Analysis of Storm Affects on Population Health and Economy in USA

Introduction

Storms and other severe weather events can cause both public health and economic problems for communities and municipalities. Many severe events can result in fatalities, injuries, and property damage, and preventing such outcomes to the extent possible is a key concern.

This project involves exploring the U.S. National Oceanic and Atmospheric Administration's (NOAA) storm database. This database tracks characteristics of major storms and weather events in the United States, including when and where they occur, as well as estimates of any fatalities, injuries, and property damage.

Data Processing

Analysis

Sum aggregates of damages will provide a meaninful measure for our analysis.

Population health (HEALTHDAMAGES) for each event is obtained after cumulative sum of reported injuries and fatilities for each year between 1950 - 2011. Economic affect (DMGCASH) for each event is obtained after cumlative sum of crop and property damage and after applying appropiate multipler. The results are then sorted and top 25 events and their values are presented. Each storm data event is first grouped into a class and then the sums are obtained for each class.

Loading

There is also some documentation of the database available: https://d396qusza40orc.cloudfront.net/repdata%2Fpeer2_doc%2Fpd01016005curr.pdf https://d396qusza40orc.cloudfront.net/repdata%2Fpeer2_doc%2FNCDC%20Storm%20Events-FAQ%20Page.pdf The data used for this analysis is available: https://d396qusza40orc.cloudfront.net/repdata%2Fdata%2FStormData.csv.bz2.

```
#repdata-data-StormData.csv.bz2 is obtained from https://d396qusza40orc.cloudfront.net/repdata%2Fdata%2
data <- read.csv(bzfile("repdata-data-StormData.csv.bz2"))
```

Processing Health Affects

Get only health affects

```
library(ggplot2)
library(data.table)
library(xtable)
health <- data[data$FATALITIES > 0 | data$INJURIES > 0,
                          c("EVTYPE", "INJURIES", "FATALITIES")]
health$EVTYPE2 <- as.factor(toupper(health$EVTYPE))
```

Calculate health affects (HEALTHDAMAGES)

```
health$HEALTHDAMAGES <- health$FATALITIES + health$INJURIES;
health.sum <- tapply(health$HEALTHDAMAGES, health$EVTYPE2, sum)
health.sum <- data.frame(EVTYPE2=names(health.sum),
                         HEALTHDAMAGES=health.sum, row.names=NULL)
health.sum <- health.sum[order(health.sum$HEALTHDAMAGES,
                               decreasing=TRUE), ]
xt <- xtable(health.sum)
print(xt, type="html", include.rownames=FALSE)
```

EVTYPE2

HEALTHDAMAGES

TORNADO

96979.00

EXCESSIVE HEAT

8428.00

TSTM WIND

7461.00

FLOOD

7259.00

LIGHTNING

6046.00

HEAT

3037.00

FLASH FLOOD

2755.00

ICE STORM

2064.00

THUNDERSTORM WIND

1621.00

WINTER STORM

1527.00

HIGH WIND

1385.00

HAIL

1376.00

HURRICANE/TYPHOON

1339.00

HEAVY SNOW

1148.00

WILDFIRE

986.00

THUNDERSTORM WINDS

972.00

BLIZZARD

906.00

FOG

796.00

RIP CURRENT

600.00

WILD/FOREST FIRE

557.00

HEAT WAVE

551.00

RIP CURRENTS

501.00

DUST STORM

462.00

WINTER WEATHER

431.00

TROPICAL STORM

398.00

AVALANCHE

394.00

EXTREME COLD

393.00

STRONG WIND

383.00

DENSE FOG

360.00

HEAVY RAIN

349.00

HIGH WINDS

337.00

HIGH SURF

260.00

EXTREME HEAT

251.00

GLAZE

223.00

TSUNAMI

162.00

WILD FIRES

153.00

EXTREME COLD/WIND CHILL

149.00

ICE

143.00

WIND

109.00

COLD/WIND CHILL

107.00

HURRICANE

107.00

URBAN/SML STREAM FLD

107.00

TSTM WIND/HAIL

100.00

WINTER WEATHER/MIX

100.00

HEAVY SURF/HIGH SURF

90.00

LANDSLIDE

90.00

COLD

86.00

WINTRY MIX

78.00

WINTER WEATHER MIX

68.00

RECORD HEAT

52.00

STORM SURGE

51.00

TROPICAL STORM GORDON

51.00

HEAVY SURF

48.00

DUST DEVIL

45.00

WATERSPOUT/TORNADO

45.00

SNOW SQUALL

37.00

ICY ROADS

36.00

MARINE STRONG WIND

36.00

MARINE THUNDERSTORM WIND

36.00

SNOW

36.00

SNOW/HIGH WINDS

36.00

FLOOD/FLASH FLOOD

32.00

WATERSPOUT

32.00

DRY MICROBURST

31.00

FREEZING RAIN

30.00

STRONG WINDS

29.00

UNSEASONABLY WARM AND DRY

29.00

MIXED PRECIP

28.00

UNSEASONABLY WARM

28.00

FLASH FLOODING

27.00

THUNDERSTORMW

27.00

WINTER STORMS

27.00

BLACK ICE

25.00

TORNADOES, TSTM WIND, HAIL

25.00

EXCESSIVE RAINFALL

23.00

HIGH WIND AND SEAS

23.00

EXTREME WINDCHILL

22.00

HEAT WAVE DROUGHT

19.00

FREEZING DRIZZLE

17.00

MARINE TSTM WIND

17.00

RECORD/EXCESSIVE HEAT

17.00

BLOWING SNOW

16.00

STORM SURGE/TIDE

16.00

TORNADO F2

16.00

WINTER STORM HIGH WINDS

16.00

GLAZE/ICE STORM

15.00

GUSTY WINDS

15.00

COLD AND SNOW

14.00

FLASH FLOOD/FLOOD

14.00

HIGH SEAS

13.00

ROUGH SEAS

13.00

THUNDERSTORM

13.00

MARINE MISHAP

12.00

HEAVY SNOW/ICE

10.00

SMALL HAIL

10.00

THUNDERSTORM WINDS

10.00

HIGH WINDS/SNOW

9.00

FLOODING

8.00

HURRICANE ERIN

7.00

HYPOTHERMIA/EXPOSURE

7.00

LOW TEMPERATURE

7.00

NON-SEVERE WIND DAMAGE

7.00

MUDSLIDE

6.00

RAIN/SNOW

6.00

COASTAL FLOOD

5.00

COASTAL FLOODING/EROSION

5.00

COASTAL STORM

5.00

COLD WEATHER

5.00

FLASH FLOODING/FLOOD

5.00

HEAT WAVES

5.00

RIP CURRENTS/HEAVY SURF

5.00

ROUGH SURF

5.00

SNOW AND ICE

5.00

TYPHOON

5.00

DROUGHT

4.00

FROST

4.00

HEAVY RAINS

4.00

HIGH WINDS/COLD

4.00

HIGH WIND/SEAS

4.00

OTHER

4.00

RIVER FLOOD

4.00

THUNDERSTORM WINDSS

4.00

TORRENTIAL RAINFALL

4.00

COASTAL FLOODING

3.00

COLD WAVE

3.00

FUNNEL CLOUD

3.00

HEAVY SEAS

3.00

HEAVY SURF AND WIND

3.00

HIGH WATER

3.00

LIGHT SNOW

3.00

MARINE ACCIDENT

3.00

RIVER FLOODING

3.00

TSTM WIND (G45)

3.00

BRUSH FIRE

2.00

COLD TEMPERATURE

2.00

DROUGHT/EXCESSIVE HEAT

2.00

EXCESSIVE SNOW

2.00

FALLING SNOW/ICE

2.00

FLASH FLOODS

2.00

FOG AND COLD TEMPERATURES

2.00

GUSTY WIND

2.00

HEAVY SNOW AND HIGH WINDS

2.00

HEAVY SNOW SHOWER

2.00

HURRICANE EDOUARD

2.00

HURRICANE-GENERATED SWELLS

2.00

HURRICANE OPAL

2.00

HURRICANE OPAL/HIGH WINDS

2.00

ICE STORM/FLASH FLOOD

2.00

LANDSLIDES

2.00

MARINE HIGH WIND

2.00

ROGUE WAVE

2.00

SLEET

2.00

THUNDERSNOW

2.00

TORNADO F3

2.00

UNSEASONABLY COLD

2.00

WARM WEATHER

2.00

WINDS

2.00

AVALANCE

1.00

COASTALSTORM

1.00

COLD/WINDS

1.00

DROWNING

1.00

DRY MIRCOBURST WINDS

1.00

EXTENDED COLD

1.00

FLOOD & HEAVY RAIN

1.00

FLOOD/RIVER FLOOD

1.00

FREEZE

1.00

FREEZING RAIN/SNOW

1.00

FREEZING SPRAY

1.00

HAZARDOUS SURF

1.00

HEAVY SNOW/BLIZZARD/AVALANCHE

1.00

HIGH

1.00

HIGH SWELLS

1.00

HIGH WAVES

1.00

HIGH WIND 48

1.00

HIGH WIND/HEAVY SNOW

1.00

HURRICANE EMILY

1.00

HURRICANE FELIX

1.00

HYPERTHERMIA/EXPOSURE

1.00

HYPOTHERMIA

1.00

ICE ON ROAD

1.00

ICE ROADS

1.00

LIGHTNING.

1.00

LIGHTNING AND THUNDERSTORM WIN

1.00

LIGHTNING INJURY

1.00

MINOR FLOODING

1.00

MUDSLIDES

1.00

NON TSTM WIND

1.00

RAIN/WIND

1.00

RAPIDLY RISING WATER

1.00

RECORD COLD

1.00

SNOW/ BITTER COLD

1.00

SNOW SQUALLS

1.00

THUNDERSTORMS WINDS

1.00

THUNDERSTORM WIND (G40)

1.00

THUNDERSTORM WIND G52

1.00

THUNDERSTORM WINDS 13

1.00

THUNDERSTORM WINDS/HAIL

1.00

THUNDERTORM WINDS

1.00

TIDAL FLOODING

1.00

TSTM WIND (G35)

1.00

TSTM WIND (G40)

1.00

URBAN AND SMALL STREAM FLOODIN

1.00

WATERSPOUT TORNADO

1.00

WHIRLWIND

1.00

WIND STORM

1.00

Processing Economic Affects

Extract economic affects

```
economic <- data[data$PROPDMG > 0 | data$CROPDMG > 0,
                         c("EVTYPE", "PROPDMG","PROPDMGEXP", "CROPDMG","CROPDMGEXP")]
economic$EVTYPE2 <- as.factor(toupper(economic$EVTYPE))
```

Calculate economic damages (DMGCASH).

The numeric values and its multiple are present in different columns. The multipler can be either character (e.g “H”, “K”, “M” or “B” for hunderds, thousands, millions or billions) or exponent values. We assume the multiplier == 1 when it does not fall into either of the above two classes.

```
economic$PROPDMGEXP <- as.factor(toupper(as.character(economic$PROPDMGEXP)))
economic$CROPDMGEXP <- as.factor(toupper(as.character(economic$CROPDMGEXP)))

dvals <- unique(union(economic$PROPDMGEXP, economic$CROPDMGEXP))
DMGEXP <- numeric(18)
names(DMGEXP) <- dvals
```

```
DMGEXP[names(DMGEXP) %in% c("", "+", "-", "?")] <- 0
DMGEXP["H"] <- 2
DMGEXP["K"] <- 3
DMGEXP["M"] <- 6
DMGEXP["B"] <- 9

economic$PROPDMGCASH <- economic$PROPDMG * (10 ^ DMGEXP[economic$PROPDMGEXP])
economic$CROPDMGCASH <- economic$CROPDMG * (10 ^ DMGEXP[economic$CROPDMGEXP])
economic$DMGCASH <- economic$CROPDMGCASH + economic$PROPDMGCASH
#sum(is.na(economic$DMGCASH))
economic.sum <- tapply(economic$DMGCASH, economic$EVTYPE2, sum)
economic.sum <- data.frame(EVTYPE2=names(economic.sum),
                           DMGCASH=economic.sum, row.names=NULL)
economic.sum <- economic.sum[order(economic.sum$DMGCASH, decreasing=TRUE), ]
```

Processing Event Class Affects

Make groups by events.

```
groups <- function (sd) {
    heat            <- grep("HEAT|HYPERTHERMIA", sd$EVTYPE2, ignore.case=TRUE)
    fire            <- grep("FIRE", sd$EVTYPE2, ignore.case=TRUE)
    drought         <- grep("DROUGHT", sd$EVTYPE2, ignore.case=TRUE)
    coastal         <- grep("CURRENT|SURF|SEAS|WAVE|MARINE", sd$EVTYPE2, ignore.case=TRUE)
    lightning       <- grep("LIGHTNING", sd$EVTYPE2, ignore.case=TRUE)
    rain            <- grep("RAIN|LANDSLIDE|MUDSLIDE|AVALANCH?E", sd$EVTYPE2, ignore.case=TRUE)
    flood           <- grep("FLOOD|TSUNAMI|WATER|FLD", sd$EVTYPE2, ignore.case=TRUE)
    fog             <- grep("FOG", sd$EVTYPE2, ignore.case=TRUE)
    snow.cold       <- grep("SNOW|COLD|HYPOTHERMIA|WINTER|HAIL|BLIZZARD|ICE|ICY|FREEZ|FROST|GLAZE|WINTR
                            sd$EVTYPE2, ignore.case=TRUE)
    blizzard        <- grep("BLIZZARD", sd$EVTYPE2, ignore.case=TRUE)
    tornado         <- grep("TORNADO", sd$EVTYPE2, ignore.case=TRUE)
    thunderstorm    <- grep("THUNDERSTORM|TSTM", sd$EVTYPE2, ignore.case=TRUE)
    hurricane       <- setdiff(grep("HURRICANE|TYPHOON", sd$EVTYPE2,
                                    ignore.case=TRUE), thunderstorm)
    storm           <- setdiff(grep("STORM", sd$EVTYPE2, ignore.case=TRUE),
                               union(thunderstorm, c(blizzard, hurricane)))
    wind            <- setdiff(grep("WIND", sd$EVTYPE2, ignore.case=TRUE), thunderstorm)
    accounted <- unique(c(tornado, heat, snow.cold, drought, flood, lightning, fire, rain, fog, coastal
                          thunderstorm, wind, hurricane, blizzard, storm))
    others <- setdiff(1:nrow(sd), accounted)

    groups <- data.frame()
    groups <- rbind(groups, data.frame(group="TORNADO", EVTYPE2=unique(sd[tornado, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="HEAT", EVTYPE2=unique(sd[heat, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="SNOW/COLD", EVTYPE2=unique(sd[snow.cold, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="DROUGHT", EVTYPE2=unique(sd[drought, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="FLOOD", EVTYPE2=unique(sd[flood, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="LIGHTNING", EVTYPE2=unique(sd[lightning, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="FIRE", EVTYPE2=unique(sd[fire, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="RAIN", EVTYPE2=unique(sd[rain, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="FOG", EVTYPE2=unique(sd[fog, c("EVTYPE2")])))
```

```
    groups <- rbind(groups, data.frame(group="COASTAL", EVTYPE2=unique(sd[coastal, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="THUNDERSTORM",
                                       EVTYPE2=unique(sd[thunderstorm, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="WIND", EVTYPE2=unique(sd[wind, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="HURRICANE", EVTYPE2=unique(sd[hurricane, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="BLIZZARD", EVTYPE2=unique(sd[blizzard, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="OTHER STORMS", EVTYPE2=unique(sd[storm, c("EVTYPE2")])))
    groups <- rbind(groups, data.frame(group="OTHER", EVTYPE2=unique(sd[others, c("EVTYPE2")])))
    groups
}
```

Calculate health affects by storm event classes

```
health.grp <- groups(health)
health.mrg <- merge(health.sum, health.grp,
                        by.x="EVTYPE2", by.y="EVTYPE2",
                        all.x=TRUE, all.y=FALSE)

health.mrg.sum <- tapply(health.mrg$HEALTHDAMAGES, health.mrg$group, sum)
health.mrg.sum <- data.frame(GROUP=names(health.mrg.sum),
                             HEALTHDAMAGES=health.mrg.sum, row.names=NULL)
xt <- xtable(health.mrg.sum)
print(xt, type="html", include.rownames=FALSE)
```

GROUP

HEALTHDAMAGES

TORNADO

97068.00

HEAT

12363.00

SNOW/COLD

9327.00

DROUGHT

25.00

FLOOD

10480.00

LIGHTNING

6049.00

FIRE

1698.00

RAIN

914.00

FOG

1158.00

COASTAL

2315.00

THUNDERSTORM

10298.00

WIND

2692.00

HURRICANE

1468.00

BLIZZARD

907.00

OTHER STORMS

4636.00

OTHER

125.00

Calculate economic affects by storm event classes

```
economic.grp <- groups(economic)
economic.mrg <- merge(economic.sum, economic.grp,
                      by.x="EVTYPE2", by.y="EVTYPE2",
                      all.x=TRUE, all.y=FALSE)

economic.mrg.sum <- tapply(economic.mrg$DMGCASH, economic.mrg$group, sum)
economic.mrg.sum <- data.frame(GROUP=names(economic.mrg.sum),
                               DMGCASH=economic.mrg.sum, row.names=NULL)
xt <- xtable(economic.mrg.sum)
print(xt, type="html", include.rownames=FALSE)
```

GROUP

DMGCASH

TORNADO

220003318555.78

HEAT

4706.04

SNOW/COLD

20001828422.38

DROUGHT

38253.45

FLOOD

22003072590.57

LIGHTNING

610292.89

FIRE

134789.03

RAIN

2000093457.15

FOG

17259.26

COASTAL

12972.51

THUNDERSTORM

80003113210.84

WIND

35015487311.30

HURRICANE

36824.44

BLIZZARD

26195.48

OTHER STORMS

296656.54

OTHER

12707.58

Results

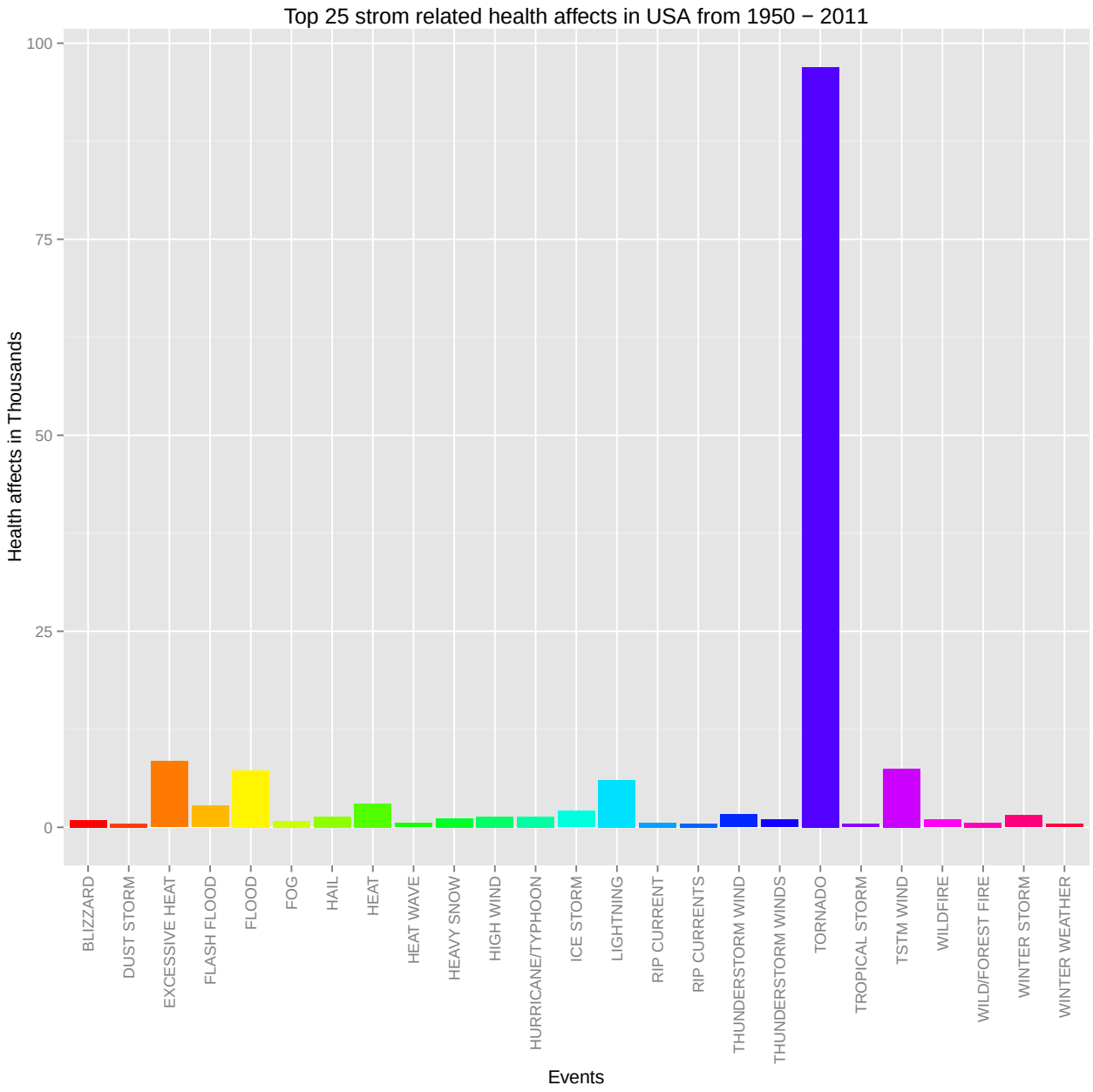
Health Affects

Show top health affects

```
health.sum.top <- head(health.sum, n=25)
health.sum.top$HEALTHDAMAGES <- health.sum.top$HEALTHDAMAGES / 1000

sdh.gp <- ggplot(health.sum.top, aes(x=EVTYPE2, y=HEALTHDAMAGES)) +
    xlab("Events") +
    ylab("Health affects in Thousands") +
    ggtitle(paste("Top", nrow(health.sum.top),
                  "strom related health affects in USA from 1950 - 2011")) +
    geom_bar(stat="identity", fill=rainbow(n=length(health.sum.top$EVTYPE2))) +
    theme(axis.text.x = element_text(angle = 90, hjust = 1, vjust=0.5))

sdh.gp
```



Economic Affects

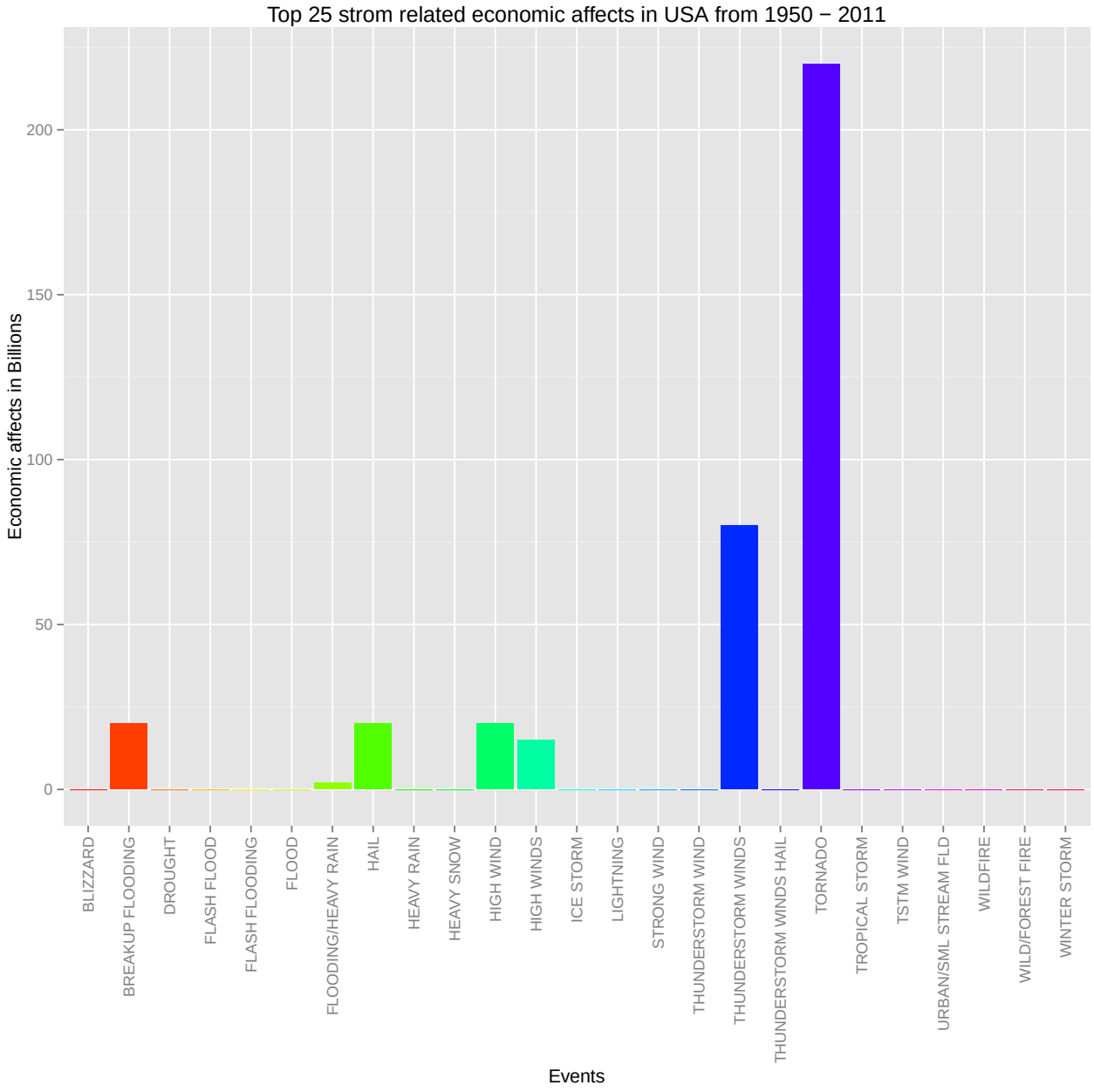
Show top economic affects

```
economic.sum.top <- head(economic.sum, n=25)
economic.sum.top$DMGCASH <- economic.sum.top$DMGCASH / (10^9)

sde.gp <- ggplot(economic.sum.top, aes(x=EVTYPE2, y=DMGCASH)) +
    xlab("Events") +
    ylab("Economic affects in Billions") +
    ggtitle(paste("Top", nrow(economic.sum.top),
                  "strom related economic affects in USA from 1950 - 2011")) +
    geom_bar(stat="identity", fill=rainbow(n=length(economic.sum.top$EVTYPE2))) +
```

```
    theme(axis.text.x = element_text(angle = 90, hjust = 1, vjust=0.5))

sde.gp
```



Event Class Affects

We use multiplot function, which is obtained from http://www.cookbook-r.com/Graphs/Multiple_graphs_on_one_page_(ggplot2)/

Show health and economic affects by storm event classes

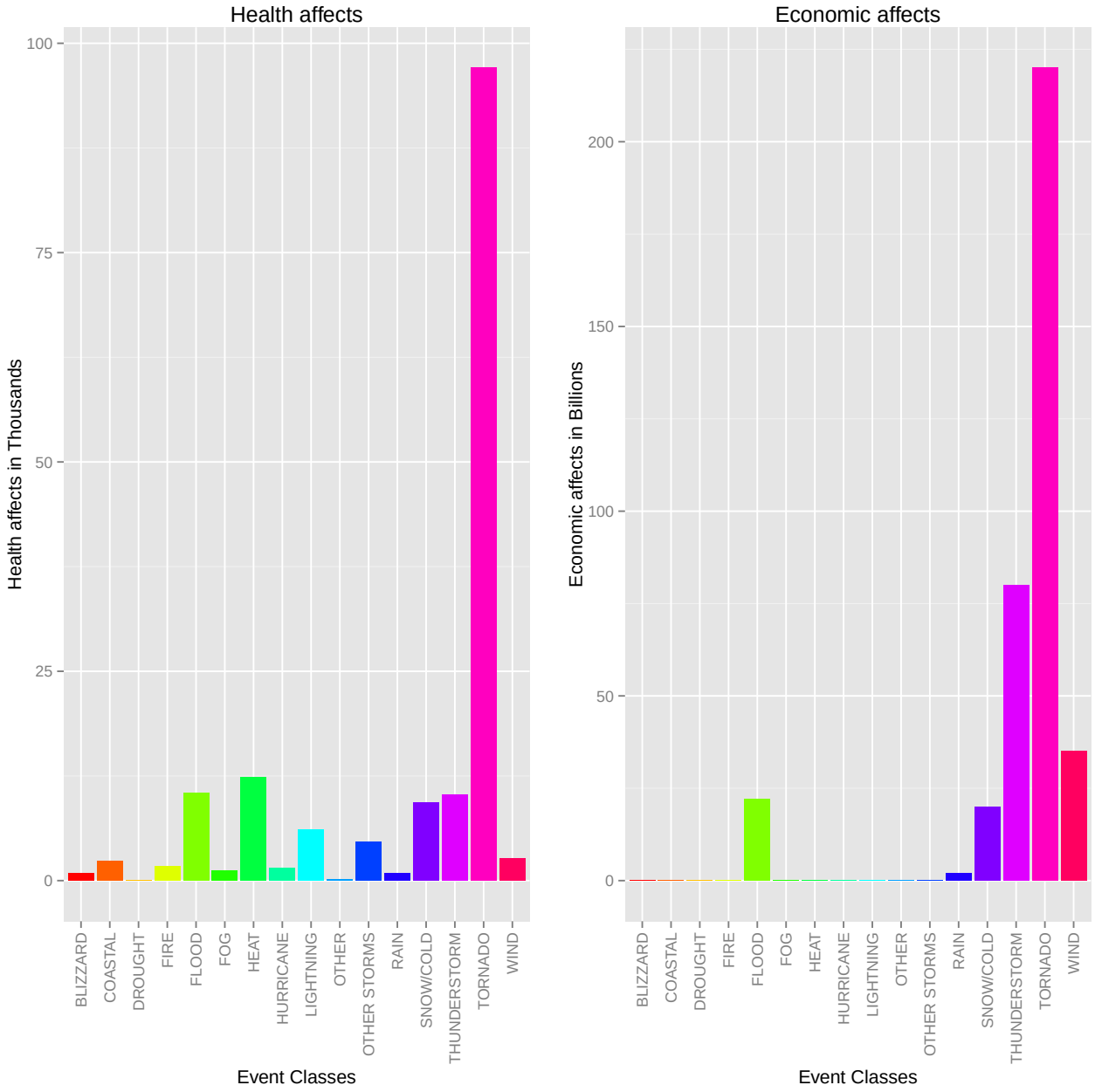
```
health.mrg.sum$HEALTHDAMAGES <- health.mrg.sum$HEALTHDAMAGES / 1000
economic.mrg.sum$DMGCASH <- economic.mrg.sum$DMGCASH / (10^9)
```

```
sdh.grp.gp <- ggplot(health.mrg.sum, aes(x=GROUP, y=HEALTHDAMAGES)) +
    xlab("Event Classes") +
    ylab("Health affects in Thousands") +
    ggtitle("Health affects") +
    geom_bar(stat="identity", fill=rainbow(n=length(health.mrg.sum$GROUP))) +
    theme(axis.text.x = element_text(angle = 90, hjust = 1, vjust=0.5))

sde.grp.gp <- ggplot(economic.mrg.sum, aes(x=GROUP, y=DMGCASH)) +
    xlab("Event Classes") +
    ylab("Economic affects in Billions") +
    ggtitle("Economic affects") +
    geom_bar(stat="identity", fill=rainbow(n=length(economic.mrg.sum$GROUP))) +
    theme(axis.text.x = element_text(angle = 90, hjust = 1, vjust=0.5))

multiplot(sdh.grp.gp, sde.grp.gp, cols=2)
```

```
## Loading required package: grid
```



Conclusion

This paper presents the types of storm related events that are responsible for most negative affects in USA from 1950 t0 2011