Economic and Population-health Impacts of U.S. Storm Event Types

Synopsis

The NOAA Storm Database was used to determine the economic and population-health impacts of different types of storm events. Because there exist only 3 storm event types in the database prior to 1993, only data from 1993 to 2011 was used. Rather than analyze the impacts of dozens of specific event types (which could not, feasibly, be targeted specifically in impact-mitigation efforts), storm event types were collected into 9 different groups. The economic impact of those groups was estimated by summing values for storm event-caused property damage and storm event-caused crop damage, and then adjusting those sums for inflation. The population-health impact of the storm event type groups was estimated by looking at both fatalities and injuries resulting from the given storm events.

Data Processing

```
{r opts_chunk$set(cache=TRUE)
```

- Read the data.

```
data1 = read.csv("stormData.csv.bz2")
```

- Save only the fields relevant to the research questions. Add a 'Year' field.

```
data2 = data1[,c(2,8,23:28,37)]
data2$date = as.Date(data2[,1], "%m/%d/%Y")
library(lubridate)
data2$year = year(data2$date)
```

- Explore property and crop damage fields.

```
table(data2$PROPDMGEXP)
```

```
##
##             -      ?      +      0      1      2      3      4      5
## 465934      1      8      5    216     25     13      4      4     28
##      6      7      8      B      h      H      K      m      M
##      4      5      1     40      1      6 424665      7  11330
```

```
table(data2$CROPDMGEXP)
```

```
##
##             ?      0      2      B      k      K      m      M
```

```
## 618413      7     19      1      9     21 281832      1   1994
```

- Delete records with unusual ‘PROPDMGEXP’ and ‘CROPDMGEXP’ values.

```
# Handle property damage
data2$pDamage = ifelse(data2$PROPDMG==0, '1', as.character(data2$PROPDMGEXP))
data2$pDamage = ifelse(data2$PROPDMGEXP %in% c('','?','0'), '1', as.character(data2$pDamage))
data3 = subset(data2, !data2$PROPDMGEXP %in% c('+', '-') )
data3 = subset(data3, !data3$PROPDMGEXP %in% c(as.character(1:8)) )

# Handle crop damage
data3$cDamage = ifelse(data3$CROPDMG==0, '1', as.character(data3$CROPDMGEXP))
data3$cDamage = ifelse(data3$CROPDMGEXP %in% c('','?','0'), '1', as.character(data3$cDamage))

data4 = subset(data3, !data3$CROPDMGEXP %in% c('+', '-') )
data4 = subset(data4, !data4$CROPDMGEXP %in% c(as.character(1:8)) )
```

- Convert property and crop damage fields into a total damage field. Adjust total damage values for inflation.

```
# Create value lookup table
multipliers = c(1,100,100,1000,1000,1000000,1000000,1000000000)
EXPlevels = c('1','H','h','K','k','M','m','B')
lookupTable = as.data.frame(cbind(EXPlevels, multipliers))

# Fill property damage integers
data4$Pmultipliers = multipliers[match(data4$pDamage, EXPlevels)]
```

```
data4$propertyDamage = data4$PROPDMG * data4$Pmultipliers

# Fill crop damage integers
data4$Cmultipliers = multipliers[match(data4$cDamage, EXPlevels)]
data4$cropDamage = data4$CROPDMG * data4$Cmultipliers

# Sum property and crop damage
data4$totalDamage = data4$propertyDamage + data4$cropDamage

# Read CPI indices
CPI = read.csv('CPIlookup.csv', header=FALSE)
CPI
```

```
##      V1       V2
## 1  1993 1.556671
## 2  1994 1.517807
## 3  1995 1.475978
## 4  1996 1.433646
## 5  1997 1.401489
## 6  1998 1.379994
## 7  1999 1.350174
## 8  2000 1.306266
## 9  2001 1.270124
## 10 2002 1.250495
## 11 2003 1.222760
## 12 2004 1.190783
## 13 2005 1.151761
## 14 2006 1.115769
```

```
## 15 2007 1.084869
## 16 2008 1.044756
## 17 2009 1.048486
## 18 2010 1.031565
## 19 2011 1.000000
```

```
# Fill CPI values per year
data4$CPI = CPI[match(data4$year, CPI[,1]), 2]

# Adjust total damage values for inflation
data4$totDamageAdjusted = data4$totalDamage * data4$CPI
```

- Examine the number of storm event types by year.

```
yearSplit = split(data4, data4$year)
countEVT = function(x) {length(unique(x[,2]))}

# Get the number of storm event types per year
typeBYyear = sapply(yearSplit, countEVT)
table(unique(data4$year), typeBYyear)
```

```
##       typeBYyear
##        1 3 38 46 50 51 99 112 121 122 126 160 170 228 267 385
##   1950 1 0  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1951 1 0  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1952 1 0  0  0  0  0  0   0   0   0   0   0   0   0   0   0
```

```
##   1953 1 0  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1954 1 0  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1955 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1956 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1957 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1958 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1959 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1960 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1961 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1962 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1963 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1964 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1965 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1966 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1967 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1968 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1969 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1970 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1971 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1972 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1973 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1974 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1975 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1976 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1977 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1978 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1979 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1980 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
```

```
##   1981 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1982 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1983 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1984 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1985 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1986 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1987 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1988 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1989 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1990 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1991 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1992 0 1  0  0  0  0  0   0   0   0   0   0   0   0   0   0
##   1993 0 0  0  0  0  0  0   0   0   0   0   0   0   0   0   1
##   1994 0 0  0  0  0  0  0   0   0   0   0   0   0   0   1   0
##   1995 0 0  0  0  0  0  0   0   0   0   0   1   0   0   0   0
##   1996 0 0  0  0  0  0  0   0   0   0   0   0   0   1   0   0
##   1997 0 0  0  0  0  0  0   0   0   0   0   0   1   0   0   0
##   1998 0 0  0  0  0  0  0   0   0   0   1   0   0   0   0   0
##   1999 0 0  0  0  0  0  0   0   1   0   0   0   0   0   0   0
##   2000 0 0  0  0  0  0  0   1   0   0   0   0   0   0   0   0
##   2001 0 0  0  0  0  0  0   0   0   1   0   0   0   0   0   0
##   2002 0 0  0  0  0  0  1   0   0   0   0   0   0   0   0   0
##   2003 0 0  0  0  0  1  0   0   0   0   0   0   0   0   0   0
##   2004 0 0  1  0  0  0  0   0   0   0   0   0   0   0   0   0
##   2005 0 0  0  1  0  0  0   0   0   0   0   0   0   0   0   0
##   2006 0 0  0  0  1  0  0   0   0   0   0   0   0   0   0   0
##   2007 0 0  0  1  0  0  0   0   0   0   0   0   0   0   0   0
##   2008 0 0  0  1  0  0  0   0   0   0   0   0   0   0   0   0
```

```
##   2009 0 0  0  1  0  0  0   0   0   0   0   0   0   0   0   0
##   2010 0 0  0  1  0  0  0   0   0   0   0   0   0   0   0   0
##   2011 0 0  0  1  0  0  0   0   0   0   0   0   0   0   0   0
```

- Because there are 3 or fewer event types per year prior to 1993, retain only records from after 1992. Collect the storm event type names from those years for processing into event-type groups.

```
later = data4[data4$year > 1992,]
EVTYPEnames = toupper(unique(factor(later$EVTYPE)))
```

- Subset the storm event types into 9 categories. Note that a number of event types could be alternately categorized. This is especially true regarding many of the event types in the ‘Other’ category; however, because fatalities and injuries for the ‘Other’ category are few, and because the cost of damage caused by events in the ‘Other’ category is low, no attempt was made to further refine the 'Other' category.

```
# Get minor storm event types
a1 = grep('t.*st.*m.*|thunder.*|.*wind.*|.*storm.*', EVTYPEnames, ignore.case = TRUE, value = TRUE)
length(a1)    #286
```

```
## [1] 286
```

```
b1 = setdiff(EVTYPEnames, a1)

# Get major storm event types
a2 = grep('hurricane|typhoon|tornado|whirlwind|waterspout|.*funnel.*', b1, ignore.case = TRUE, value = TRUE
```

```
)
length(a2)    #40
```

```
## [1] 40
```

```
b2 = setdiff(b1, a2)

# Get flood storm event types
a3 = grep('.*fl.*d.*|.*rising.*|.*high water.*|.rain.*', b2, ignore.case = TRUE, value = TRUE)
length(a3)    #137
```

```
## [1] 137
```

```
b3 = setdiff(b2, a3)

# Get heat storm event types
a4 = grep('.*warm.*|.*heat.*', b3, ignore.case = TRUE, value = TRUE)
length(a4)    #30
```

```
## [1] 30
```

```
b4 = setdiff(b3, a4)

# Get marine-related storm event types
a5 = grep('tsunami|.*tide.*|.*seas.*|.*swell.*|.*surf.*|.*wave.*|.*current.*|.*drown.*|.*marine.*', b4, ign
```

```
ore.case = TRUE, value = TRUE)
length(a5)    #44
```

```
## [1] 44
```

```
b5 = setdiff(b4, a5)

# Get winter storm event types
a6 = grep('.*snow.*|.*ic[e,y].*|.*wint.*|.*cold.*|.*exposure.*|.*blizzard*|.*sleet*|.*hail.*|.*freez.*|.*frost.*|.*LOW TEMPERATURE.*|.*hypothermia.*|.*glaze.*', b5, ignore.case = TRUE, value = TRUE)
length(a6)    #162
```

```
## [1] 162
```

```
b6 = setdiff(b5, a6)

# Get fire-related storm event types
a7 = grep('.*fire.*|.*lightning.*', b6, ignore.case = TRUE, value = TRUE)
length(a7)    #17
```

```
## [1] 17
```

```
b7 = setdiff(b6, a7)

# Get other storm event types
```

```
a8 = grep('.*slide.*|.*avalan.*e.*', b7, ignore.case = TRUE, value = TRUE)
length(a8)    #11
```

```
## [1] 11
```

```
b8 = setdiff(b7, a8)

eventLookup = list(list(a1,a2,a3,a4,a5,a6,a7,a8,b8), c('minorStorm','majorStorm','flood','heat','marine','winter','fire','slides','other'))

eventLookup
```

```
## [[1]]
## [[1]][[1]]
##   [1] "ICE STORM/FLASH FLOOD"          "WINTER STORM"
##   [3] "HURRICANE OPAL/HIGH WINDS"      "THUNDERSTORM WINDS"
##   [5] "THUNDERSTORM WIND"              "THUNDERSTORM WINS"
##   [7] "HIGH WINDS"                     "THUNDERSTORM WINDS LIGHTNING"
##   [9] "THUNDERSTORM WINDS/HAIL"        "WIND"
##  [11] "THUNDERSTORM WINDS HAIL"        "FLASH FLOODING/THUNDERSTORM WI"
##  [13] "THUNDERSTORM"                   "HIGH WIND"
##  [15] "WIND CHILL"                     "HIGH WIND/BLIZZARD"
##  [17] "HIGH WIND AND HIGH TIDES"       "HIGH WIND/BLIZZARD/FREEZING RA"
##  [19] "HIGH WIND AND HEAVY SNOW"       "RECORD COLD AND HIGH WIND"
##  [21] "HIGH WINDS HEAVY RAINS"         "HIGH WIND/ BLIZZARD"
##  [23] "ICE STORM"                      "BLIZZARD/HIGH WIND"
##  [25] "HIGH WIND/LOW WIND CHILL"       "HIGH WINDS AND WIND CHILL"
```

```
##  [27] "HEAVY SNOW/HIGH WINDS/FREEZING" "WIND CHILL/HIGH WIND"
##  [29] "HIGH WIND/WIND CHILL/BLIZZARD"  "HIGH WIND/WIND CHILL"
##  [31] "HIGH WIND/HEAVY SNOW"           "HIGH WIND/SEAS"
##  [33] "HIGH WINDS/HEAVY RAIN"          "HEAVY SNOW/WIND"
##  [35] "WIND DAMAGE"                    "DUST STORM"
##  [37] "HAIL STORM"                     "TSTM WIND"
##  [39] "THUNDERSTORM WINDS/FUNNEL CLOU" "WINTER STORM/HIGH WIND"
##  [41] "WINTER STORM/HIGH WINDS"        "GUSTY WINDS"
##  [43] "STRONG WINDS"                   "SNOW AND WIND"
##  [45] "HIGH WINDS DUST STORM"          "WINTER STORM HIGH WINDS"
##  [47] "WINTER STORMS"                  "RAINSTORM"
##  [49] "SEVERE THUNDERSTORM"            "SEVERE THUNDERSTORMS"
##  [51] "SEVERE THUNDERSTORM WINDS"      "THUNDERSTORMS WINDS"
##  [53] "FLOOD/RAIN/WINDS"               "WINDS"
##  [55] "THUNDERSTORMS"                  "FLASH FLOOD WINDS"
##  [57] "STRONG WIND"                    "HIGH WIND DAMAGE"
##  [59] "FLOOD/RAIN/WIND"                "DOWNBURST WINDS"
##  [61] "DRY MICROBURST WINDS"           "DRY MIRCOBURST WINDS"
##  [63] "MICROBURST WINDS"               "HIGH WINDS 57"
##  [65] "HIGH WINDS 66"                  "HIGH WINDS 76"
##  [67] "HIGH WINDS 63"                  "HIGH WINDS 67"
##  [69] "HEAVY SNOW/HIGH WINDS"          "HIGH WINDS 82"
##  [71] "HIGH WINDS 80"                  "HIGH WINDS 58"
##  [73] "LIGHTNING THUNDERSTORM WINDSS"  "HIGH WINDS 73"
##  [75] "HIGH WINDS 55"                  "THUNDERSTORM WINDS 60"
##  [77] "THUNDERSTORM WINDSS"            "HIGH WINDS/FLOODING"
##  [79] "STORM SURGE"                    "TORNADOES, TSTM WIND, HAIL"
##  [81] "TROPICAL STORM ALBERTO"         "TROPICAL STORM"
```

```
##  [83] "TROPICAL STORM GORDON"          "TROPICAL STORM JERRY"
##  [85] "LIGHTNING THUNDERSTORM WINDS"   "LIGHTNING AND THUNDERSTORM WIN"
##  [87] "THUNDERSTORM WINDS53"           "THUNDERSTORM WINDS 13"
##  [89] "HEAVY SNOW/HIGH WIND"           "HIGH WINDS/"
##  [91] "THUNDERSNOW"                    "EXTREME WIND CHILLS"
##  [93] "HIGH  WINDS"                    "EXTREME WIND CHILL"
##  [95] "GRADIENT WINDS"                 "SLEET/ICE STORM"
##  [97] "THUNDERSTORM WINDS URBAN FLOOD" "THUNDERSTORM WINDS SMALL STREA"
##  [99] "BLOWING SNOW- EXTREME WIND CHI" "SNOW- HIGH WIND- WIND CHILL"
## [101] "THUNDERSTORM WINDS 2"           "TSTM WIND 51"
## [103] "TSTM WIND 50"                   "TSTM WIND 52"
## [105] "TSTM WIND 55"                   "THUNDERSTORM WINDS 61"
## [107] "THUNDERSTORM DAMAGE"            "THUNDERTORM WINDS"
## [109] "HAIL/WINDS"                     "WIND STORM"
## [111] "SNOWSTORM"                      "HAIL/WIND"
## [113] "THUNDERSTORMW 50"               "WIND/HAIL"
## [115] "SNOW AND ICE STORM"             "THUNDERSTORMS WIND"
## [117] "THUNDERSTORM  WINDS"            "TUNDERSTORM WIND"
## [119] "TROPICAL STORM DEAN"            "THUNDERTSORM WIND"
## [121] "THUNDERSTORM WINDS/ HAIL"       "THUNDERSTORM WIND/LIGHTNING"
## [123] "THUNDESTORM WINDS"              "HEAVY SNOW/ICE STORM"
## [125] "HIGH WIND 63"                   "HEAVY SNOW AND ICE STORM"
## [127] "HIGH WINDS/COASTAL FLOOD"       "THUNDERSTORM WIND G50"
## [129] "THUNDERSTORM WINDS/HEAVY RAIN"  "THUNDERSTROM WINDS"
## [131] "THUNDERSTORM WINDS      LE CEN" "ICE STORM AND SNOW"
## [133] "BLIZZARD AND EXTREME WIND CHIL" "LOW WIND CHILL"
## [135] "BLOWING SNOW & EXTREME WIND CH" "THUNDERSTORM WINDS G"
## [137] "GLAZE/ICE STORM"                "HEAVY SNOW/WINTER STORM"
```

```
## [139] "BLIZZARD/WINTER STORM"          "DUST STORM/HIGH WINDS"
## [141] "THUNDERSTORM WIND G60"          "THUNDERSTORM WINDS."
## [143] "THUNDERSTORM WIND G55"          "THUNDERSTORM WINDS G60"
## [145] "THUNDERSTORM WINDS FUNNEL CLOU" "THUNDERSTORM WINDS 62"
## [147] "HEAVY SNOW AND HIGH WINDS"      "HEAVY SNOW/HIGH WINDS & FLOOD"
## [149] "THUNDERSTORM WINDS/FLASH FLOOD" "HIGH WIND 70"
## [151] "THUNDERSTORM WINDS 53"          "RAIN AND WIND"
## [153] "THUNDERSTORM WIND 59"           "THUNDERSTORM WIND 52"
## [155] "SNOW/ICE STORM"                 "THUNDERSTORM WIND 69"
## [157] "LIGHTNING AND WINDS"            "TSTM WIND G58"
## [159] "THUNDERSTORMW WINDS"            "THUNDERSTORM WIND 60 MPH"
## [161] "THUNDERSTORM WIND 65MPH"        "THUNDERSTORM WIND/ TREES"
## [163] "THUNDERSTORM WIND/AWNING"       "THUNDERSTORM WIND 98 MPH"
## [165] "THUNDERSTORM WIND TREES"        "THUNDERSTORM WIND 59 MPH"
## [167] "THUNDERSTORM WINDS 63 MPH"      "THUNDERSTORM WIND/ TREE"
## [169] "THUNDERSTORM DAMAGE TO"         "THUNDERSTORM WIND 65 MPH"
## [171] "THUNDERSTORM WIND."             "THUNDERSTORM WIND 59 MPH."
## [173] "THUNDERSTORM HAIL"              "THUNDERSTORM WINDSHAIL"
## [175] "THUDERSTORM WINDS"              "STORM FORCE WINDS"
## [177] "THUNDERSTORM WINDS AND"         "HEAVY RAIN; URBAN FLOOD WINDS;"
## [179] "TSTM WIND DAMAGE"               "RAIN/WIND"
## [181] "THUNDERSTORM WINDS 50"          "THUNDERSTORM WIND G52"
## [183] "THUNDERSTORM WINDS 52"          "THUNDERSTORM WIND G51"
## [185] "THUNDERSTORM WIND G61"          "THUNDERESTORM WINDS"
## [187] "THUNDERSTORM WINDS/FLOODING"    "THUNDEERSTORM WINDS"
## [189] "THUNDERSTORM W INDS"            "THUNDERSTORM WIND 50"
## [191] "THUNERSTORM WINDS"              "HIGH WINDS/COLD"
## [193] "COLD/WINDS"                     "THUNDERSTORM WIND 56"
```

```
## [195] "ICE/STRONG WINDS"                "EXTREME WIND CHILL/BLOWING SNO"
## [197] "SNOW/HIGH WINDS"                 "HIGH WINDS/SNOW"
## [199] "HEAVY SNOW AND STRONG WINDS"     "BLOWING SNOW/EXTREME WIND CHIL"
## [201] "THUNDERSTORM WIND/HAIL"          "THUNDERSTORMW"
## [203] "HAILSTORM"                       "TSTM WINDS"
## [205] "HAILSTORMS"                      "TSTMW"
## [207] "TSTM WIND 65)"                   "THUNDERSTORM WINDS/ FLOOD"
## [209] "HIGH WIND AND SEAS"              "THUNDERSTORMWINDS"
## [211] "THUNDERSTORM WINDS HEAVY RAIN"   "DUSTSTORM"
## [213] "THUNDERSTROM WIND"               "HIGH WIND 48"
## [215] "EXTREME WINDCHILL"               "TSTM WIND/HAIL"
## [217] "HIGH WIND"                       "TSTM WIND"
## [219] "WIND"                            "WIND DAMAGE"
## [221] "STRONG WIND"                     "COASTAL STORM"
## [223] "HEAVY RAIN AND WIND"             "THUNDERSTORM WIND"
## [225] "COASTAL STORM"                   "HEAVY RAIN/WIND"
## [227] "STRONG WINDS"                    "STRONG WINDS"
## [229] "WHIRLWIND"                       "GUSTY WIND"
## [231] "GRADIENT WIND"                   "METRO STORM, MAY 26"
## [233] "GUSTY WIND/RAIN"                 "GUSTY WIND/HVY RAIN"
## [235] "THUNDERSNOW SHOWER"              "TSTM WIND (G45)"
## [237] "TSTM HEAVY RAIN"                 "GUSTY WINDS"
## [239] "GUSTY WIND"                      "TSTM WIND 40"
## [241] "TSTM WIND 45"                    "TSTM WIND (41)"
## [243] "TSTM WIND (G40)"                 "TSTM WND"
## [245] " TSTM WIND"                      "STRONG WIND GUST"
## [247] "COASTALSTORM"                    "GUSTY WINDS"
## [249] "GRADIENT WIND"                   "ICESTORM/BLIZZARD"
```

```
## [251] "FLOOD/STRONG WIND"              "TSTM WIND AND LIGHTNING"
## [253] "GRADIENT WIND"                  "HEAVY SURF AND WIND"
## [255] " TSTM WIND (G45)"               "TSTM WIND  (G45)"
## [257] "HIGH WIND (G40)"                "TSTM WIND (G35)"
## [259] "WAKE LOW WIND"                  "COLD WIND CHILL TEMPERATURES"
## [261] "BITTER WIND CHILL"              "BITTER WIND CHILL TEMPERATURES"
## [263] "TSTM"                           "WIND ADVISORY"
## [265] "GUSTY WIND/HAIL"                "EXTREME WINDCHILL TEMPERATURES"
## [267] "WIND AND WAVE"                  " WIND"
## [269] "TSTM WIND G45"                  "NON-SEVERE WIND DAMAGE"
## [271] "THUNDERSTORM WIND (G40)"        "WIND GUSTS"
## [273] "GUSTY LAKE WIND"                "NON-TSTM WIND"
## [275] "NON TSTM WIND"                  "GUSTY THUNDERSTORM WINDS"
## [277] "MARINE TSTM WIND"               "WHIRLWIND"
## [279] "EXTREME COLD/WIND CHILL"        "GUSTY THUNDERSTORM WIND"
## [281] "SLEET STORM"                    "STORM SURGE/TIDE"
## [283] "COLD/WIND CHILL"                "MARINE HIGH WIND"
## [285] "MARINE THUNDERSTORM WIND"       "MARINE STRONG WIND"
##
## [[1]][[2]]
##  [1] "TORNADO"                   "HURRICANE ERIN"
##  [3] "HURRICANE OPAL"            "FUNNEL CLOUD"
##  [5] "TORNADO F0"                "FUNNEL"
##  [7] "WALL CLOUD/FUNNEL CLOUD"   "WATERSPOUT"
##  [9] "FUNNEL CLOUDS"             "TORNADOS"
## [11] "WATERSPOUT/TORNADO"        "WATERSPOUTS"
## [13] "WATERSPOUT TORNADO"        "WATERSPOUT-TORNADO"
## [15] "WATERSPOUT-"               "HURRICANE"
```

```
## [17] "COLD AIR FUNNEL"            "COLD AIR FUNNELS"
## [19] "COLD AIR TORNADO"           "FUNNEL CLOUD/HAIL"
## [21] "WATERSPOUT/ TORNADO"        "HURRICANE-GENERATED SWELLS"
## [23] "DUST DEVIL WATERSPOUT"      "WATERSPOUT/"
## [25] "TORNADO F3"                 "FUNNEL CLOUD."
## [27] "TORNADO F1"                 "TORNADO/WATERSPOUT"
## [29] "TORNADO F2"                 "HURRICANE EMILY"
## [31] "HURRICANE GORDON"           "HURRICANE FELIX"
## [33] "TORNADOES"                  "FUNNELS"
## [35] "WATERSPOUT FUNNEL CLOUD"    "HURRICANE EDOUARD"
## [37] "TYPHOON"                    " WATERSPOUT"
## [39] "TORNADO DEBRIS"             "HURRICANE/TYPHOON"
##
## [[1]][[3]]
##   [1] "FREEZING RAIN"                 "HEAVY RAIN"
##   [3] "FLASH FLOOD"                   "FLASH FLOODING"
##   [5] "HEAVY RAINS"                   "LIGHTNING AND HEAVY RAIN"
##   [7] "FLOODING"                      "FLOOD"
##   [9] "HEAVY RAIN/LIGHTNING"          "LIGHTNING/HEAVY RAIN"
##  [11] "RIVER FLOOD"                   "COASTAL FLOOD"
##  [13] "FLOOD WATCH/"                  "RECORD RAINFALL"
##  [15] "FLASH FLOODS"                  "HEAVY SURF COASTAL FLOODING"
##  [17] "URBAN FLOODING"                "URBAN/SMALL FLOODING"
##  [19] "LOCAL FLOOD"                   "FLOOD/FLASH FLOOD"
##  [21] "URBAN/SMALL STREAM FLOODING"   "STREAM FLOODING"
##  [23] "FLASH FLOOD/"                  "SMALL STREAM URBAN FLOOD"
##  [25] "URBAN FLOOD"                   "HEAVY RAIN/FLOODING"
##  [27] "COASTAL FLOODING"              "FREEZING RAIN AND SLEET"
```

```
##  [29] "SLEET/RAIN/SNOW"                "SNOW/RAIN/SLEET"
##  [31] "URBAN/SMALL STREAM FLOOD"       "MINOR FLOODING"
##  [33] "URBAN/SMALL STREAM  FLOOD"      "URBAN AND SMALL STREAM FLOOD"
##  [35] "SMALL STREAM FLOODING"          "FREEZING RAIN/SNOW"
##  [37] "FLOODS"                         "HEAVY RAIN/SNOW"
##  [39] "SMALL STREAM AND URBAN FLOODIN" "SMALL STREAM/URBAN FLOOD"
##  [41] "SNOW/SLEET/FREEZING RAIN"       "SMALL STREAM AND URBAN FLOOD"
##  [43] "RURAL FLOOD"                    "MAJOR FLOOD"
##  [45] "FREEZING RAIN/SLEET"            "ICE JAM FLOODING"
##  [47] "STREET FLOOD"                   "SMALL STREAM FLOOD"
##  [49] "LAKE FLOOD"                     "URBAN AND SMALL STREAM FLOODIN"
##  [51] "HEAVY RAIN/SEVERE WEATHER"      "RIVER AND STREAM FLOOD"
##  [53] "MINOR FLOOD"                    "RIVER FLOODING"
##  [55] "SNOW/RAIN"                      "BLIZZARD/FREEZING RAIN"
##  [57] "HEAVY SNOW/FREEZING RAIN"       "FLOOD/RIVER FLOOD"
##  [59] "MUD SLIDES URBAN FLOODING"      "HVY RAIN"
##  [61] "HAIL FLOODING"                  "HEAVY RAIN AND FLOOD"
##  [63] "LOCAL FLASH FLOOD"              "FLOOD/FLASH FLOODING"
##  [65] "COASTAL/TIDAL FLOOD"            "FLASH FLOOD/FLOOD"
##  [67] "EXCESSIVE RAIN"                 "FLASH FLOOD FROM ICE JAMS"
##  [69] "SNOW FREEZING RAIN"             "SNOW/FREEZING RAIN"
##  [71] "TORRENTIAL RAIN"                "FLASH FLOOD - HEAVY RAIN"
##  [73] "FLASH FLOOD/ STREET"            "HEAVY SNOW   FREEZING RAIN"
##  [75] "FREEZING RAIN AND SNOW"         "FREEZING RAIN SLEET AND"
##  [77] "FLASH FLOOD/HEAVY RAIN"         "HIGH WATER"
##  [79] "FLOOD FLASH"                    "FLOOD FLOOD/FLASH"
##  [81] "FREEZING RAIN SLEET AND LIGHT"  "RECORD/EXCESSIVE RAINFALL"
##  [83] "TIDAL FLOOD"                    "FLOOD/FLASH"
```

```
##  [85] "SLEET & FREEZING RAIN"          "HEAVY RAINS/FLOODING"
##  [87] "HIGHWAY FLOODING"               "FLASH FLOOD/ FLOOD"
##  [89] "HEAVY RAIN/MUDSLIDES/FLOOD"     "BEACH EROSION/COASTAL FLOOD"
##  [91] "RAPIDLY RISING WATER"           "SNOWMELT FLOODING"
##  [93] "FLASH FLOODING/FLOOD"           "FLASH FLOOODING"
##  [95] "EXCESSIVE RAINFALL"             "BEACH FLOOD"
##  [97] "HEAVY RAINFALL"                 "SNOW/SLEET/RAIN"
##  [99] "FLOOD & HEAVY RAIN"             "FLOOD/FLASHFLOOD"
## [101] "URBAN SMALL STREAM FLOOD"       "URBAN FLOOD LANDSLIDE"
## [103] "URBAN FLOODS"                   "HEAVY RAIN/URBAN FLOOD"
## [105] "FLASH FLOOD/LANDSLIDE"          "LANDSLIDE/URBAN FLOOD"
## [107] "HEAVY RAIN/SMALL STREAM URBAN"  "FLASH FLOOD LANDSLIDES"
## [109] "URBAN/SML STREAM FLD"           "ICE JAM FLOOD (MINOR"
## [111] "COASTALFLOOD"                   "EROSION/CSTL FLOOD"
## [113] "TIDAL FLOODING"                 "HEAVY RAIN/HIGH SURF"
## [115] "STREET FLOODING"                "TORRENTIAL RAINFALL"
## [117] " COASTAL FLOOD"                 "MONTHLY RAINFALL"
## [119] "SML STREAM FLD"                 "SLEET/FREEZING RAIN"
## [121] "URBAN/SML STREAM FLDG"          "URBAN/SMALL STRM FLDG"
## [123] "UNSEASONAL RAIN"                "EARLY RAIN"
## [125] "PROLONGED RAIN"                 "COASTAL FLOODING/EROSION"
## [127] "URBAN/STREET FLOODING"          "COASTAL  FLOODING/EROSION"
## [129] "REMNANTS OF FLOYD"              "FLOOD/FLASH/FLOOD"
## [131] "LIGHT FREEZING RAIN"            " FLASH FLOOD"
## [133] "LOCALLY HEAVY RAIN"             "CSTL FLOODING/EROSION"
## [135] "RECORD LOW RAINFALL"            "HEAVY RAIN EFFECTS"
## [137] "LAKESHORE FLOOD"
##
```

```
## [[1]][[4]]
##  [1] "HEAT"                      "RECORD WARMTH"
##  [3] "EXTREME HEAT"              "EXCESSIVE HEAT"
##  [5] "RECORD HEAT"               "HEAT WAVE"
##  [7] "UNSEASONABLY WARM"         "DROUGHT/EXCESSIVE HEAT"
##  [9] "WARM DRY CONDITIONS"       "RECORD HEAT WAVE"
## [11] "RECORD/EXCESSIVE HEAT"     "HEAT WAVES"
## [13] "HEAT WAVE DROUGHT"         "UNSEASONABLY WARM AND DRY"
## [15] "HEAT/DROUGHT"              "HEAT DROUGHT"
## [17] "RECORD WARM TEMPS."        "HEATBURST"
## [19] "ABNORMAL WARMTH"           "UNUSUAL WARMTH"
## [21] "UNUSUAL/RECORD WARMTH"     "UNSEASONABLY WARM YEAR"
## [23] "RECORD WARM"               "UNSEASONABLY WARM/WET"
## [25] "UNUSUALLY WARM"            "WARM WEATHER"
## [27] "UNSEASONABLY WARM & WET"   "PROLONG WARMTH"
## [29] "EXCESSIVE HEAT/DROUGHT"    "VERY WARM"
##
## [[1]][[5]]
##  [1] "RIP CURRENT"            "HIGH TIDES"
##  [3] "MARINE MISHAP"          "HIGH SEAS"
##  [5] "HEAVY SURF"             "HIGH SURF"
##  [7] "UNSEASONABLY DRY"       "UNSEASONABLY WET"
##  [9] "UNSEASONABLY COLD"      "RIP CURRENTS HEAVY SURF"
## [11] "COLD WAVE"              "HIGH WAVES"
## [13] "RIP CURRENTS/HEAVY SURF" "RIP CURRENTS"
## [15] "HEAVY SEAS"             "HEAVY SWELLS"
## [17] "ROUGH SURF"             "MARINE ACCIDENT"
## [19] "UNSEASONABLE COLD"      "LATE-SEASON SNOWFALL"
```

```
## [21] "LATE SEASON SNOWFALL"    "SEASONAL SNOWFALL"
## [23] "BLOW-OUT TIDES"          "UNSEASONABLY COOL"
## [25] "BLOW-OUT TIDE"           "HIGH SWELLS"
## [27] "HIGH  SWELLS"            "UNSEASONABLY HOT"
## [29] "LATE SEASON HAIL"        "ROUGH SEAS"
## [31] "UNSEASONABLY COOL & WET" "UNSEASONAL LOW TEMP"
## [33] "HIGH SURF ADVISORY"      "LATE SEASON SNOW"
## [35] "ROGUE WAVE"              "   HIGH SURF ADVISORY"
## [37] "HAZARDOUS SURF"          "ASTRONOMICAL HIGH TIDE"
## [39] "DROWNING"                "MARINE HAIL"
## [41] "HIGH SURF ADVISORIES"    "HEAVY SURF/HIGH SURF"
## [43] "TSUNAMI"                 "ASTRONOMICAL LOW TIDE"
##
## [[1]][[6]]
##   [1] "SNOW"                          "SNOW/ICE"
##   [3] "HAIL"                          "RECORD COLD"
##   [5] "COLD"                          "EXTREME COLD"
##   [7] "HAIL 1.75)"                    "BLIZZARD"
##   [9] "BLIZZARD WEATHER"              "HEAVY SNOW"
##  [11] "FREEZE"                        "HEAVY SNOW/HIGH"
##  [13] "LOW TEMPERATURE RECORD"        "RECORD SNOWFALL"
##  [15] "SLEET"                         "HEAVY SNOWPACK"
##  [17] "ICE"                           "BLIZZARD/HEAVY SNOW"
##  [19] "BLOWING SNOW"                  "FREEZING DRIZZLE"
##  [21] "HAIL 75"                       "LIGHT SNOW AND SLEET"
##  [23] "GLAZE"                         "FIRST SNOW"
##  [25] "WINTRY MIX"                    "WINTER WEATHER"
##  [27] "EXTREME/RECORD COLD"           "RAIN/SNOW"
```

```
##  [29] "DAMAGING FREEZE"              "SMALL HAIL"
##  [31] "FROST"                        "SEVERE COLD"
##  [33] "GLAZE ICE"                    "EARLY SNOW"
##  [35] "HAIL 80"                      "COLD AND WET CONDITIONS"
##  [37] "HEAVY SNOW/BLOWING SNOW"      "SNOW AND HEAVY SNOW"
##  [39] "GROUND BLIZZARD"              "SNOW/HEAVY SNOW"
##  [41] "ICE/SNOW"                     "HEAVY SNOW/BLIZZARD"
##  [43] "HAIL 0.75"                    "HAIL 1.00"
##  [45] "SNOW AND ICE"                 "PROLONG COLD"
##  [47] "HAIL 1.75"                    "HEAVY SNOW/SLEET"
##  [49] "AGRICULTURAL FREEZE"          "ICE FLOES"
##  [51] "SNOW SQUALLS"                 "SNOW SQUALL"
##  [53] "HEAVY LAKE SNOW"              "LAKE EFFECT SNOW"
##  [55] "HEAVY WET SNOW"               "HAIL 225"
##  [57] "BLIZZARD AND HEAVY SNOW"      "HEAVY SNOW AND ICE"
##  [59] "HEAVY SNOW ANDBLOWING SNOW"   "HEAVY SNOW/ICE"
##  [61] "HAIL 0.88"                    "DEEP HAIL"
##  [63] "ICE JAM"                      "FROST\\FREEZE"
##  [65] "HAIL 88"                      "HAIL 175"
##  [67] "HAIL 100"                     "HAIL 150"
##  [69] "HAIL 075"                     "HAIL 125"
##  [71] "HARD FREEZE"                  "HAIL 200"
##  [73] "WET SNOW"                     "LIGHT SNOW"
##  [75] "HAIL DAMAGE"                  "FOG AND COLD TEMPERATURES"
##  [77] "RECORD SNOW"                  "SNOW/COLD"
##  [79] "HEAVY SNOW SQUALLS"           "HEAVY SNOW/SQUALLS"
##  [81] "HEAVY SNOW-SQUALLS"           "ICY ROADS"
##  [83] "LACK OF SNOW"                 "SNOW/SLEET"
```

```
##  [85] "SNOW DROUGHT"                    "HAIL 088"
##  [87] "ICE AND SNOW"                    "RECORD COLD/FROST"
##  [89] "HEAVY SNOW & ICE"                "FREEZING DRIZZLE AND FREEZING"
##  [91] "HAIL/ICY ROADS"                  "SNOW SHOWERS"
##  [93] "HEAVY SNOW/BLIZZARD/AVALANCHE" "RECORD SNOW/COLD"
##  [95] "LOW TEMPERATURE"                 "HYPOTHERMIA"
##  [97] "SNOW/ BITTER COLD"               "SNOW SLEET"
##  [99] "COLD WEATHER"                    "HAIL ALOFT"
## [101] "EARLY FREEZE"                    "EARLY FROST"
## [103] "SNOW ACCUMULATION"               "SNOW/ ICE"
## [105] "SNOW/BLOWING SNOW"               "HAIL 275"
## [107] "HAIL 450"                        "NEAR RECORD SNOW"
## [109] "SLEET/SNOW"                      "SNOW AND COLD"
## [111] "PROLONG COLD/SNOW"               "SNOW\\COLD"
## [113] "WINTER MIX"                      "SNOWFALL RECORD"
## [115] "HEAVY SNOW AND"                  "LAKE-EFFECT SNOW"
## [117] "LIGHT SNOW/FLURRIES"             "ICE FOG"
## [119] "EXCESSIVE COLD"                  "EXTENDED COLD"
## [121] "FREEZING FOG"                    "DRIFTING SNOW"
## [123] "HEAVY SNOW SHOWER"               "LATE SNOW"
## [125] "RECORD MAY SNOW"                 "RECORD WINTER SNOW"
## [127] "BLACK ICE"                       "FREEZING SPRAY"
## [129] "HAIL(0.75)"                      "LIGHT SNOWFALL"
## [131] "EARLY SNOWFALL"                  "MONTHLY SNOWFALL"
## [133] "COLD TEMPERATURE"                "COLD AND SNOW"
## [135] "FROST/FREEZE"                    "COLD AND FROST"
## [137] "LATE FREEZE"                     "HYPOTHERMIA/EXPOSURE"
## [139] "SNOW AND SLEET"                  "BLIZZARD SUMMARY"
```

```
## [141] "MOUNTAIN SNOWS"                "WINTERY MIX"
## [143] "COLD TEMPERATURES"             "MODERATE SNOW"
## [145] "MODERATE SNOWFALL"             "HYPERTHERMIA/EXPOSURE"
## [147] "ICE PELLETS"                   "FIRST FROST"
## [149] "LIGHT SNOW/FREEZING PRECIP"    "RECORD  COLD"
## [151] "EXCESSIVE SNOW"                "ICE ROADS"
## [153] "NON SEVERE HAIL"               "UNUSUALLY COLD"
## [155] "WINTER WEATHER MIX"            "SNOW ADVISORY"
## [157] "UNUSUALLY LATE SNOW"           "ACCUMULATED SNOWFALL"
## [159] "FALLING SNOW/ICE"              "PATCHY ICE"
## [161] "WINTER WEATHER/MIX"            "ICE ON ROAD"
##
## [[1]][[7]]
##  [1] "LIGHTNING"          "WILD FIRES"         "LIGHTNING INJURY"
##  [4] "WILDFIRE"           "WILD/FOREST FIRE"   "GRASS FIRES"
##  [7] "LIGHTNING."         "LIGHTNING FIRE"     "FOREST FIRES"
## [10] "WILDFIRES"          "LIGHTNING DAMAGE"   "LIGHTNING  WAUSEON"
## [13] "WILD/FOREST FIRES"  "BRUSH FIRES"        "BRUSH FIRE"
## [16] " LIGHTNING"         "RED FLAG FIRE WX"
##
## [[1]][[8]]
##  [1] "AVALANCHE"          "MUDSLIDES"          "MUD SLIDE"
##  [4] "MUD SLIDES"         "AVALANCE"           "MUDSLIDE"
##  [7] "MUD/ROCK SLIDE"     "LANDSLIDE"          "LANDSLIDES"
## [10] "MUDSLIDE/LANDSLIDE" "ROCK SLIDE"
##
## [[1]][[9]]
##   [1] "DENSE FOG"                "LIGHTING"
```

```
##   [3] "WALL CLOUD"                 "RECORD HIGH TEMPERATURE"
##   [5] "RECORD HIGH"                "RECORD LOW"
##   [7] "HIGH TEMPERATURE RECORD"    "RECORD HIGH TEMPERATURES"
##   [9] "SEVERE TURBULENCE"          "APACHE COUNTY"
##  [11] "DUST DEVIL"                 "HEAVY PRECIPATATION"
##  [13] "BLOWING DUST"               "URBAN/SMALL"
##  [15] "HIGH"                       "WATER SPOUT"
##  [17] "DRY MICROBURST"             "DRY MICROBURST 61"
##  [19] "MICROBURST"                 "URBAN AND SMALL"
##  [21] "DOWNBURST"                  "GUSTNADO AND"
##  [23] "WET MICROBURST"             "DRY MICROBURST 53"
##  [25] "DRY MICROBURST 50"          "DRY MICROBURST 58"
##  [27] "DRY MICROBURST 84"          "DROUGHT"
##  [29] "NORMAL PRECIPITATION"       "DRY"
##  [31] "WAYTERSPOUT"                "URBAN AND SMALL STREAM"
##  [33] "LIGNTNING"                  "COOL AND WET"
##  [35] "SMALL STREAM AND"           "EXCESSIVE WETNESS"
##  [37] "ROTATING WALL CLOUD"        "LARGE WALL CLOUD"
##  [39] "GUSTNADO"                   "FOG"
##  [41] "COASTAL SURGE"              "RAIN"
##  [43] "URBAN/SMALL STREAM"         "TORNDAO"
##  [45] "BELOW NORMAL PRECIPITATION" "RECORD TEMPERATURES"
##  [47] "OTHER"                      "HEAVY MIX"
##  [49] "DAM FAILURE"                "SOUTHEAST"
##  [51] "HEAVY PRECIPITATION"        "WET WEATHER"
##  [53] "BEACH EROSIN"               "DRY HOT WEATHER"
##  [55] "EXCESSIVE"                  "?"
##  [57] "HOT PATTERN"                "EXCESSIVE PRECIPITATION"
```

```
##  [59] "HOT/DRY PATTERN"          "DRY PATTERN"
##  [61] "MILD/DRY PATTERN"         "MILD PATTERN"
##  [63] "HEAVY SHOWERS"            "SAHARAN DUST"
##  [65] "HEAVY SHOWER"             "URBAN SMALL"
##  [67] "SMALL STREAM"             "RECORD DRY MONTH"
##  [69] "TEMPERATURE RECORD"       "WET MONTH"
##  [71] "WET YEAR"                 "BEACH EROSION"
##  [73] "HOT AND DRY"              "RAIN DAMAGE"
##  [75] "LANDSLUMP"                "RECORD TEMPERATURE"
##  [77] "MIXED PRECIP"             "SUMMARY JAN 17"
##  [79] "SUMMARY OF MARCH 14"      "SUMMARY OF MARCH 23"
##  [81] "SUMMARY OF MARCH 24"      "SUMMARY OF APRIL 3RD"
##  [83] "SUMMARY OF APRIL 12"      "SUMMARY OF APRIL 13"
##  [85] "SUMMARY OF APRIL 21"      "SUMMARY AUGUST 11"
##  [87] "SUMMARY OF APRIL 27"      "SUMMARY OF MAY 9-10"
##  [89] "SUMMARY OF MAY 10"        "SUMMARY OF MAY 13"
##  [91] "SUMMARY OF MAY 14"        "SUMMARY OF MAY 22 AM"
##  [93] "SUMMARY OF MAY 22 PM"     "SUMMARY OF MAY 26 AM"
##  [95] "SUMMARY OF MAY 26 PM"     "SUMMARY OF MAY 31 AM"
##  [97] "SUMMARY OF MAY 31 PM"     "SUMMARY OF JUNE 3"
##  [99] "SUMMARY OF JUNE 4"        "SUMMARY JUNE 5-6"
## [101] "SUMMARY JUNE 6"           "SUMMARY OF JUNE 11"
## [103] "SUMMARY OF JUNE 12"       "SUMMARY OF JUNE 13"
## [105] "SUMMARY OF JUNE 15"       "SUMMARY OF JUNE 16"
## [107] "SUMMARY JUNE 18-19"       "SUMMARY OF JUNE 23"
## [109] "SUMMARY OF JUNE 24"       "SUMMARY OF JUNE 30"
## [111] "SUMMARY OF JULY 2"        "SUMMARY OF JULY 3"
## [113] "SUMMARY OF JULY 11"       "SUMMARY OF JULY 22"
```

```
## [115] "SUMMARY JULY 23-24"          "SUMMARY OF JULY 26"
## [117] "SUMMARY OF JULY 29"          "SUMMARY OF AUGUST 1"
## [119] "SUMMARY AUGUST 2-3"          "SUMMARY AUGUST 7"
## [121] "SUMMARY AUGUST 9"            "SUMMARY AUGUST 10"
## [123] "SUMMARY AUGUST 17"           "SUMMARY AUGUST 21"
## [125] "SUMMARY AUGUST 28"           "SUMMARY SEPTEMBER 4"
## [127] "SUMMARY SEPTEMBER 20"        "SUMMARY SEPTEMBER 23"
## [129] "SUMMARY SEPT. 25-26"         "SUMMARY: OCT. 20-21"
## [131] "SUMMARY: OCTOBER 31"         "SUMMARY: NOV. 6-7"
## [133] "SUMMARY: NOV. 16"            "WET MICOBURST"
## [135] "NO SEVERE WEATHER"           "SUMMARY OF MAY 22"
## [137] "SUMMARY OF JUNE 6"           "SUMMARY AUGUST 4"
## [139] "SUMMARY OF JUNE 10"          "SUMMARY OF JUNE 18"
## [141] "SUMMARY SEPTEMBER 3"         "SUMMARY: SEPT. 18"
## [143] "VOLCANIC ASH"                "VOLCANIC ASH PLUME"
## [145] "NONE"                        "DAM BREAK"
## [147] "RAIN (HEAVY)"                "MIXED PRECIPITATION"
## [149] "SUMMARY OF MARCH 24-25"      "SUMMARY OF MARCH 27"
## [151] "SUMMARY OF MARCH 29"         "MILD AND DRY PATTERN"
## [153] "DRY SPELL"                   "HOT SPELL"
## [155] "DRY WEATHER"                 "COASTAL EROSION"
## [157] "SEICHE"                      "PATCHY DENSE FOG"
## [159] "RECORD COOL"                 "HOT WEATHER"
## [161] "TROPICAL DEPRESSION"         "VOLCANIC ERUPTION"
## [163] "COOL SPELL"                  "EXCESSIVELY DRY"
## [165] "VOG"                         "MONTHLY PRECIPITATION"
## [167] "MONTHLY TEMPERATURE"         "RECORD DRYNESS"
## [169] "DRY CONDITIONS"              "LANDSPOUT"
```

```
## [171] "DRIEST MONTH"                "DRYNESS"
## [173] "RECORD PRECIPITATION"        "ABNORMALLY DRY"
## [175] "RED FLAG CRITERIA"           "WND"
## [177] "SMOKE"                       "EXTREMELY WET"
## [179] "VERY DRY"                    "DUST DEVEL"
## [181] "NORTHERN LIGHTS"             "ABNORMALLY WET"
## [183] "DENSE SMOKE"                 "VOLCANIC ASHFALL"
##
##
## [[2]]
## [1] "minorStorm" "majorStorm" "flood"      "heat"       "marine"
## [6] "winter"     "fire"       "slides"     "other"
```

- Add event-type categories to the records in the data set.

```
later$event = NA

for(i in 1:length(later$EVTYPE))   {
  for(j in 1:9)   {
    if(later[i,2] %in% eventLookup[[1]][[j]])   {later[i,21] = eventLookup[[2]][[j]]}
  }
}

table(later$event)
```

```
##
##       fire      flood       heat majorStorm     marine minorStorm
```

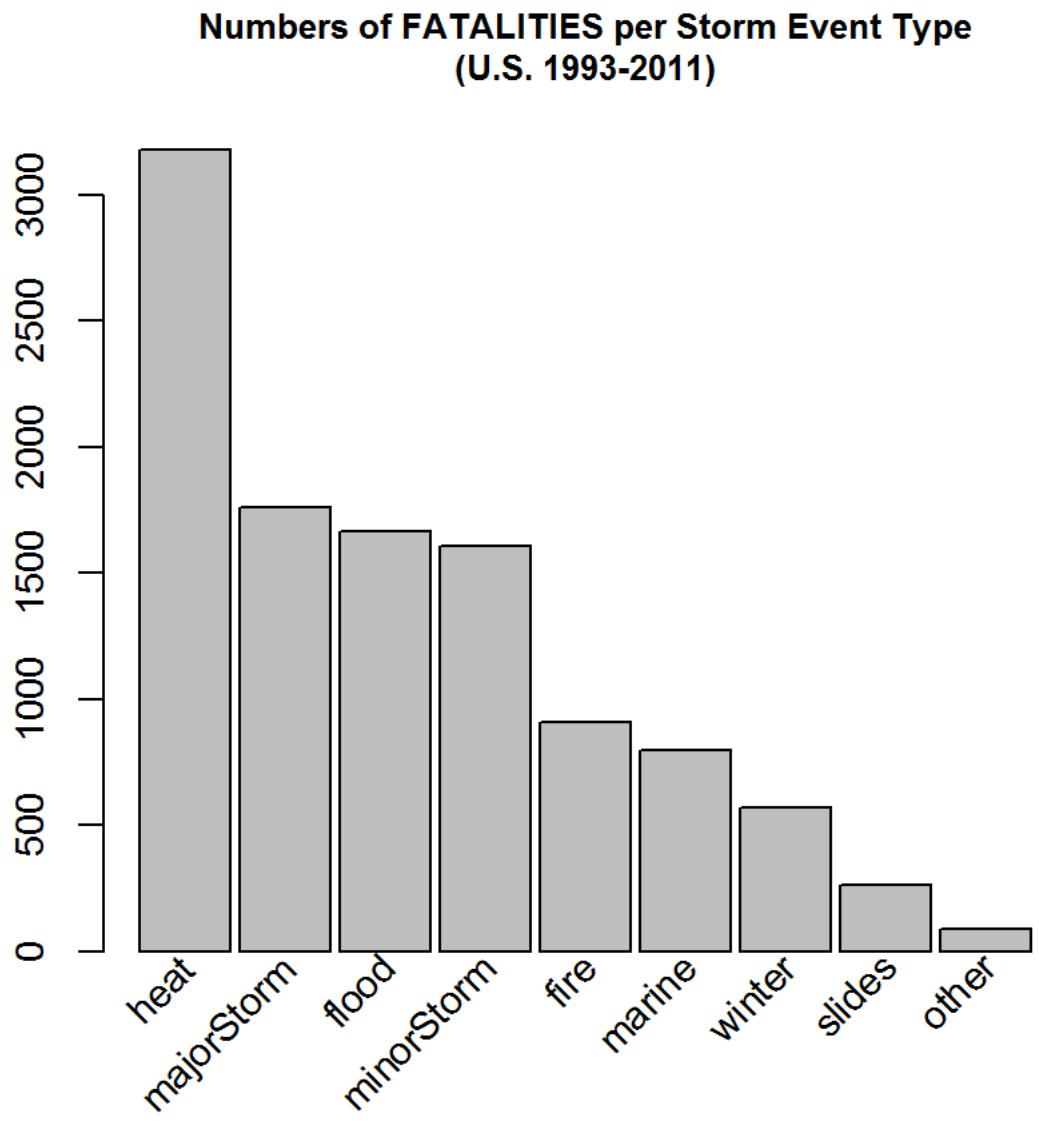
```
##      19990      98174       2964      37049       2724     288978
##      other     slides     winter
##       5123       1020     258061
```

Results

- Plot the number of fatalities by storm event-type group

```
sumF = function(x) {sum(x[,3])}
splitF = split(later, later$event)
sumFatals = sapply(splitF, sumF)
plotFatals = sort(sumFatals, decreasing = TRUE)

brplt = barplot(plotFatals, width=1, space=.1, axisnames=FALSE, cex.axis=.9, main='Numbers of FATALITIES pe
r Storm Event Type\n(U.S. 1993-2011)', cex.main=.8)
text(brplt, x=seq(.5, 9.3, by=1.1), labels = names(plotFatals), srt = 45, adj = c(1,1), xpd=TRUE, cex=.9, o
ffset=1.9)
```

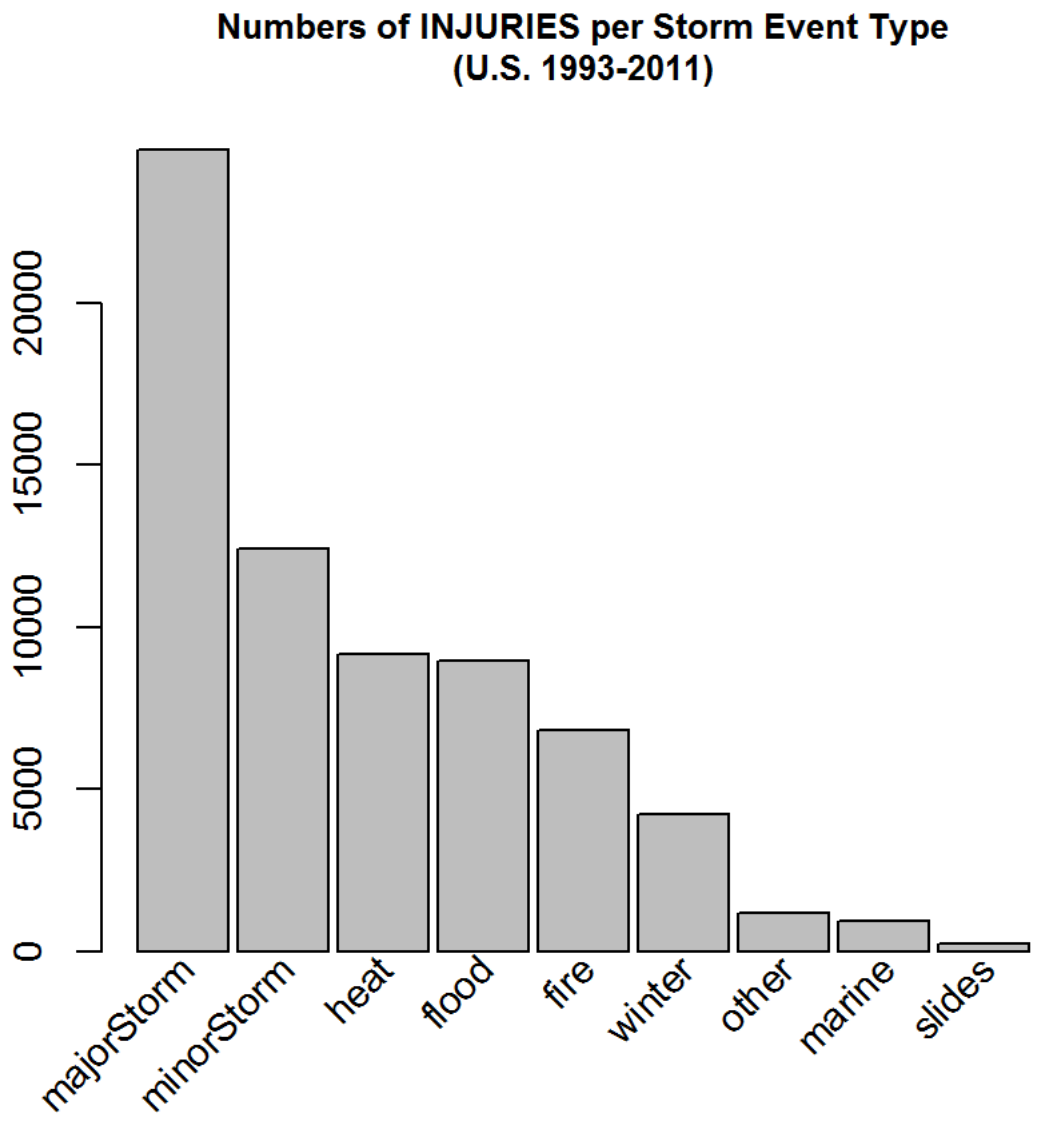


- Plot the number of injuries by storm event type group

```
sumI = function(x) {sum(x[,4])}
```

```
splitI = split(later, later$event)
sumInjuries = sapply(splitI, sumI)
plotInjuries = sort(sumInjuries, decreasing = TRUE)

brplt2 = barplot(plotInjuries, width=1, space=.1, axisnames=FALSE, cex.axis=.9, main='Numbers of INJURIES p
er Storm Event Type\n(U.S. 1993-2011)', cex.main=.8)
text(brplt2, x=seq(.5, 9.3, by=1.1), labels = names(plotInjuries), srt = 45, adj = c(1,1), xpd=TRUE, cex=.9
, offset=1.9)
```

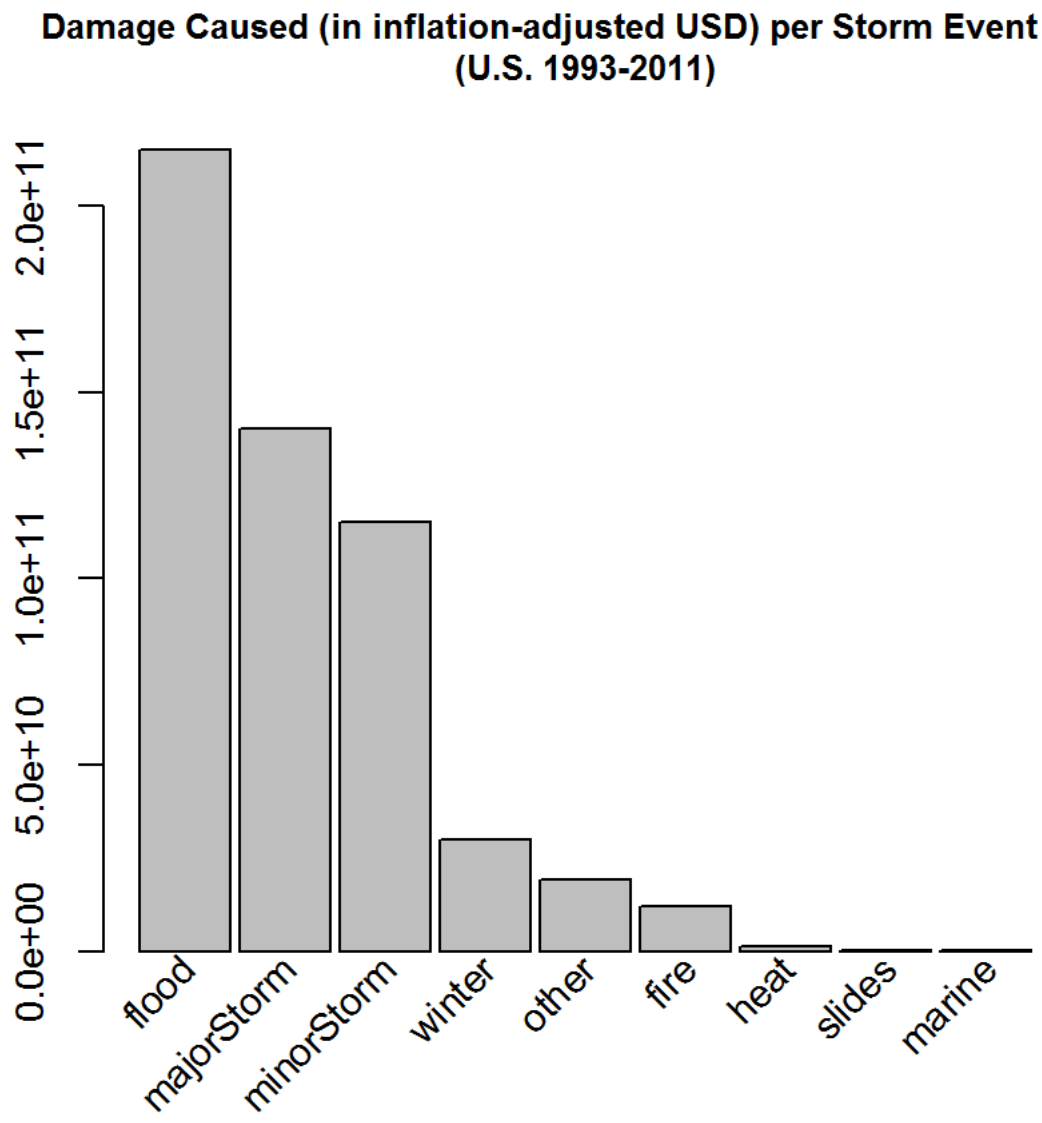


Four event types account for both more fatalities and more injuries than any other types of storm events. Resources dedicated to preserving population health should be allocated to major storm events, minor storm events, heat events, and flood events.

- Plot the amount of damage caused by storm event type groups

```
sumD = function(x) {sum(x[,20])}
splitD = split(later, later$event)
sumDamage = sapply(splitD, sumD)
plotDamage = sort(sumDamage, decreasing = TRUE)

brplt3 = barplot(plotDamage, width=1, space=.1, axisnames=FALSE, cex.axis=.9, main='Damage Caused (in infla
tion-adjusted USD) per Storm Event Type\n(U.S. 1993-2011)', cex.main=.8)
text(brplt3, x=seq(.5, 9.3, by=1.1), labels = names(plotDamage), srt = 45, adj = c(1,1), xpd=TRUE, cex=.9,
offset=1.9)
```



Damage-mitigating resources should be allocated primarily to flood events and secondarily to major and minor storm events.