Severe Weather Events: Data Analysis for Peer Assignment 2

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Synoposis

The purpose of this data analysis is to answer the following questions about severe weather event from data collected and available for download from the National Weather Service. The two questions being explored in this report include the following:

Across the United States from 1996 to 2011,

- which types of events are most harmful with respect to population health?
- which types of events have the greatest economic consequences?

In summary, tornados, heat, and floods appear to have the greatest number of human casualties and injuries. This information suggests that any efforts to assist citizens with evacuation and aftercare efforts for tornado's and heat will result in the greatest impact on human life. As for economic costs, generally Hurricanes/Tsunamis and floods contribute to the greatest costs associated with property damage and crop damage.

Data Processing

The first step of any data analysis is to better understand the data within the database along with setting the libraries to be used.

```
library(ggplot2)
library(dplyr)
library(cowplot)
data <-read.csv('repdata_data_StormData.csv')
head(data)
```

```
##   STATE__           BGN_DATE BGN_TIME TIME_ZONE COUNTY COUNTYNAME STATE  EVTYPE
## 1       1  4/18/1950 0:00:00     0130       CST     97     MOBILE    AL TORNADO
## 2       1  4/18/1950 0:00:00     0145       CST      3    BALDWIN    AL TORNADO
## 3       1  2/20/1951 0:00:00     1600       CST     57    FAYETTE    AL TORNADO
## 4       1   6/8/1951 0:00:00     0900       CST     89    MADISON    AL TORNADO
## 5       1 11/15/1951 0:00:00     1500       CST     43    CULLMAN    AL TORNADO
## 6       1 11/15/1951 0:00:00     2000       CST     77 LAUDERDALE    AL TORNADO
##   BGN_RANGE BGN_AZI BGN_LOCATI END_DATE END_TIME COUNTY_END COUNTYENDN
## 1         0                                               0         NA
## 2         0                                               0         NA
## 3         0                                               0         NA
## 4         0                                               0         NA
```

```
## 5         0                                                    0         NA
## 6         0                                                    0         NA
##   END_RANGE END_AZI END_LOCATI LENGTH WIDTH F MAG FATALITIES INJURIES PROPDMG
## 1         0                    14.0   100 3   0          0       15    25.0
## 2         0                     2.0   150 2   0          0        0     2.5
## 3         0                     0.1   123 2   0          0        2    25.0
## 4         0                     0.0   100 2   0          0        2     2.5
## 5         0                     0.0   150 2   0          0        2     2.5
## 6         0                     1.5   177 2   0          0        6     2.5
##   PROPDMGEXP CROPDMG CROPDMGEXP WFO STATEOFFIC ZONENAMES LATITUDE LONGITUDE
## 1          K       0                                         3040      8812
## 2          K       0                                         3042      8755
## 3          K       0                                         3340      8742
## 4          K       0                                         3458      8626
## 5          K       0                                         3412      8642
## 6          K       0                                         3450      8748
##   LATITUDE_E LONGITUDE_ REMARKS REFNUM
## 1       3051       8806              1
## 2          0          0              2
## 3          0          0              3
## 4          0          0              4
## 5          0          0              5
## 6          0          0              6
```

```
summary(data)
```

```
##     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
##
```

Based on the data within the data set, we had decided to only keep the event type, the date, information

about human life impacts (fatalities and injuries), as well as the economic costs associated with the events. Based on the materials provided by the database (https://www.ncdc.noaa.gov/stormevents/details.jsp), all event types should be present from 1996 onward, as a result, the dataset will be limited to 1997 onward.

The analytic and processing syntax will include syntax from the dplyr package. Unique values were assessed to determine some of the next cleaning steps.

From here, some immediate data cleaning steps needed to occur. Primarily, the following specifications:

- Converting the date to a date format (Done in step prior to subset)
- Adding a Year
- Subsetting to 1997 onward
- Subsetting to exclude summary data, monthly data, and advisory data to limit analysis to only looking at specific weather events.

```
#format date as date
data$BGN_DATE <- as.Date(data$BGN_DATE, format= "%m/%d/%Y")
#Add in column for year
data<- data %>%
        mutate(Year=format(BGN_DATE, format="%Y"))

data2 <- subset(data, between(data$Year, "1997", "2011"))
data2 <- subset(data2, grepl("Summary|MONTHLY|month|year|ADVISORY|NONE|Other|No Severe|
                             Marine Accident|DROWNING|NORTHERN LIGHTS|RED FLAG CRITERIA",
                             data2$EVTYPE, ignore.case = TRUE)!=TRUE)
#see options for crop and property damage
unique(data2$PROPDMGEXP)
```

```
## [1] "K" ""  "M" "B" "0"
```

```
unique(data2$CROPDMGEXP)
```

```
## [1] "K" ""  "M" "B"
```

```
unique(data2$EVTYPE)
```

```
##   [1] "TSTM WIND"                  "FUNNEL CLOUD"
##   [3] "HAIL"                       "LIGHTNING"
##   [5] "EXTREME COLD"               "FLASH FLOOD"
##   [7] "EXCESSIVE HEAT"             "TORNADO"
##   [9] "WINTER STORM"               "HIGH WIND"
##  [11] "TSTM WIND/HAIL"             "WATERSPOUT"
##  [13] "HEAVY RAIN"                 "HURRICANE"
##  [15] "FLOOD"                      "HEAVY SNOW"
##  [17] "EXTREME WINDCHILL"          "BLIZZARD"
##  [19] "Thundersnow shower"         "URBAN/SML STREAM FLD"
##  [21] "Temperature record"         "DROUGHT"
##  [23] "STORM SURGE"                "DUST DEVIL"
##  [25] "DUST STORM"                 "TROPICAL STORM"
##  [27] "FOG"                        "ICE STORM"
##  [29] "Heavy Rain"                 "COLD AND SNOW"
##  [31] "Heavy Surf"                 "Strong Wind"
```

```
##  [33] "WILD/FOREST FIRE"             "DAM BREAK"
##  [35] "RIP CURRENTS"                 "HEAVY SURF"
##  [37] "RAIN"                         "RAIN/SNOW"
##  [39] "WIND"                         "DRY MICROBURST"
##  [41] "FREEZE"                       "TSTM WIND (G45)"
##  [43] "COASTAL FLOOD"                "FREEZING RAIN"
##  [45] "RECORD WARMTH"                "STRONG WINDS"
##  [47] "COASTAL STORM"                "STRONG WIND"
##  [49] "MIXED PRECIP"                 "COASTAL FLOODING"
##  [51] "SNOW"                         "FREEZING DRIZZLE"
##  [53] "UNSEASONABLY WARM"            "SLEET/FREEZING RAIN"
##  [55] "BLACK ICE"                    "WINTRY MIX"
##  [57] "BLOW-OUT TIDES"               "UNSEASONABLY COLD"
##  [59] "UNSEASONABLY COOL"            "TSTM HEAVY RAIN"
##  [61] "UNSEASONABLY DRY"             "Winter Weather"
##  [63] "Gusty Winds"                  "GUSTY WIND"
##  [65] "TSTM WIND 40"                 "TSTM WIND 45"
##  [67] "HARD FREEZE"                  "TSTM WIND (41)"
##  [69] "HEAT"                         "RIVER FLOOD"
##  [71] "TSTM WIND (G40)"              "RIP CURRENT"
##  [73] "TSTM WND"                     "DENSE FOG"
##  [75] "Snow"                         "Wintry mix"
##  [77] "COLD"                         "HIGH SURF"
##  [79] " TSTM WIND"                   "MUD SLIDE"
##  [81] "MUDSLIDES"                    "MUDSLIDE"
##  [83] "Frost"                        "Frost/Freeze"
##  [85] "SNOW AND ICE"                 "WIND DAMAGE"
##  [87] "RAIN (HEAVY)"                 "Record Warmth"
##  [89] "Cold"                         "Prolong Cold"
##  [91] "Cold and Frost"               "RECORD COLD"
##  [93] "PROLONG COLD"                 "AGRICULTURAL FREEZE"
##  [95] "URBAN/SML STREAM FLDG"        "WINTER WEATHER"
##  [97] "SNOW SQUALL"                  "HEAVY SNOW SQUALLS"
##  [99] "SNOW/ICE"                     "GUSTY WINDS"
## [101] "SMALL HAIL"                   "SNOW SQUALLS"
## [103] "LAKE EFFECT SNOW"             "STRONG WIND GUST"
## [105] "LATE FREEZE"                  "RECORD TEMPERATURES"
## [107] "Blowing Snow"                 "ICY ROADS"
## [109] "Heavy rain"                   "AVALANCHE"
## [111] "RECORD SNOWFALL"              "BLOW-OUT TIDE"
## [113] "THUNDERSTORM"                 "Light Snow"
## [115] "Lake Effect Snow"             "Freezing Rain"
## [117] "Mixed Precipitation"          "Freezing Drizzle"
## [119] "Record High"                  "COASTALSTORM"
## [121] "LIGHT SNOW"                   "Snow and sleet"
## [123] "Freezing rain"                "Black Ice"
## [125] "Icy Roads"                    "Dust Devil"
## [127] "Gusty winds"                  "FUNNEL CLOUDS"
## [129] "WATERSPOUTS"                  "blowing snow"
## [131] "FROST"                        "ICE"
## [133] "GRADIENT WIND"                "Mudslides"
## [135] "Strong Winds"                 "Icestorm/Blizzard"
## [137] "Flood/Strong Wind"            "TSTM WIND AND LIGHTNING"
## [139] "Glaze"                        "gradient wind"
```

```
## [141] "Gradient wind"                   "SEVERE THUNDERSTORMS"
## [143] "Coastal Flood"                   "EXCESSIVE RAIN"
## [145] "Freezing drizzle"                "Snow Squalls"
## [147] "Mountain Snows"                  "URBAN/SMALL STRM FLDG"
## [149] "WET MICROBURST"                  "Mudslide"
## [151] "Heavy surf and wind"             "Mild and Dry Pattern"
## [153] "COLD AND FROST"                  "RECORD HEAT"
## [155] "TYPHOON"                         "LANDSLIDES"
## [157] "HIGH SWELLS"                     "HIGH  SWELLS"
## [159] "VOLCANIC ASH"                    "HIGH WINDS"
## [161] "DRY SPELL"                       " LIGHTNING"
## [163] "BEACH EROSION"                   "UNSEASONAL RAIN"
## [165] "EARLY RAIN"                      "PROLONGED RAIN"
## [167] "WINTERY MIX"                     "COASTAL FLOODING/EROSION"
## [169] "UNSEASONABLY WET"                "HOT SPELL"
## [171] "HEAT WAVE"                       "UNSEASONABLY HOT"
## [173] "UNSEASONABLY WARM AND DRY"       " TSTM WIND (G45)"
## [175] "TSTM WIND  (G45)"                "HIGH WIND (G40)"
## [177] "TSTM WIND (G35)"                 "DRY WEATHER"
## [179] "TSTM WINDS"                      "FREEZING RAIN/SLEET"
## [181] "ABNORMAL WARMTH"                 "UNUSUAL WARMTH"
## [183] "GLAZE"                           "WAKE LOW WIND"
## [185] "COLD TEMPERATURES"               "COLD WIND CHILL TEMPERATURES"
## [187] "MODERATE SNOW"                   "MODERATE SNOWFALL"
## [189] "URBAN/STREET FLOODING"           "COASTAL EROSION"
## [191] "UNUSUAL/RECORD WARMTH"           "BITTER WIND CHILL"
## [193] "BITTER WIND CHILL TEMPERATURES" "TIDAL FLOODING"
## [195] "SEICHE"                          "TSTM"
## [197] "COASTAL  FLOODING/EROSION"       "SNOW DROUGHT"
## [199] "HYPERTHERMIA/EXPOSURE"           "SNOW/SLEET"
## [201] "ROCK SLIDE"                      "ICE PELLETS"
## [203] "URBAN FLOOD"                     "PATCHY DENSE FOG"
## [205] "RECORD COOL"                     "RECORD WARM"
## [207] "HEAVY RAIN/WIND"                 "HOT WEATHER"
## [209] "RIVER FLOODING"                  "RECORD TEMPERATURE"
## [211] "SAHARAN DUST"                    "TROPICAL DEPRESSION"
## [213] "VOLCANIC ERUPTION"               "COOL SPELL"
## [215] "GUSTY WIND/HAIL"                 "RED FLAG FIRE WX"
## [217] "FIRST FROST"                     "EXCESSIVELY DRY"
## [219] "HEAVY SEAS"                      "FLASH FLOOD/FLOOD"
## [221] "SNOW AND SLEET"                  "LIGHT SNOW/FREEZING PRECIP"
## [223] "VOG"                             "EXCESSIVE RAINFALL"
## [225] "FLASH FLOODING"                  "RECORD DRYNESS"
## [227] "EXTREME WINDCHILL TEMPERATURES" "MIXED PRECIPITATION"
## [229] "STREET FLOODING"                 "EXTREME WIND CHILL"
## [231] "DRY CONDITIONS"                  "HEAVY RAINFALL"
## [233] "REMNANTS OF FLOYD"               "EARLY SNOWFALL"
## [235] "FREEZING FOG"                    "LANDSPOUT"
## [237] "RECORD  COLD"                    "LATE SEASON HAIL"
## [239] "EXCESSIVE SNOW"                  "WINTER MIX"
## [241] "DRYNESS"                         "FLOOD/FLASH/FLOOD"
## [243] "WINDS"                           "WIND AND WAVE"
## [245] "SEVERE THUNDERSTORM"             "LIGHT FREEZING RAIN"
## [247] " WIND"                           "DRY"
```

```
## [249] "RECORD RAINFALL"               "RECORD PRECIPITATION"
## [251] "ICE ROADS"                     "HIGH SEAS"
## [253] "SLEET"                         "THUNDERSTORMS"
## [255] "ROUGH SEAS"                    "UNSEASONABLY WARM/WET"
## [257] "UNSEASONABLY COOL & WET"       "UNUSUALLY WARM"
## [259] "TSTM WIND G45"                 "NON SEVERE HAIL"
## [261] "RECORD SNOW"                   "SNOW/FREEZING RAIN"
## [263] "SNOW/BLOWING SNOW"             "NON-SEVERE WIND DAMAGE"
## [265] "UNUSUALLY COLD"                "WARM WEATHER"
## [267] "LANDSLUMP"                     "THUNDERSTORM WIND (G40)"
## [269] "LANDSLIDE"                     "WALL CLOUD"
## [271] "HIGH WATER"                    "UNSEASONABLY WARM & WET"
## [273] " FLASH FLOOD"                  "LOCALLY HEAVY RAIN"
## [275] "WIND GUSTS"                    "UNSEASONAL LOW TEMP"
## [277] "LATE SEASON SNOW"              "GUSTY LAKE WIND"
## [279] "ABNORMALLY DRY"                "WINTER WEATHER MIX"
## [281] "WND"                           "CSTL FLOODING/EROSION"
## [283] "SMOKE"                         " WATERSPOUT"
## [285] "EXTREMELY WET"                 "UNUSUALLY LATE SNOW"
## [287] "VERY DRY"                      "RECORD LOW RAINFALL"
## [289] "ROGUE WAVE"                    "SNOWMELT FLOODING"
## [291] "PROLONG WARMTH"                "ACCUMULATED SNOWFALL"
## [293] "FALLING SNOW/ICE"              "DUST DEVEL"
## [295] "NON-TSTM WIND"                 "NON TSTM WIND"
## [297] "BRUSH FIRE"                    "GUSTY THUNDERSTORM WINDS"
## [299] "PATCHY ICE"                    "SNOW SHOWERS"
## [301] "HEAVY RAIN EFFECTS"            "BLOWING DUST"
## [303] "EXCESSIVE HEAT/DROUGHT"        "MARINE TSTM WIND"
## [305] "WIND CHILL"                    "HAZARDOUS SURF"
## [307] "WILDFIRE"                      "FROST/FREEZE"
## [309] "WINTER WEATHER/MIX"            "ASTRONOMICAL HIGH TIDE"
## [311] "COLD WEATHER"                  "WHIRLWIND"
## [313] "VERY WARM"                     "ABNORMALLY WET"
## [315] "TORNADO DEBRIS"                "EXTREME COLD/WIND CHILL"
## [317] "ICE ON ROAD"                   "FIRST SNOW"
## [319] "ICE/SNOW"                      "GUSTY THUNDERSTORM WIND"
## [321] "MARINE HAIL"                   "HIGH SURF ADVISORIES"
## [323] "HURRICANE/TYPHOON"             "HEAVY SURF/HIGH SURF"
## [325] "SLEET STORM"                   "STORM SURGE/TIDE"
## [327] "COLD/WIND CHILL"               "LAKE-EFFECT SNOW"
## [329] "MARINE HIGH WIND"              "THUNDERSTORM WIND"
## [331] "TSUNAMI"                       "DENSE SMOKE"
## [333] "LAKESHORE FLOOD"               "MARINE THUNDERSTORM WIND"
## [335] "MARINE STRONG WIND"            "ASTRONOMICAL LOW TIDE"
## [337] "VOLCANIC ASHFALL"
```

From here, we wanted to subset the data frame to only include the columns of interest. But first, we needed to convert the crop and property damage variables into one column to obtain the specific costs associated with the different weather events. Based on web searches, these values typically refer to Millions, Billions, and Thousands.

Additionally, the event information was more streamlined to allow for unable categories for event types. The event type categories were further subset into the categories included in the reference materials (https://d396qusza40orc.cloudfront.net/repdata%2Fpeer2_doc%2Fpd01016005curr.pdf). The storm types listed under 7 are the categories selected with the following additional parameters for more general categories:

- Cold/Wind Chill and Excessive Cold/Wind Chill were combined.
- Coastal Flood, Flash Flood, Flood, and Lakeshore Flood were combined.
- Excessive Heat and Heat were combined.
- Freezing Fog, Frost, and sleet were combined. This also includes freezing rain and black ice.
- Avalanches and Mudslides were combined
- Heavy Rain and Heavy Snow were combined.
- Hail and Marine Hail were combined.
- High Wind, Marine Strong Wind, Marine High Wind, and Strong Wind were combined.
- Storm Tide,Seiche, and Rip Current were combined.
- Storm includes thunderstorms and tropical storms.
- Tornados and Water Spouts were combined.
- Hurricanes and Tsunamis were combined
- High Surf and Storm Tide were combined
- Dust Devils and Dust Storms were combined
- atypical weather(i.e. late season weather or record weather) was added as a new category.
- Storm includes thunderstorms and lightening.
- Winter Weather includes Winter Storm, blizzard, lake-effect snow, and blowing snow.
- Categories that did not appear to have a phrase associated with them based on websearches were excluded.

From there the data was further subset to only include the variables of interest: human cost(i.e. injuries and fatalities), economic cost (crop and property damage), event type, and event date (both full date and year)

```
data2 <- data2 %>%
            mutate(Property_Damage=case_when(PROPDMGEXP=='K' ~ PROPDMG*1000 ,
                                             PROPDMGEXP=='M' ~ PROPDMG*1000000 ,
                                             PROPDMGEXP=='B' ~ PROPDMG*1000000000 ,
                                             TRUE ~ PROPDMG),
                   Crop_Damage=case_when(CROPDMGEXP=='K' ~ CROPDMG*1000,
                                         CROPDMGEXP=='M' ~ CROPDMG*1000000,
                                         CROPDMGEXP=='B' ~ CROPDMG*1000000000,
                                         TRUE ~ CROPDMG),
                   Event_Type=case_when(grepl("ASTRONOMICAL", EVTYPE, ignore.case = TRUE
                                              )==TRUE
                                        ~ 'Astronomical Low/High Tide',
                                        grepl("LATE|ABNORMAL|UNSEASONA|UNUSUAL|RECORD",
                                              EVTYPE, ignore.case = TRUE) ==TRUE
                                        ~ 'Atypical Weather',
                                        grepl("FOG|VOG", EVTYPE,
                                              ignore.case = TRUE)==TRUE
                                        ~ 'Dense Fog',
                                        grepl("DRY|Drought", EVTYPE,
                                              ignore.case = TRUE)==TRUE
                                        ~ 'Drought',
                                        grepl("DUST", EVTYPE,
                                              ignore.case = TRUE)==TRUE
                                        ~ 'Dust Devil & Storms',
                                        grepl("Flood|DAM|FLD|EROSION|COASTAL SURGE",
                                              EVTYPE, ignore.case = TRUE)==TRUE
                                        ~ 'Flood',
                                        grepl("Landslump|Mud|LANDSLIDE|ROCK SLIDE|AVALAN",
                                              EVTYPE, ignore.case = TRUE)==TRUE
                                        ~ 'Landslide/Avalanche',
                                        grepl("HEAT|HOT|HYPERTHERMIA|WARM",
```

```
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'Heat',
                                grepl("HAIL|ICE PELLETS",
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'Hail',
                                grepl("BLOW-OUT TIDE|COASTAL SURGE|HAZARDOUS SURF|Heavy Surf|
                                    HIGH SEA|SWELL|HIGH WA|SURF|RIP CURRENT|
                                    HIGH SURF ADVISORIES|ROGUE WAVE|SEAS|SEICHE",
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'High Surf/Storm Tide',
                                grepl("GUSTNADO|WIND|GUSTY|HIGH WIND|Whirlwind|Strong wind|
                                    BLOWING|LANDSPOUT|WND|WALL CLOUD|FUNNEL",
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'High/Strong Wind',
                                grepl("HURRICANE|FLOYD|TSUNAMI|TYPHOON",
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'Hurricane/Tsunami',
                                grepl("THUNDERSTORM|Storm|TSTM|burst|LIGHTNING",
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'Storm',
                                grepl("TORNADO|WATERSPOUT",
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'Tornado/Waterspouts',
                                grepl("TROPICAL DEPRESSION",
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'Tropical Depression',
                                grepl("Volcanic Ash|VOLCANIC ERUPTION",
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'Volcanic Ash',
                                grepl("FIRE|GRASS FIRES|SMOKE",
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'Wildfire',
                                grepl("FREEZING RAIN|FREEZING DRIZZLE|FREEZ|FROST|Glaze|
                                    HYPOTHERMIA|ICE|ICY|SLEET|Black Ice",
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'Freezing  Weather',
                                grepl("((EXCESSIVE|HEAVY)&
                                    ( RAIN| SNOW| PRECIP| MIXED PRECIP))
                                    |Wintry Mix|Torrential Rainfall|snowfall|Rain
                                    |Snow|PRECIP|EXTREMELY WET",
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'Heavy Precipitation',
                                grepl("WIND CHILL|COLD TEMP|EXTREME WIND CHI|WINDCHILL
                                    |EXTREME COLD|COLD|COOL SPELL",
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'Cold',
                                grepl("WINTER|BLIZZARD|blowing snow|Snow Accumulation
                                    |Drifting Snow|LAKE-EFFECT SNOW|Lake Effect Snow",
                                    EVTYPE, ignore.case = TRUE)==TRUE
                                ~ 'Winter Storm Weather')) %>%
        rename(Date=BGN_DATE,
               Injuries=INJURIES,
               Fatalities=FATALITIES) %>%
```

```
            select(Year, Date, Event_Type, Injuries, Fatalities, Property_Damage, Crop_Damage)
```

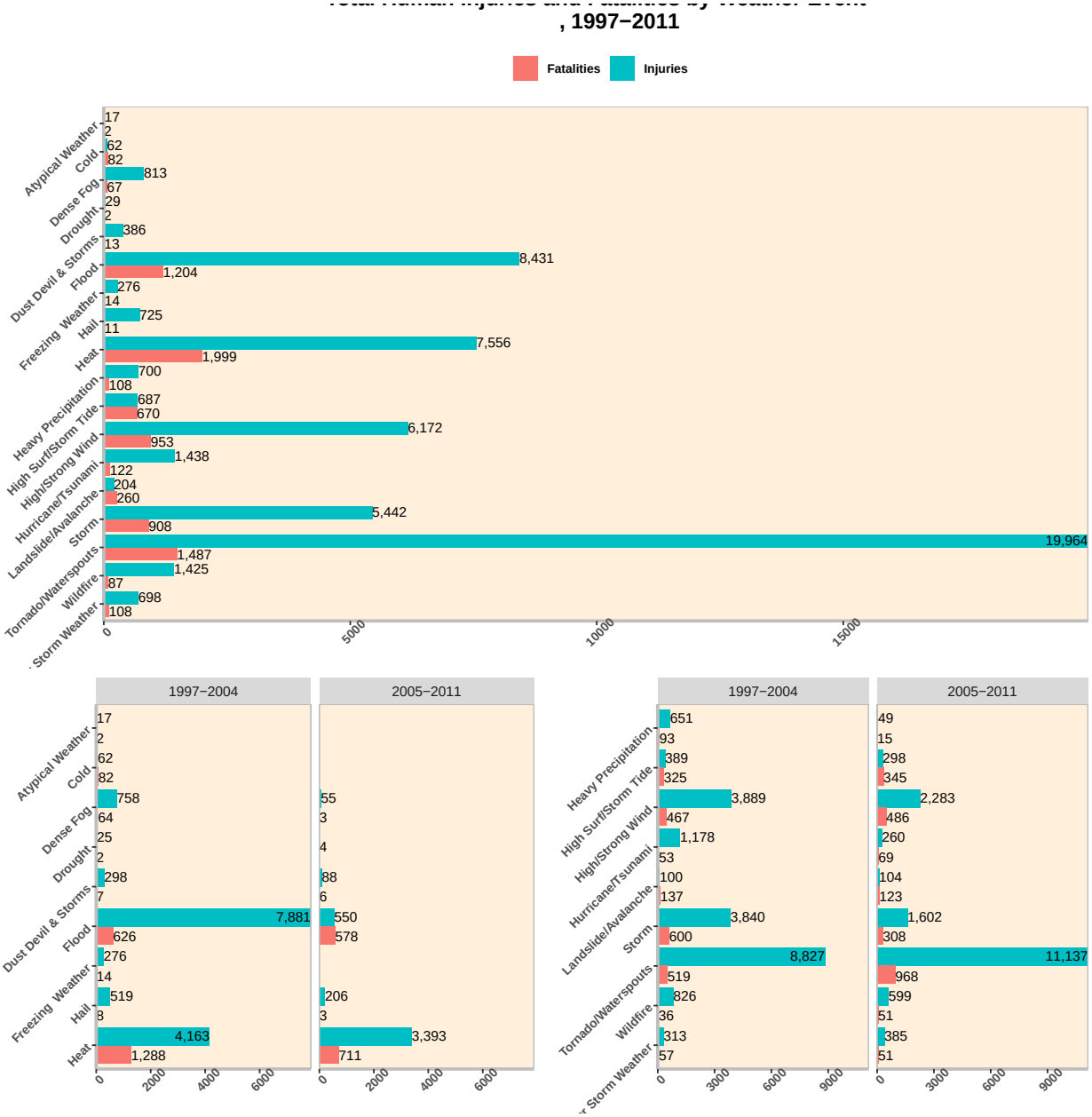
##Results From there we looked at the impact of these events on human life and the economic costs associated with it.

First we wanted to look at Fatalities and Injuries. We looked at these events over time in 7 year intervals to identify variations in these events.

```
fatality<-subset(data2,Fatalities>0)
injury<-subset(data2,Injuries>0)

fatality_1<-subset(fatality,between(fatality$Year,'2005','2011'))
fatality_2<-subset(fatality,between(fatality$Year,'1997','2004'))

injury_1<-subset(injury,between(injury$Year,'2005','2011'))
injury_2<-subset(injury,between(injury$Year,'1997','2004'))

agg_fat_1<-aggregate(fatality_1$Fatalities,by=list(fatality_1$Event_Type), FUN="sum")
agg_fat_1<- agg_fat_1 %>%
            rename(Number=x, Event_Type=Group.1) %>%
            mutate(Data_set='2005-2011') %>%
              mutate(Data_Type='Fatalities')

agg_fat_2<-aggregate(fatality_2$Fatalities,by=list(fatality_2$Event_Type), FUN="sum")
agg_fat_2<- agg_fat_2 %>%
              rename(Number=x, Event_Type=Group.1) %>%
              mutate(Data_set='1997-2004') %>%
              mutate(Data_Type='Fatalities')

agg_inj_1<-aggregate(injury_1$Injuries,by=list(injury_1$Event_Type), FUN="sum")
agg_inj_1<- agg_inj_1 %>%
            rename(Number=x, Event_Type=Group.1) %>%
            mutate(Data_set='2005-2011') %>%
            mutate(Data_Type='Injuries')

agg_inj_2<-aggregate(injury_2$Injuries,by=list(injury_2$Event_Type), FUN="sum")
agg_inj_2<- agg_inj_2 %>%
              rename(Number=x, Event_Type=Group.1) %>%
              mutate(Data_set='1997-2004')  %>%
              mutate(Data_Type='Injuries')

#Overall
agg_fat<-aggregate(fatality$Fatalities,by=list(fatality$Event_Type), FUN="sum")
agg_fat<- agg_fat %>%
          rename(Number=x, Event_Type=Group.1) %>%
          mutate(Data_set='1997-2011') %>%
          mutate(Data_Type='Fatalities')

agg_inj<-aggregate(injury$Injuries,by=list(injury$Event_Type), FUN="sum")
agg_inj<- agg_inj %>%
              rename(Number=x, Event_Type=Group.1) %>%
              mutate(Data_set='1997-2011') %>%
              mutate(Data_Type='Injuries')
```

```
#Merge
aggregation_personcost<-rbind(agg_fat_1, agg_fat_2, agg_inj_1, agg_inj_2)
aggregation_personcost_all<-rbind(agg_fat, agg_inj)

#Group Events to separate
event_type_group<-data.frame(Event_Type=unique(aggregation_personcost$Event_Type))
event_type_group<-data.frame(Event_Type=event_type_group[order(event_type_group$Event_Type),])
event_type_group<- event_type_group %>%
                   mutate(rownum=row_number()) %>%
                   mutate(Category=case_when(between(rownum, "1","9")==TRUE ~ 'Group 1',
                                             between(rownum, "10","18")==TRUE ~ 'Group 2')) %>%
                   select(Event_Type,Category)

aggregation_personcost<-merge(aggregation_personcost, event_type_group)
aggregation_personcost<-aggregation_personcost[order(aggregation_personcost$Event_Type,
                                                     decreasing=TRUE),]

Group_1_order<-subset(event_type_group,event_type_group$Category=='Group 1')
Group_1_order<-Group_1_order[order(Group_1_order$Event_Type,decreasing=TRUE),]
Group_2_order<-subset(event_type_group,event_type_group$Category=='Group 2')
Group_2_order<-Group_2_order[order(Group_2_order$Event_Type,decreasing=TRUE),]
overall_order<-event_type_group[order(event_type_group$Event_Type,decreasing=TRUE),]

plot1<- ggplot(subset(aggregation_personcost, aggregation_personcost$Category=='Group 1'),
               aes(Event_Type, Number, fill=Data_Type,
                   label = scales::comma(Number, big.mark = ","))) +
               theme(axis.title = element_blank(),
                     axis.text = element_text(size=8, angle=45,face="bold"),
                     panel.background = element_rect(fill = "antiquewhite1"),
                     panel.border=element_rect(colour="grey",fill = NA),
                     panel.grid.major = element_blank(),
                     panel.grid.minor = element_blank(),
                     plot.subtitle = element_text(size=12, hjust=0.5),
                     axis.line = element_line(linewidth = 1, colour = "grey"),
                     legend.position = "none") +
               geom_bar(stat="identity", position = 'dodge')+
               facet_grid(cols=vars(Data_set)) +
               coord_flip()+
               geom_text(size = 3, hjust='inward', position = position_dodge(1)) +
               scale_y_continuous(expand=c(0,0.9)) +
               scale_x_discrete(limits=Group_1_order$Event_Type)

plot2<- ggplot(subset(aggregation_personcost, aggregation_personcost$Category=='Group 2'),
               aes(Event_Type, Number, fill=Data_Type,
                   label = scales::comma(Number, big.mark = ","))) +
               theme(axis.title = element_blank(),
                     axis.text = element_text(size=8, angle=45,face="bold"),
                     panel.background = element_rect(fill = "antiquewhite1"),
                     panel.border=element_rect(colour="grey",fill = NA),
                     panel.grid.major = element_blank(),
                     panel.grid.minor = element_blank(),
                     plot.subtitle = element_text(size=12, hjust=0.5),
                     axis.line = element_line(linewidth = 1, colour = "grey"),
```

```
                    legend.position = "none") +
              geom_bar(stat="identity", position = 'dodge')+
              facet_grid(cols=vars(Data_set)) +
              coord_flip()+
              geom_text(size = 3, hjust='inward', position = position_dodge(1)) +
              scale_y_continuous(expand=c(0,0.9)) +
              scale_x_discrete(limits=Group_2_order$Event_Type)

nested_bottom<-plot_grid(plot1,plot2)

plot3<- ggplot(aggregation_personcost_all,
               aes(Event_Type, Number, fill=Data_Type,
                   label = scales::comma(Number, big.mark = ","))) +
               theme(plot.title = element_text(size=14, hjust=0.5),
                     plot.subtitle = element_text(size=12, hjust=0.5),
                     legend.position = "top",
                     legend.text = element_text(size=8, face="bold"),
                     legend.title = element_blank(),
                     axis.title = element_blank(),
                     axis.text = element_text(size=8, angle=45,face="bold"),
                     panel.background = element_rect(fill = "antiquewhite1"),
                     panel.border=element_rect(colour="grey",fill = NA),
                     panel.grid.major = element_blank(),
                     panel.grid.minor = element_blank(),
                     axis.line = element_line(linewidth = 1, colour = "grey")) +
              geom_bar(stat="identity", position = 'dodge')+
              ggtitle(expression(bold("Total Human Injuries and Fatalities by Weather Event
                                      , 1997-2011"))) +
              coord_flip()+
              geom_text(size = 3, hjust='inward', position = position_dodge(1)) +
              scale_y_continuous(expand=c(0,0.9))+
              scale_x_discrete(limits=overall_order$Event_Type)

#make into one output chart
plot_grid(plot3,nested_bottom,ncol=1,rel_heights=c(1.5,1))
```



As you can see from the chart, for each 7 year grouping, there are different weather events that resulted in injuries and fatalities.

For earlier years (1996-2004), the top three included:

- Heat
- Flood
- Tornado/Waterspouts

For the later years(2005-2011), the top three included:

- Tornado/Waterspouts
- Heat
- High/Strong winds

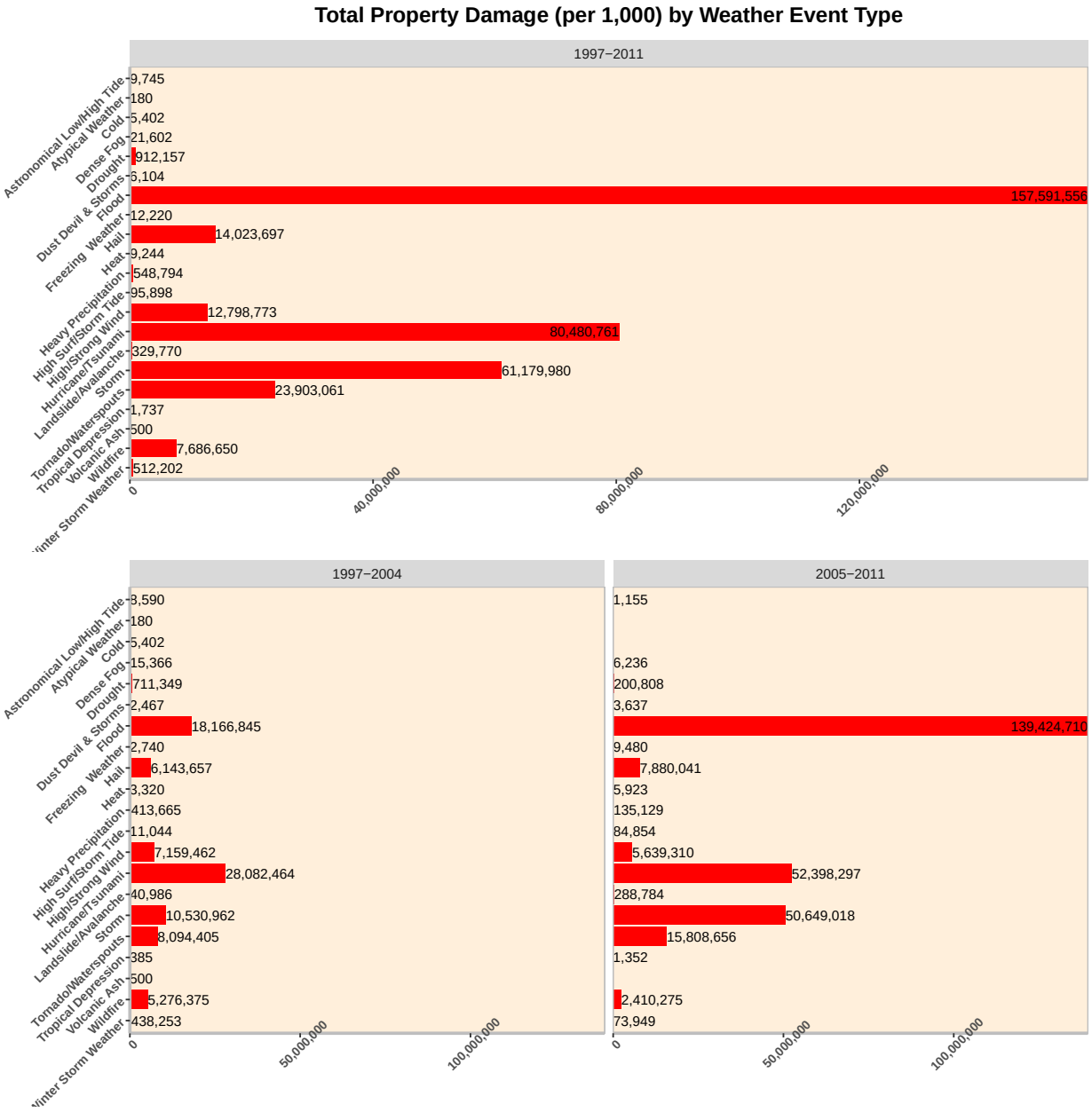
Overall, the top three included:

- Tornado/Waterspouts
- Flood
- Heat

From there, the property damages were assessed.

```
property<-subset(data2,Property_Damage>0)
property<- property %>%
           rename(Damages=Property_Damage)

property_1<-subset(property,between(property$Year,'2005','2011'))
property_2<-subset(property,between(property$Year,'1997','2004'))

agg_prop_1<-aggregate(property_1$Damages,by=list(property_1$Event_Type), FUN="sum")
agg_prop_1<- agg_prop_1 %>%
            rename(Damages=x, Event_Type=Group.1) %>%
            mutate(Data_set='2005-2011')

agg_prop_2<-aggregate(property_2$Damages,by=list(property_2$Event_Type), FUN="sum")
agg_prop_2<- agg_prop_2 %>%
                rename(Damages=x, Event_Type=Group.1) %>%
                mutate(Data_set='1997-2004')

aggregation_property<-rbind(agg_prop_1, agg_prop_2)

overall_order<-data.frame(Event_Type=unique(aggregation_property$Event_Type))
overall_order<-overall_order[order(overall_order$Event_Type,decreasing=TRUE),]

#Overall
agg_prop<-aggregate(property$Damages,by=list(property$Event_Type), FUN="sum")
agg_prop<- agg_prop %>%
          rename(Damages=x, Event_Type=Group.1) %>%
          mutate(Data_set='1997-2011')

plot1<- ggplot(aggregation_property, aes(Event_Type, Damages/1000,
                                         label = scales::comma(Damages/1000, accuracy = 1, big.mark = "
       theme(axis.title = element_blank(),
                    axis.text = element_text(size=8, angle=45,face="bold"),
                    panel.background = element_rect(fill = "antiquewhite1"),
                    panel.border=element_rect(colour="grey",fill = NA),
                    panel.grid.major = element_blank(),
                    panel.grid.minor = element_blank(),
                    plot.subtitle = element_text(size=12, hjust=0.5),
                    axis.line = element_line(linewidth = 1, colour = "grey"),
                    legend.position = "none") +
       geom_bar(stat="identity", fill='red')+
       coord_flip()+
       geom_text(size = 3, hjust='inward', position = position_dodge(1)) +
       facet_grid(cols=vars(Data_set)) +
       scale_y_continuous(expand=c(0,0.9),
                          labels = scales::number_format(accuracy = 1,big.mark = ","))+
```

```
       scale_x_discrete(limits=overall_order)

plot2<-ggplot(agg_prop, aes(Event_Type, Damages/1000, label = scales::comma(Damages/1000, accuracy = 1,
       theme(axis.title = element_blank(),
                    axis.text = element_text(size=8, angle=45,face="bold"),
                    panel.background = element_rect(fill = "antiquewhite1"),
                    panel.border=element_rect(colour="grey",fill = NA),
                    panel.grid.major = element_blank(),
                    panel.grid.minor = element_blank(),
                    plot.title = element_text(size=14, hjust=0.5),
                    axis.line = element_line(linewidth = 1, colour = "grey"),
                    legend.position = "none") +
       geom_bar(stat="identity", fill='red')+
       ggtitle(expression(bold("Total Property Damage (per 1,000) by Weather Event Type"))) +
       coord_flip()+
       geom_text(size = 3, hjust='inward', position = position_dodge(1)) +
       facet_grid(cols=vars(Data_set)) +
       scale_y_continuous(expand=c(0,0.9),
                          labels = scales::number_format(accuracy = 1,big.mark = ","))+
       scale_x_discrete(limits=overall_order)
#make into one output chart
plot_grid(plot2,plot1,ncol=1)
```



As you can see from the chart, for each 7 year grouping, there are different weather events that resulted in large amounts of property damage.

Overall, the top three included:

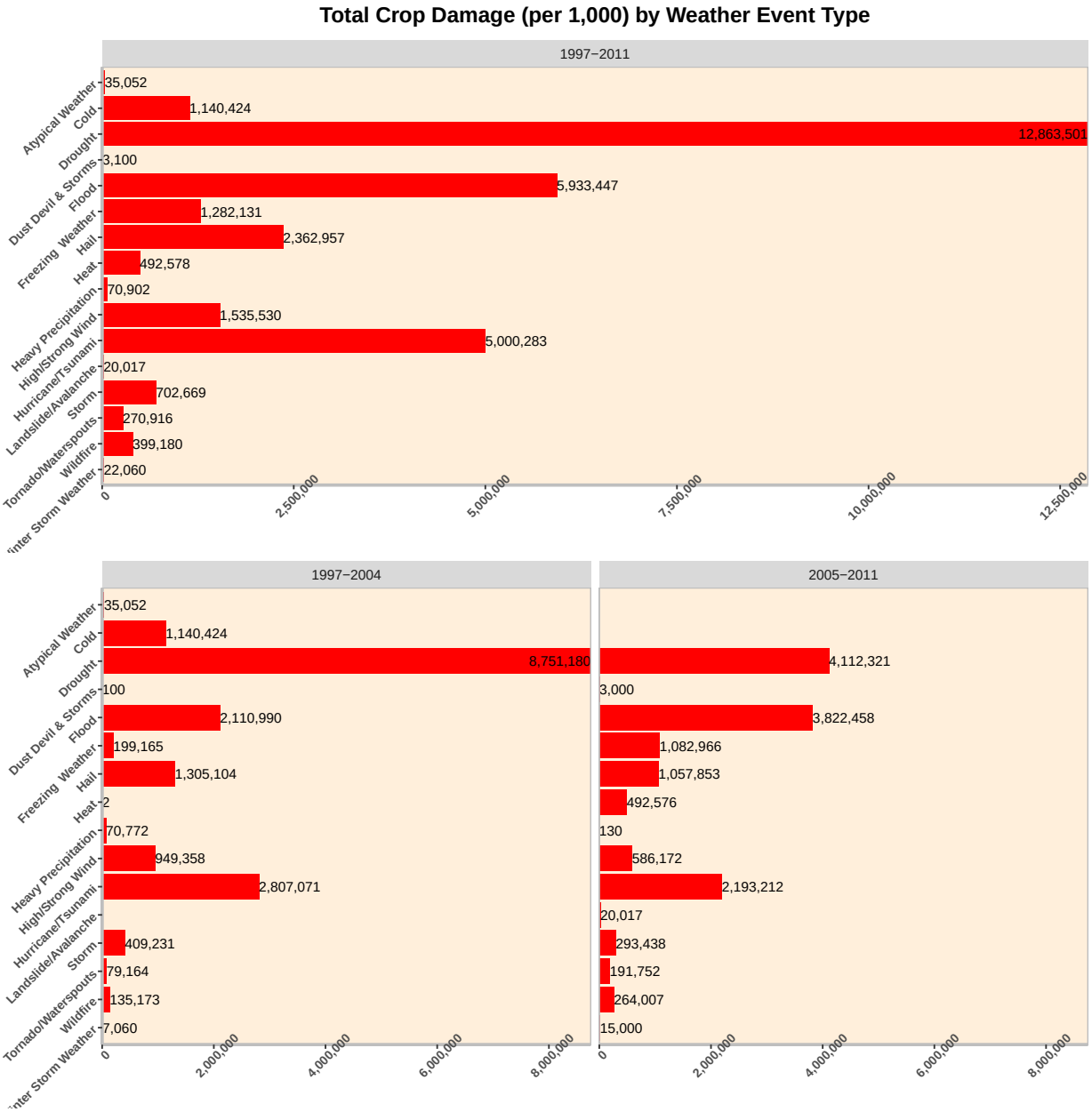
- Flood
- Hurricane/Tsunami
- Storms

As you can see from the charts, although the order of the top three may have changed overtime; however, these appear to result in the greatest cost in regard to property damage.

From there, the Crop damages were assessed.

```r
crop<-subset(data2,Crop_Damage>0)
crop<- crop %>%
          rename(Damages=Crop_Damage)

crop_1<-subset(crop,between(crop$Year,'2005','2011'))
crop_2<-subset(crop,between(crop$Year,'1997','2004'))

agg_prop_1<-aggregate(crop_1$Damages,by=list(crop_1$Event_Type), FUN="sum")
agg_prop_1<- agg_prop_1 %>%
            rename(Damages=x, Event_Type=Group.1) %>%
            mutate(Data_set='2005-2011')

agg_prop_2<-aggregate(crop_2$Damages,by=list(crop_2$Event_Type), FUN="sum")
agg_prop_2<- agg_prop_2 %>%
                rename(Damages=x, Event_Type=Group.1) %>%
                mutate(Data_set='1997-2004')

aggregation_crop<-rbind(agg_prop_1, agg_prop_2)

overall_order<-data.frame(Event_Type=unique(aggregation_crop$Event_Type))
overall_order<-overall_order[order(overall_order$Event_Type,decreasing=TRUE),]

#Overall
agg_prop<-aggregate(crop$Damages,by=list(crop$Event_Type), FUN="sum")
agg_prop<- agg_prop %>%
          rename(Damages=x, Event_Type=Group.1) %>%
          mutate(Data_set='1997-2011')

plot1<- ggplot(aggregation_crop, aes(Event_Type, Damages/1000,
                                     label = scales::comma(Damages/1000, accuracy = 1, big.mark = ","))
       theme(axis.title = element_blank(),
                    axis.text = element_text(size=8, angle=45,face="bold"),
                    panel.background = element_rect(fill = "antiquewhite1"),
                    panel.border=element_rect(colour="grey",fill = NA),
                    panel.grid.major = element_blank(),
                    panel.grid.minor = element_blank(),
                    plot.subtitle = element_text(size=12, hjust=0.5),
                    axis.line = element_line(linewidth = 1, colour = "grey"),
                    legend.position = "none") +
       geom_bar(stat="identity", fill='red')+
       coord_flip()+
       geom_text(size = 3, hjust='inward', position = position_dodge(1)) +
       facet_grid(cols=vars(Data_set)) +
       scale_y_continuous(expand=c(0,0.9),
                          labels = scales::number_format(accuracy = 1,big.mark = ","))+
       scale_x_discrete(limits=overall_order)

plot2<-ggplot(agg_prop, aes(Event_Type, Damages/1000, label = scales::comma(Damages/1000, accuracy = 1,
       theme(axis.title = element_blank(),
                    axis.text = element_text(size=8, angle=45,face="bold"),
                    panel.background = element_rect(fill = "antiquewhite1"),
                    panel.border=element_rect(colour="grey",fill = NA),
                    panel.grid.major = element_blank(),
```

```
                    panel.grid.minor = element_blank(),
                    plot.title = element_text(size=14, hjust=0.5),
                    axis.line = element_line(linewidth = 1, colour = "grey"),
                    legend.position = "none") +
      geom_bar(stat="identity", fill='red')+
      ggtitle(expression(bold("Total Crop Damage (per 1,000) by Weather Event Type"))) +
      coord_flip()+
      geom_text(size = 3, hjust='inward', position = position_dodge(1)) +
      facet_grid(cols=vars(Data_set)) +
      scale_y_continuous(expand=c(0,0.9),
                         labels = scales::number_format(accuracy = 1,big.mark = ","))+
      scale_x_discrete(limits=overall_order)
#make into one output chart
plot_grid(plot2,plot1,ncol=1)
```



As you can see from the chart, for each 7 year grouping, there are different weather events that resulted in large amounts of property damage.

Overall, the top three included:

- Drought
- Floods
- Hurricane/Tsunami

As you can see from the charts, although the order of the top three may have changed overtime; however, these appear to result in the greatest cost in regard to crop damage.