healthData, id = "state", id.vars = "variable", measure.vars = "value")
```

Phase 2 - Results

Economic impact

Costs in Bn $

```
colnames(economicData) <- c("eventType", "totalCost_Bn", "state")
economicData <- economicData[, c("state", "eventType", "totalCost_Bn")]
```

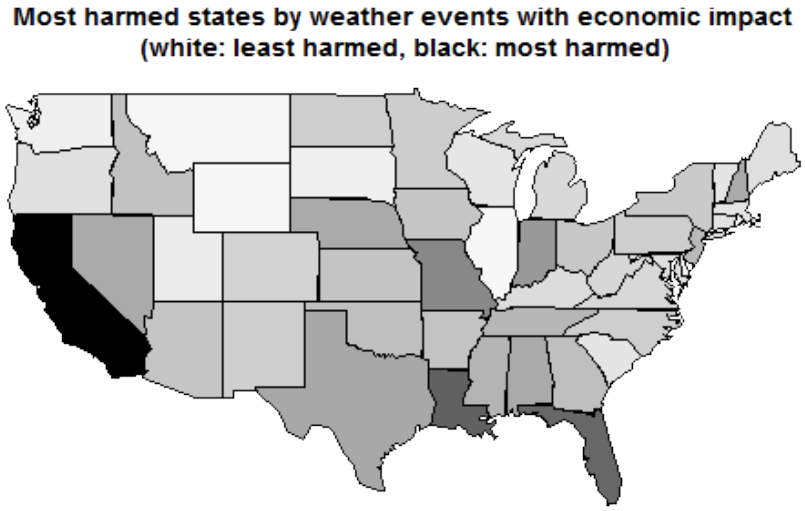
```
# convert in Bn$
economicData$totalCost_Bn <- economicData$totalCost_Bn/10^9
economicData[!is.na(economicData$totalCost_Bn), ]
```

```
##    state                eventType totalCost_Bn
## 1     AK                    FLOOD    1.571e-01
## 2     AL                  TORNADO    6.378e+00
```

```
## 3     AM               WATERSPOUT    5.102e-03
## 4     AN MARINE THUNDERSTORM WIND    1.690e-04
## 5     AR                  TORNADO    2.592e+00
## 6     AS                  TSUNAMI    8.102e-02
## 7     AZ                     HAIL    2.829e+00
## 8     CA                    FLOOD    1.174e+02
## 9     CO                     HAIL    1.515e+00
## 10    CT                  TORNADO    5.962e-01
## 11    DC            TROPICAL STORM    1.276e-01
## 12    DE             COASTAL FLOOD    4.015e-02
## 13    FL         HURRICANE/TYPHOON    2.855e+01
## 14    GA                  TORNADO    3.272e+00
## 15    GM          MARINE TSTM WIND    3.226e-03
## 16    GU                  TYPHOON    6.011e-01
## 17    HI               FLASH FLOOD    1.571e-01
## 18    IA                    FLOOD    2.970e+00
## 19    ID                    FLOOD    1.142e-01
## 20    IL               RIVER FLOOD    1.003e+01
## 21    IN                  TORNADO    2.595e+00
## 22    KS                  TORNADO    2.682e+00
## 23    KY                  TORNADO    8.907e-01
## 24    LA              STORM SURGE    3.174e+01
## 26    LE MARINE THUNDERSTORM WIND    2.500e-05
## 28    LM          MARINE TSTM WIND    1.205e-03
## 29    LO          MARINE TSTM WIND    5.000e-05
## 30    LS          MARINE TSTM WIND    4.000e-04
## 31    MA                  TORNADO    7.560e-01
## 32    MD            TROPICAL STORM    5.392e-01
## 33    ME                 ICE STORM    3.182e-01
## 34    MH                 HIGH SURF    5.000e-03
## 35    MI                  TORNADO    1.073e+00
## 36    MN                  TORNADO    1.917e+00
## 37    MO                  TORNADO    4.823e+00
## 38    MS         HURRICANE/TYPHOON    1.501e+01
## 39    MT                     HAIL    1.291e-01
## 40    NC                 HURRICANE    6.405e+00
## 41    ND                    FLOOD    3.990e+00
## 42    NE                  TORNADO    1.746e+00
## 43    NH                 ICE STORM    6.493e-02
## 44    NJ                    FLOOD    2.112e+00
## 45    NM          WILD/FOREST FIRE    1.510e+00
## 46    NV                    FLOOD    6.839e-01
## 47    NY               FLASH FLOOD    1.835e+00
## 48    OH                  TORNADO    2.285e+00
## 49    OK                  TORNADO    3.319e+00
## 50    OR                    FLOOD    7.410e-01
```

```
## 51    PA                  TORNADO    1.796e+00
## 53    PK         MARINE HIGH WIND    3.100e-05
## 55    PR                HURRICANE    2.275e+00
## 56    PZ       MARINE STRONG WIND    7.600e-05
## 57    RI                    FLOOD    9.286e-02
## 58    SC                  TORNADO    5.368e-01
## 59    SD                  TORNADO    2.319e-01
## 60    SL         MARINE TSTM WIND    1.500e-05
## 62    TN                    FLOOD    4.250e+00
## 63    TX                  DROUGHT    6.722e+00
## 64    UT                    FLOOD    3.319e-01
## 65    VA        HURRICANE/TYPHOON    5.266e-01
## 66    VI                HURRICANE    2.822e-02
## 67    VT                    FLOOD    1.112e+00
## 68    WA                     HAIL    2.199e-01
## 69    WI              FLASH FLOOD    1.188e+00
## 70    WV              FLASH FLOOD    4.865e-01
## 71    WY                     HAIL    1.131e-01
```

```
library(maps)

economicData <- economicData[!is.na(economicData$totalCost_Bn), ]

data(state.fips)
tmp <- state.fips
tmp <- data.frame(tmp$abb, tmp$polyname)
colnames(tmp) <- c("state", "stateName")
economicData <- merge(economicData, tmp)

economicData$totalCost_Bn <- (economicData$totalCost_Bn)^(1/3)

economicData$normCost <- (economicData$totalCost_Bn - min(economicData$totalCost_Bn))/(max(e
    min(economicData$totalCost_Bn))

# plot
pal <- colorRamp(c("white", "black"))
map("state", regions = economicData$stateName, lty = 1, lwd = 1, boundary = TRUE,
    fill = TRUE, col = rgb(pal(economicData$normCost)/255))
title(main = "Most harmed states by weather events with economic impact\n (white: least harm
```



Health impact

```
colnames(healthData) <- c("eventType", "totalHealthCost", "state")
healthData <- healthData[, c("state", "eventType", "totalHealthCost")]
healthData[!is.na(healthData$totalHealthCost), ]
```

```
##    state                eventType totalHealthCost
## 1     AK                ICE STORM         33.4125
## 2     AL                  TORNADO       7877.1258
## 3     AM MARINE THUNDERSTORM WIND         21.2689
## 4     AN       MARINE STRONG WIND         17.4015
## 5     AR                  TORNADO       5064.5173
## 6     AS                  TSUNAMI        130.1814
## 7     AZ               DUST STORM        176.8428
## 8     CA                 WILDFIRE        611.4135
```

```
## 9     CO                  TORNADO       253.2910
## 10    CT                  TORNADO       699.6226
## 11    DC            EXCESSIVE HEAT       315.6478
## 12    DE                  TORNADO        70.9818
## 13    FL                  TORNADO      3283.4283
## 14    GA                  TORNADO      3867.7126
## 16    GU         HURRICANE/TYPHOON       332.3795
## 17    HI                 HIGH SURF        20.4146
## 18    IA                  TORNADO      2175.5368
## 19    ID         THUNDERSTORM WIND        73.4522
## 20    IL                  TORNADO      4099.1294
## 21    IN                  TORNADO      4187.3505
## 22    KS                  TORNADO      2688.0431
## 23    KY                  TORNADO      2774.4141
## 24    LA                  TORNADO      2580.4577
## 28    LM MARINE THUNDERSTORM WIND         0.9347
## 31    MA                  TORNADO      1756.8414
## 32    MD            EXCESSIVE HEAT       461.5193
## 33    ME                 LIGHTNING        64.2321
## 34    MH                 HIGH SURF         0.8426
## 35    MI                  TORNADO      3340.9094
## 36    MN                  TORNADO      1952.4496
## 37    MO                  TORNADO      4287.0509
## 38    MS                  TORNADO      6191.3236
## 39    MT          WILD/FOREST FIRE        31.5576
## 40    NC                  TORNADO      2501.9325
## 41    ND                  TORNADO       318.3618
## 42    NE                  TORNADO      1136.1336
## 43    NH                 LIGHTNING        78.3421
## 44    NJ            EXCESSIVE HEAT       299.5644
## 45    NM                  TORNADO       151.4231
## 46    NV                    FLOOD        49.8827
## 47    NY                  TORNADO       304.1441
## 48    OH                  TORNADO      4407.0040
## 49    OK                  TORNADO      4767.5576
## 50    OR                 HIGH WIND        49.1107
## 51    PA                  TORNADO      1221.4486
## 55    PR                HEAVY RAIN         9.6124
## 56    PZ        MARINE STRONG WIND         2.7763
## 57    RI                  TORNADO        22.6628
## 58    SC                  TORNADO      1288.2890
## 59    SD                  TORNADO       439.4989
## 62    TN                  TORNADO      4706.3186
## 63    TX                  TORNADO      8105.6196
## 64    UT              WINTER STORM       411.2769
## 65    VA                  TORNADO       901.2121
```

```
## 66    VI                LIGHTNING          0.8887
## 67    VT                TSTM WIND         22.6593
## 68    WA                  TORNADO        302.3291
## 69    WI                  TORNADO       1571.1703
## 70    WV                TSTM WIND        135.0149
## 71    WY             WINTER STORM        117.6506
```

```
library(maps)

healthData <- healthData[!is.na(healthData$totalHealthCost), ]

data(state.fips)
tmp <- state.fips
tmp <- data.frame(tmp$abb, tmp$polyname)
colnames(tmp) <- c("state", "stateName")
healthData <- merge(healthData, tmp)

healthData$normCost <- (healthData$totalHealthCost - min(healthData$totalHealthCost))/(max(h
    min(healthData$totalHealthCost))

# plot
pal <- colorRamp(c("white", "blue"))
map("state", regions = healthData$stateName, lty = 1, lwd = 1, boundary = TRUE,
    fill = TRUE, col = rgb(pal(healthData$normCost)/255))
title(main = "Most harmed states by weather events with health impact\n (blue: most harmed,
```

Most harmed states by weather events with health impact
(blue: most harmed, white: least harmed)