Assessing the Health and Economic Consequences of Weather Events in the US

A project for JHU's *Reproducible Research* on-line course

This report looks at the health and economic consequences of weather events in the United States from 1950 to 2011. We use three barometers to measure health consequences: fatalities, casualties (*i.e.* fatalities plus injuries) and deadliness (the ratio of fatalities to casualties). It is shown that tornadoes cause the most fatalities and casualties, while the most deadly weather event is extremely cold temperatures.

To gauge economic consequences, we consider damage to both property and crops, as well as overall damage. We find that flash floods and thunderstorm wind cause the most property damage, while drought and floods cause the most crop damage.

Data Processing

The data is loaded directly from the .bz2 file, which is obtained from the National Weather Service. It will be easier to deal with the event types as characters, rather than factors. Additionally, a handful of the events are in lower-case, so we convert all events to upper-case:

```
rawdata <- read.csv(bzfile("repdata-data-StormData.csv.bz2"))
rawdata$EVTYPE <- toupper(as.character(rawdata$EVTYPE))
```

There are 37 variables, most of which we can ignore. We are interested only in the event type, the health consequences (fatalities and injuries) and the economic consequences (property and crop damage). A complete analysis would also examine the remarks, but trying to access this variable caused our software to crash, and so for practical reasons it was ignored. The health and economic variables are separated into two different data frames:

```
healthdata <- rawdata[,c(8,23,24)]
damagedata <- rawdata[,c(8,25,26,27,28)]
```

The damage variables are recorded in quasi-scientific notation, in that there are extra columns for exponents. The exponent codes here aren't completely consistent, but we interpret a number n as an instruction to multiply by 10^n and the letters 'h', 'H', 'k', 'K', 'm', 'M' and 'B' to multiply by one hundred, thousand, million or billion. The symbols '+' and '-' are ignored.

```
# Convert hundreds exponents
damagedata$PROPDMG[damagedata$PROPDMGEXP %in% c("h","H")] <-
                damagedata$PROPDMG[damagedata$PROPDMGEXP %in% c("h","H")]*100
damagedata$CROPDMG[damagedata$CROPDMGEXP == "2" ] <-
                damagedata$CROPDMG[damagedata$CROPDMGEXP == "2"]*100
# Convert thousands exponents
damagedata$PROPDMG[damagedata$PROPDMGEXP == "K"] <-
                damagedata$PROPDMG[damagedata$PROPDMGEXP == "K"]*1000
damagedata$CROPDMG[damagedata$CROPDMGEXP %in% c("k","K")] <-
                damagedata$CROPDMG[damagedata$CROPDMGEXP %in% c("k","K")]*1000
# Convert millions exponents
damagedata$PROPDMG[damagedata$PROPDMGEXP %in% c("m","M")] <-
                damagedata$PROPDMG[damagedata$PROPDMGEXP %in% c("m","M")]*1000000
damagedata$CROPDMG[damagedata$CROPDMGEXP %in% c("m","M")] <-
                damagedata$CROPDMG[damagedata$CROPDMGEXP %in% c("m","M")]*1000000
```

```
# Convert billions exponents
damagedata$PROPDMG[damagedata$PROPDMGEXP == "B"] <-
                damagedata$PROPDMG[damagedata$PROPDMGEXP == "B"]*1000000000
damagedata$CROPDMG[damagedata$CROPDMGEXP == "B"] <-
                damagedata$CROPDMG[damagedata$CROPDMGEXP == "B"]*1000000000
# Convert remaining numerical exponents
damagedata$PROPDMG[damagedata$PROPDMGEXP %in% c("1","2","3","4","5","6","7","8")] <-
  damagedata$PROPDMG[damagedata$PROPDMGEXP %in% c("1","2","3","4","5","6","7","8")]*
  10^as.integer(damagedata$PROPDMGEXP[damagedata$PROPDMGEXP %in%
                                        c("1","2","3","4","5","6","7","8")])
# Strip the exponent columns
damagedata <- damagedata[,-c(3,5)]
```

Our data sets are quite large, so we would like to dispose of unnecessary data points immediately. So first we remove all events with no health or economic consequences. Next we sum the relevant variables for each data type:

```
# Get rid of rows with zero health consequences/damage
newhealthdata <- healthdata[(healthdata$FATALITIES > 0 | healthdata$INJURIES > 0),]
newdamagedata <- damagedata[(damagedata$PROPDMG > 0 | damagedata$CROPDMG > 0),]
# Sum the relevant variables for each event type
agghealth <- aggregate(newhealthdata[,2:3],list(newhealthdata$EVTYPE),sum)
aggdamage <- aggregate(newdamagedata[,2:3],list(newdamagedata$EVTYPE),sum)
# Clean the variable names
names(agghealth) <- c("Event","Fatalities","Injuries")
names(aggdamage) <- c("Event","PropertyDamage","CropDamage")
```

There are 48 official event types, yet a quick glance at our processed data-frames indicates we have significantly more rows:

```
length(agghealth$Event)
```

```
## [1] 205
```

```
length(aggdamage$Event)
```

```
## [1] 397
```

A complete analysis would require re-categorizing the 350+ misrecorded types, but for the sake of time, this report will look only at the entries in the top quartile of each variable:

```
# Print distribution of each data frame
summary(agghealth)
```

```
##     Event             Fatalities         Injuries
##  Length:205         Min.   :   0.00   Min.   :    0.0
##  Class :character   1st Qu.:   1.00   1st Qu.:    0.0
##  Mode  :character   Median :   2.00   Median :    3.0
##                     Mean   :  73.88   Mean   :  685.5
##                     3rd Qu.:  13.00   3rd Qu.:   40.0
##                     Max.   :5633.00   Max.   :91346.0
```

```
summary(aggdamage)
```

```
##     Event           PropertyDamage        CropDamage
##  Length:397         Min.   :0.000e+00   Min.   :0.000e+00
##  Class :character   1st Qu.:1.000e+04   1st Qu.:0.000e+00
##  Mode  :character   Median :1.500e+05   Median :0.000e+00
##                     Mean   :2.293e+11   Mean   :1.237e+08
##                     3rd Qu.:4.860e+06   3rd Qu.:3.000e+04
##                     Max.   :6.820e+13   Max.   :1.397e+10
```

```
# Keep only entries in the top quartiles
trunchealth <- agghealth[agghealth$Fatalities >= quantile(agghealth$Fatalities)[4] |
      agghealth$Injuries >= quantile(agghealth$Injuries)[4],]
truncdamage <- aggdamage[aggdamage$PropertyDamage >= quantile(aggdamage$PropertyDamage)[4] |
      aggdamage$CropDamage >= quantile(aggdamage$CropDamage)[4],]
```

Next we consider the herculean task of re-categorization. There are several judgment calls to make here. Some entries are trivial to re-categorize. Here follows a list of the not-so-trivial decisions:

- It's not clear what the difference between "High winds" and "Strong winds" is, so the latter was merged with the former
- "Cold and snow" and "Cold and wet conditions" were categorized as "Extreme cold/windchill", even though the snow/wetness were presumably significant factors.
- On the other hand "Cool and wet" was classified as "Heavy rain", as was "Excessive wetness"
- "Glaze", "Ice" and "Freezing rain" are interpreted as "Winter weather"
- "Storm surge" and "Astronomical high tide" are interpreted as forms of coastal flooding
- "Waterspout/tornado" is classified as a "Waterspout"
- "Snow/high winds" was classified as "High winds"
- "Tornadoes, tstm wind, hail" was classified as "Tornado"
- "Thunderstorm wind, hail" and "Tstm wind, hail" were classified as "Thunderstorm wind"
- "Unseasonably warm and dry" and "Heat wave/drought" were categorized as "Excessive heat" rather than "Drought"
- Entries related to urban flooding were categorized as "Heavy rain", as this is indicated in the supporting documentation
- "Winter storm/High winds" was classified as "Winter storm"
- A microburst was interpreted as "Thunderstorm wind"
- "Heavy Snow, Blizzard, Avalanche" was classified as "Blizzard"
- "High Winds, Cold", "High Winds, Coastal Flood" and "High Winds, Heavy Rain" were classified as "High Wind", "Coastal Flood" and "High Wind", respectively
- "Heavy rain/lightning" and "Lightning fire" were interpreted as "Lightning"

The code is long and inelegant, but it must be included. Here is the code for the health data:

```
# Re-name
trunchealth$Event[trunchealth$Event=="LANDSLIDE"] <- "DEBRIS FLOW"
trunchealth$Event[grepl("SPOUT",trunchealth$Event)] <- "WATERSPOUT"
# Consolide heat events
trunchealth[trunchealth$Event == "EXCESSIVE HEAT", 2:3] <-
    colSums(trunchealth[grepl("HEAT|WARM",trunchealth$Event), 2:3])
trunchealth <- trunchealth[!(grepl("HEAT|WARM",trunchealth$Event)&trunchealth$Event!="EXCESSIVE HEAT"),]
# Consolidate wildfires
```

```
truncheath[truncheath$Event == "WILDFIRE", 2:3] <-
  colSums(truncheath[grepl("FIRE",truncheath$Event), 2:3])
truncheath <- truncheath[!(grepl("FIRE",truncheath$Event)&truncheath$Event!="WILDFIRE"),]
# Consolidate fog events
truncheath[truncheath$Event == "DENSE FOG", 2:3] <-
  colSums(truncheath[grepl("FOG",truncheath$Event), 2:3])
truncheath <- truncheath[!(grepl("FOG",truncheath$Event)&truncheath$Event!="DENSE FOG"),]
# Consolidate surf events
truncheath[truncheath$Event == "HIGH SURF", 2:3] <-
  colSums(truncheath[grepl("SURF",truncheath$Event), 2:3])
truncheath <- truncheath[!(grepl("SURF",truncheath$Event)&truncheath$Event!="HIGH SURF"),]
# Consolidate hurricane events
truncheath[truncheath$Event == "HURRICANE", 2:3] <-
  colSums(truncheath[grepl("HURRIC",truncheath$Event), 2:3])
truncheath <- truncheath[!(grepl("HURRIC",truncheath$Event)&truncheath$Event!="HURRICANE"),]
# Consolidate rip current events
truncheath[truncheath$Event == "RIP CURRENT", 2:3] <-
  colSums(truncheath[grepl("RIP CURR",truncheath$Event), 2:3])
truncheath <- truncheath[!(grepl("RIP CURR",truncheath$Event)&truncheath$Event!="RIP CURRENT"),]
# Consolidate tornado events
truncheath[truncheath$Event == "TORNADO", 2:3] <-
  colSums(truncheath[grepl("TORNADO",truncheath$Event), 2:3])
truncheath <- truncheath[!(grepl("TORNADO",truncheath$Event)&truncheath$Event!="TORNADO"),]
# Consolidate thunderstorm wind events
truncheath[truncheath$Event == "THUNDERSTORM WIND", 2:3] <-
  colSums(truncheath[grepl("THUNDERSTORM|TSTM",truncheath$Event), 2:3])
truncheath <- truncheath[!(grepl("THUNDERSTORM|TSTM",truncheath$Event)&truncheath$Event!=
                             "THUNDERSTORM WIND"),]
# Consolidate cold events
truncheath[truncheath$Event == "EXTREME COLD", 2:3] <-
  colSums(truncheath[grepl("COLD|CHILL",truncheath$Event), 2:3])
truncheath <- truncheath[!(grepl("COLD|CHILL",truncheath$Event)&truncheath$Event!=
                             "EXTREME COLD"),]
# Consolidate tropical storm events
truncheath[truncheath$Event == "TROPICAL STORM", 2:3] <-
  colSums(truncheath[grepl("TROPICAL",truncheath$Event), 2:3])
truncheath <- truncheath[!(grepl("TROPICAL",truncheath$Event)&truncheath$Event!="TROPICAL STORM"),]
# Consolidate high wind events
truncheath[truncheath$Event == "HIGH WIND", 2:3] <-
  colSums(truncheath[grepl("WIND",truncheath$Event)&
                       !grepl("MARINE|THUNDERSTORM|CHILL",truncheath$Event), 2:3])
truncheath <- truncheath[!(grepl("WIND",truncheath$Event)&
                             !grepl("MARINE|THUNDERSTORM|CHILL",truncheath$Event)&
                             truncheath$Event!="HIGH WIND"),]
# Consolidate heavy rain events
truncheath[truncheath$Event == "HEAVY RAIN", 2:3] <-
  colSums(truncheath[grepl("RAIN|URBAN",truncheath$Event), 2:3])
truncheath <- truncheath[!(grepl("RAIN|URBAN",truncheath$Event)&truncheath$Event!=
                             "HEAVY RAIN"),]
# Consolidate winter weather events
truncheath[truncheath$Event == "WINTER WEATHER", 2:3] <-
  colSums(truncheath[grepl("WINTER|WINTRY|ICE|GLAZE",truncheath$Event)&
                       !grepl("STORM",truncheath$Event), 2:3])
```

```
trunchealth <- trunchealth[!(grepl("WINTER|WINTRY|ICE|GLAZE",trunchealth$Event)&
                             !grepl("STORM",trunchealth$Event)&
                             trunchealth$Event!="WINTER WEATHER"),]
# Consolidate flash flood events
trunchealth[trunchealth$Event == "FLASH FLOOD", 2:3] <-
  colSums(trunchealth[grepl("FLASH",trunchealth$Event), 2:3])
trunchealth <- trunchealth[!(grepl("FLASH",trunchealth$Event)&
                               trunchealth$Event!="FLASH FLOOD"),]
# Re-name
trunchealth$Event[grepl("SURGE",trunchealth$Event)] <- "COASTAL FLOOD"
```

Here is the code for the damage data:

```
# Re-name
truncdamage$Event[truncdamage$Event=="LANDSLIDE"] <- "DEBRIS FLOW"
# Consolidate waterspout events
truncdamage[truncdamage$Event == "WATERSPOUT", 2:3] <-
                       colSums(truncdamage[grepl("SPOUT",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("SPOUT",truncdamage$Event)&
                               truncdamage$Event!="WATERSPOUT"),]
# Consolidate heat events
truncdamage[truncdamage$Event == "EXCESSIVE HEAT", 2:3] <-
                      colSums(truncdamage[grepl("HEAT|WARM",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("HEAT|WARM",truncdamage$Event)&
                               truncdamage$Event!="EXCESSIVE HEAT"),]
# Consolidate lightning events
truncdamage[truncdamage$Event == "LIGHTNING", 2:3] <-
                     colSums(truncdamage[grepl("LIGHTN",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("LIGHTN",truncdamage$Event)&
                               truncdamage$Event!="LIGHTNING"),]
# Consolidate wildfire events
truncdamage[truncdamage$Event == "WILDFIRE", 2:3] <-
                    colSums(truncdamage[grepl("FIRE",truncdamage$Event)&
                    grepl("WILD|FOREST",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("FIRE",truncdamage$Event)&
                      grepl("WILD|FOREST",truncdamage$Event)&truncdamage$Event!="WILDFIRE"),]
# Consolidate fog events
truncdamage[truncdamage$Event == "DENSE FOG", 2:3] <-
                   colSums(truncdamage[grepl("FOG",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("FOG",truncdamage$Event)&
                               truncdamage$Event!="DENSE FOG"),]
# Consolidate surf events
truncdamage[truncdamage$Event == "HIGH SURF", 2:3] <-
                colSums(truncdamage[grepl("SURF",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("SURF",truncdamage$Event)&truncdamage$Event!="HIGH SURF"),]
# Consolidate hurricane events
truncdamage[truncdamage$Event == "HURRICANE", 2:3] <-
               colSums(truncdamage[grepl("HURRIC|TYPHOON",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("HURRIC|TYPHOON",truncdamage$Event)&
                               truncdamage$Event!="HURRICANE"),]
# Consolidate thunderstorm wind events
truncdamage[truncdamage$Event == "THUNDERSTORM WIND", 2:3] <-
             colSums(truncdamage[grepl("THUNDERSTORM|TSTM|MICROBURST",truncdamage$Event), 2:3])
```

```
truncdamage <- truncdamage[!(grepl("THUNDERSTORM|TSTM|MICROBURST",truncdamage$Event)&
                               truncdamage$Event!= "THUNDERSTORM WIND"),]
# Consolidate cold events
truncdamage[truncdamage$Event == "EXTREME COLD", 2:3] <-
               colSums(truncdamage[grepl("COLD|CHILL",truncdamage$Event)&
                                     !grepl("HIGH WIND",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("COLD|CHILL",truncdamage$Event)&
                     !grepl("HIGH WIND",truncdamage$Event)&truncdamage$Event!="EXTREME COLD"),]
# Consolidate frost/freeze events
truncdamage[truncdamage$Event == "FROST/FREEZE", 2:3] <-
                colSums(truncdamage[grepl("FROST|FREEZE",truncdamage$Event)&
                                      !grepl("RAIN",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("FROST|FREEZE",truncdamage$Event)&
                    !grepl("RAIN",truncdamage$Event)&truncdamage$Event!="FROST/FREEZE"),]
# Consolidate tropical storm events
truncdamage[truncdamage$Event == "TROPICAL STORM", 2:3] <-
                  colSums(truncdamage[grepl("TROPICAL",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("TROPICAL",truncdamage$Event)&
                               truncdamage$Event!="TROPICAL STORM"),]
# Consolidate tornado events
truncdamage[truncdamage$Event == "TORNADO", 2:3] <-
                          colSums(truncdamage[grepl("TORNADO",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("TORNADO",truncdamage$Event)&
                               truncdamage$Event!="TORNADO"),]
# Consolidate high wind events
truncdamage[truncdamage$Event == "HIGH WIND", 2:3] <-
                         colSums(truncdamage[grepl("WIND",truncdamage$Event)&
                        !grepl("MARINE|STORM|CHILL|FLOOD",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("WIND",truncdamage$Event)&
        !grepl("MARINE|STORM|CHILL|FLOOD",truncdamage$Event)&truncdamage$Event!="HIGH WIND"),]
# Consolidate heavy rain events
truncdamage[truncdamage$Event == "HEAVY RAIN", 2:3] <-
                colSums(truncdamage[grepl("RAIN|WET|URBAN",truncdamage$Event)&
                                      !grepl("FREEZ",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("RAIN|WET|URBAN",truncdamage$Event)&
                      !grepl("FREEZ",truncdamage$Event)&truncdamage$Event!="HEAVY RAIN"),]
# Consolidate flash flood events
truncdamage[truncdamage$Event == "FLASH FLOOD", 2:3] <-
                    colSums(truncdamage[grepl("FLASH",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("FLASH",truncdamage$Event)&
                               truncdamage$Event!="FLASH FLOOD"),]
# Consolidate winter weather events
truncdamage[truncdamage$Event == "WINTER WEATHER", 2:3] <-
                colSums(truncdamage[grepl("WINTER|ICE",truncdamage$Event)&
                       !grepl("STORM|FLOOD",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("WINTER|ICE",truncdamage$Event)&
               !grepl("STORM|FLOOD",truncdamage$Event)&truncdamage$Event!="WINTER WEATHER"),]
# Consolidate winter storm events
truncdamage[truncdamage$Event == "WINTER STORM", 2:3] <-
  colSums(truncdamage[grepl("WINTER STORM",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("WINTER STORM",truncdamage$Event)&
                               truncdamage$Event!="WINTER STORM"),]
# Consolidate coast flood events
```

```
truncdamage[truncdamage$Event == "COASTAL FLOOD", 2:3] <-
                colSums(truncdamage[grepl("TIDE|COASTAL|CSTL|SURGE",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("TIDE|COASTAL|CSTL|SURGE",truncdamage$Event)&
                               truncdamage$Event!="COASTAL FLOOD"),]
# Consolidate flood events
truncdamage[truncdamage$Event == "FLOOD", 2:3] <-
                          colSums(truncdamage[grepl("FLOOD",truncdamage$Event)&
                         !grepl("FLASH|COASTAL",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("FLOOD",truncdamage$Event)&
                       !grepl("FLASH|COASTAL",truncdamage$Event)&truncdamage$Event!="FLOOD"),]
# Consolidate hail events
truncdamage[truncdamage$Event == "HAIL", 2:3] <-
                     colSums(truncdamage[grepl("HAIL",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("HAIL",truncdamage$Event)&truncdamage$Event!="HAIL"),]
# Consolidate blizzard events
truncdamage[truncdamage$Event == "BLIZZARD", 2:3] <-
                     colSums(truncdamage[grepl("BLIZZ",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("BLIZZ",truncdamage$Event)&truncdamage$Event!="BLIZZARD"),]
# Consolidate heavy snow events
truncdamage[truncdamage$Event == "HEAVY SNOW", 2:3] <-
                   colSums(truncdamage[grepl("SNOW",truncdamage$Event)&
                                       !grepl("LAKE",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("SNOW",truncdamage$Event)&
                       !grepl("LAKE",truncdamage$Event)&truncdamage$Event!="HEAVY SNOW"),]
# Add freezing rain to winter weather
truncdamage[truncdamage$Event == "WINTER WEATHER", 2:3] <-
                     colSums(truncdamage[grepl("FREEZING RAIN",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("FREEZING RAIN",truncdamage$Event)&
                               truncdamage$Event!="WINTER WEATHER"),]
# Consolidate dust storm events
truncdamage[truncdamage$Event == "DUST STORM", 2:3] <-
                       colSums(truncdamage[grepl("DUST",truncdamage$Event), 2:3])
truncdamage <- truncdamage[!(grepl("DUST",truncdamage$Event)&
                               truncdamage$Event!="DUST STORM"),]
# Remove other
truncdamage <- truncdamage[truncdamage$Event!="OTHER",]
```

Results

Now that our data is cleaned we can examine the tables.

Health Consequences

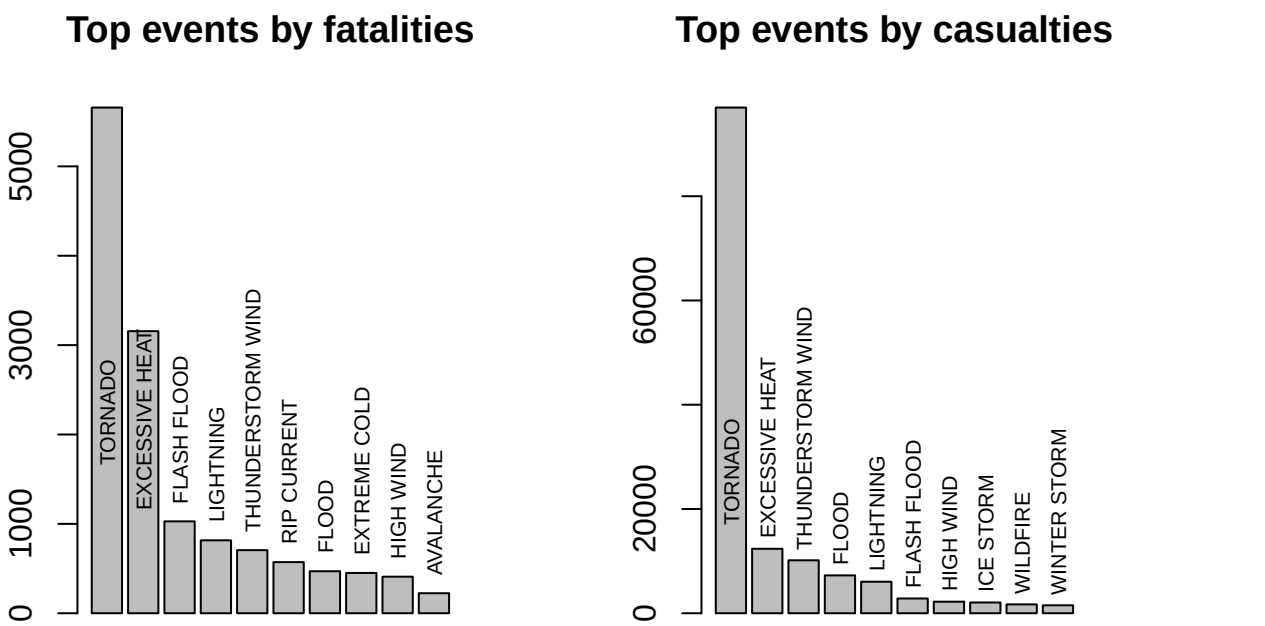
We have decided to use three different indicators to measure health consequences: the number of fatalities, the number of casualties (fatalities plus injuries) and the "deadliness", *i.e.* the ratio of fatalities to casualties:

```
# Isolate events with highest fatalities
p1data <- head(trunchealth[order(trunchealth$Fatalities,decreasing=TRUE),1:2],10)
# Isolate events with highest casualties
combinedFI <- data.frame(Event=trunchealth$Event,Casualties=trunchealth$Fatalities+
                           trunchealth$Injuries)
p2data <- head(combinedFI[order(combinedFI$Casualties,decreasing=TRUE),],10)
```

```
# Isolate deadliest events
deadliness <- data.frame(Event=trunchealth$Event,Deadliness=
                           trunchealth$Fatalities/combinedFI$Casualties)
p3data <- head(deadliness[order(deadliness$Deadliness,decreasing=TRUE),],10)
```

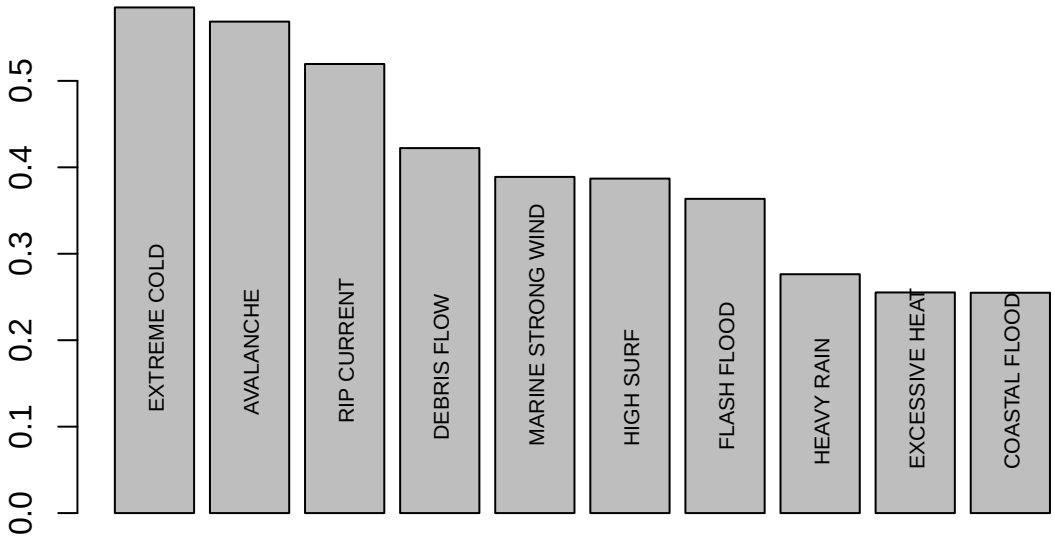
If we plot the top ten events of each variable, we get:

```
par(mfrow=c(1,2))
# Fatalities
barplot(p1data$Fatalities)
title(main="Top events by fatalities")
text(1.2*(1:10-.4),y=p1data$Fatalities+
       c(-4000,-2000,200,200,200,200,200,200,200,200),adj=0,p1data$Event,srt=90,cex=0.7)
# Casualties
barplot(p2data$Casualties)
title(main="Top events by casualties")
text(1.2*(1:10-.4),y=p2data$Casualties+
       c(-80000,2000,2000,2000,2000,2000,2000,2000,2000,2000),
     adj=0,p2data$Event,srt=90,cex=0.7)
```



It appears that tornadoes are the most dangerous weather event, at least in an extensive sense. Also dangerous are excessive heat, thunderstorm winds, floods, flash floods and lightning. The fact that rip currents and avalanches appear in the fatalities plot and not the injuries plot leads us to consider the most dangerous events in the intensive sense. The ratio of fatalities to casualties will give us a good sense of how good a weather event is at killing you:

```
barplot(p3data$Deadliness)
title(main="Top events by deadliness")
text(1.2*(1:10-.4),y=0.2*p3data$Deadliness,
     adj=0,p3data$Event,srt=90,cex=0.7)
```



Not surprisingly, avalanches and rip currents are in the top three, joined by the extreme cold.

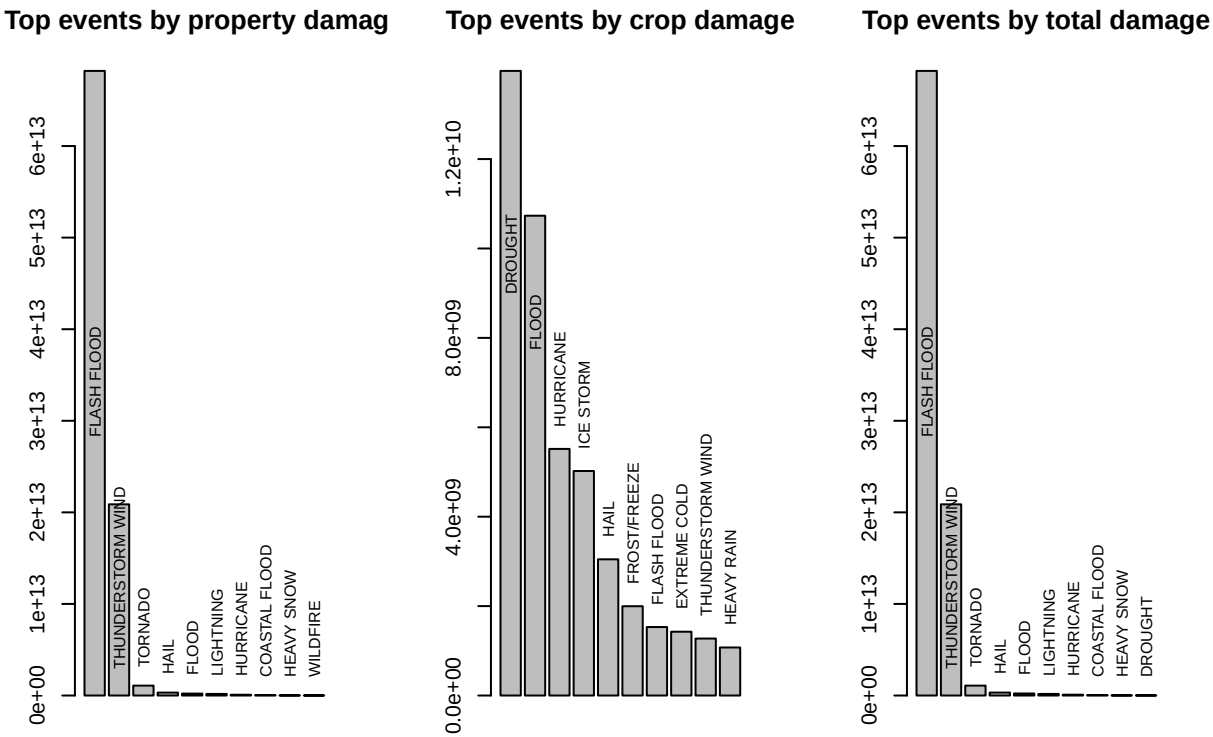
Economic Consequences

To gauge economic damage, we look at the damage to both property and crops, as well the total damage.

```
q1data <- head(truncdamage[order(truncdamage$PropertyDamage,decreasing=TRUE),1:2],10)
q2data <- head(truncdamage[order(truncdamage$CropDamage,decreasing=TRUE),c(1,3)],10)
combinedPC <- data.frame(Event=truncdamage$Event, Damage = truncdamage$PropertyDamage+
                           truncdamage$CropDamage)
q3data <- head(combinedPC[order(combinedPC$Damage,decreasing=TRUE),],10)
```

If we plot the top ten for each of these three variables, we get:

```
par(mfrow=c(1,3))
# Property
barplot(q1data$PropertyDamage)
title(main="Top events by property damage")
text(1.2*(1:10-.4),y=q1data$PropertyDamage+
       c(-4e+13,-1.8e13,2e12,2e12,2e12,2e12,2e12,2e12,2e12,2e12),
     adj=0,q1data$Event,srt=90,cex=0.7)
# Crop
barplot(q2data$CropDamage)
title(main="Top events by crop damage")
text(1.2*(1:10-.4),y=q2data$CropDamage+
       c(-5e9,-3e9,5e8,5e8,5e8,5e8,5e8,5e8,5e8,5e8),adj=0,q2data$Event,srt=90,cex=0.7)
# Property
barplot(q3data$Damage)
title(main="Top events by total damage")
text(1.2*(1:10-.4),y=q3data$Damage+
     c(-4e13,-1.8e13,2e12,2e12,2e12,2e12,2e12,2e12,2e12,2e12),
     adj=0,q3data$Event,srt=90,cex=0.7)
```



Flash floods and thunderstorm winds are clearly the two leading causes of both property and overall damage, dwarfing other events. Crop damage is not surprisingly caused by drought and flooding.