

# Health and Economic Consequences of Storms: 1950 - 2011

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## Contents

### 0.0.1 Synopsis

This report explores the NOAA Storm Database and shows the types of Events that are most harmful to population health and that cause the most property and crop damage.

### 0.0.2 Data Processing

```
strUrl <- "https://d396qusza40orc.cloudfront.net/repdata%2Fdata%2FStormData.csv.bz2"
strFilename <- "stormdata.bz2"
strDataDir <- ""
```

- Download the compressed data file: <https://d396qusza40orc.cloudfront.net/repdata%2Fdata%2FStormData.csv.bz2>.

```
strPathFilename <- file.path(getwd(), strDataDir, strFilename, fsep = "/")
strPathFilename <- sub(pattern = "{2,}", replacement = "/", x = strPathFilename)
if (!file.exists(strPathFilename))
{
  download.file(url = strUrl, destfile = strPathFilename, mode = "wb")
}
```

- The compressed data file, stormdata.bz2, is very large: 46.9 Megabytes.
  - Read just the required variables into the data frame.
  - Cache the read to disk: {r, ReadDataIntoDataFrame, cache=TRUE}.

```
df <- read.csv(file = strPathFilename, stringsAsFactors = FALSE,
              colClasses = c(rep("NULL", 7), "character", rep("NULL", 14),
                           rep("numeric", 3), "character", "numeric", "character",
                           rep("NULL", 9)))
summary(df)
```

##	EVTYPE	FATALITIES	INJURIES	
##	Length:902297	Min. : 0.0000	Min. : 0.0000	
##	Class :character	1st Qu.: 0.0000	1st Qu.: 0.0000	
##	Mode :character	Median : 0.0000	Median : 0.0000	
##		Mean : 0.0168	Mean : 0.1557	
##		3rd Qu.: 0.0000	3rd Qu.: 0.0000	
##		Max. :583.0000	Max. :1700.0000	
##	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	

- Calculate a new Event Group variable (df\$EVTGROUP) to summarize the 985 Event Types.

```
df$EVTGROUP <-NA
#
df[grep("^astro|^blow-out tide|^high tides",df$EVTYPE,ignore.case = TRUE),
  "EVTGROUP"] <- "Tides"
df[grep("^aval",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Avalanche"
df[grep("^blizz",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Blizzard"
df[grep("^coastal flood",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Coastal Flood"
df[grep("wind chill",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Wind Chill"
df[grep("debris flow",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Debris Flow"
df[grep("dense fog",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Dense Fog"
df[grep("smoke",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Dense Smoke"
df[grep("drought",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Drought"
df[grep("dust devil",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Dust Devil"
df[grep("^dust storm",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Dust Storm"
df[grep("^excessive heat|record/excessive heat",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Excessive Heat"
df[grep("extreme cold",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Extreme Cold/Wind Chill"
df[grep("^flood|flooding$",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Flood"
df[grep("^flash flood",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Flash Flood"
df[grep("frost",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Forst/Freeze"
df[grep("funnel",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Funnel Cloud"
df[grep("freezing fog",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Freezing Fog"
df[grep("hail",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Hail"
df[grep("^excessive heat|^extreme heat|^record heat", df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Heat"
df[grep("^heat|excessive heat$", df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Heat"
df[grep("^heavy rain",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Heavy Rain"
df[grep("^heavy snow|snow and heavy snow|snow/heavy snow",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Heavy Snow"
df[grep("^high surf",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "High Surf"
df[grep("^high wind",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "High Wind"
df[grep("^hurricane|^typhoon",df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Hurricane Typhoon"
df[grep("^ice storm|glaze/ice storm|sleet/ice storm", df$EVTYPE, ignore.case = TRUE),
  "EVTGROUP"] <- "Ice Storm"
df[grep("snow and ice storm|snow/ice storm", df$EVTYPE, ignore.case = TRUE),
```

```

    "EVTGROUP" ] <- "Ice Storm"
df[ grep("lake-effect snow", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Lake-Effect Snow"
df[ grep("lakeshore flood", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Lakeshore Flood"
df[ grep("^lightning", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Lightning"
df[ grep("marine hail", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Marine Hail"
df[ grep("marine high wind", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Marine High Wind"
df[ grep("marine strong wind", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Marine Strong Wind"
df[ grep("marine thunderstorm wind", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Marine Thunderstorm Wind"
df[ grep("rip current", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Rip Current"
df[ grep("seiche", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Seiche"
df[ grep("sleet|^freezing drizzle|^freezing rain", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Sleet"
df[ grep("storm surge", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Storm Surge"
df[ grep("^strong wind", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Strong Wind"
df[ grep("gusty thunderstorm wind|^severe thunderstorm wind", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Thunderstorm Wind"
df[ grep("^thunderstorm wind", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Thunderstorm Wind"
df[ grep("tornado", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Tornado"
df[ grep("tropical depression", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Tropical Depression"
df[ grep("tropical storm", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Tropical Storm"
df[ grep("tsunami", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Tsunami"
df[ grep("volcanic", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Volcanic Ash"
df[ grep("^waterspout", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Waterspout"
df[ grep("wildfire", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Wildfire"
df[ grep("^winter storm", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "WinterStorm"
df[ grep("winter weather", df$EVTYPE, ignore.case = TRUE),
    "EVTGROUP" ] <- "Winter Weather"

```

- Calculate new Damage Amount variables (df\$PROPDMGAMT & df\$CROPDMGAMT) for each Event Type.

```

df$PROPDMGAMT <- NA
#
df[ grep("[0-9]", df$PROPDMGEXP, "PROPDMGAMT") <- (10^as.numeric(df[ grep("[0-9]",
    df$PROPDMGEXP, ), "PROPDMGEXP"])) * df[ grep("[0-9]", df$PROPDMGEXP, ), "PROPDMG"
df[ grep("B", df$PROPDMGEXP, ignore.case = TRUE), "PROPDMGAMT"] <- df[ grep("B",
    df$PROPDMGEXP, ignore.case = TRUE), "PROPDMG"] * 1e+09
df[ grep("M", df$PROPDMGEXP, ignore.case = TRUE), "PROPDMGAMT"] <- df[ grep("M",
    df$PROPDMGEXP, ignore.case = TRUE), "PROPDMG"] * 1e+06

```

```
df[grep("K", df$PROPDMGEXP, ignore.case = TRUE), "PROPDMGAMT"] <- df[grep("K",
  df$PROPDMGEXP, ignore.case = TRUE), "PROPDMG"] * 1000
df[grep("H", df$PROPDMGEXP, ignore.case = TRUE), "PROPDMGAMT"] <- df[grep("H",
  df$PROPDMGEXP, ignore.case = TRUE), "PROPDMG"] * 100
#
df$CROPDMGAMT <- NA
#
df[grep("[0-9]", df$CROPDMGEXP), "CROPDMGAMT"] <- (10as.numeric(df[grep("[0-9]",
  df$CROPDMGEXP, ), "CROPDMGEXP"])) * df[grep("[0-9]", df$CROPDMGEXP, ), "CROPDMG"]
df[grep("B", df$CROPDMGEXP, ignore.case = TRUE), "CROPDMGAMT"] <- df[grep("B",
  df$CROPDMGEXP, ignore.case = TRUE), "CROPDMG"] * 1e+09
df[grep("M", df$CROPDMGEXP, ignore.case = TRUE), "CROPDMGAMT"] <- df[grep("M",
  df$CROPDMGEXP, ignore.case = TRUE), "CROPDMG"] * 1e+06
df[grep("K", df$CROPDMGEXP, ignore.case = TRUE), "CROPDMGAMT"] <- df[grep("K",
  df$CROPDMGEXP, ignore.case = TRUE), "CROPDMG"] * 1000
df[grep("H", df$CROPDMGEXP, ignore.case = TRUE), "CROPDMGAMT"] <- df[grep("H",
  df$CROPDMGEXP, ignore.case = TRUE), "CROPDMG"] * 100
```

- Calculate new Total Vectors for Fatalities, Injuries, Property Damage and Crop Damage by the Event Group (df\$EVTGROUP).

```
Fatalities <-tapply(X = df$FATALITIES, INDEX = df$EVTGROUP, FUN = sum, na.rm = TRUE)
Injuries <-tapply(X = df$INJURIES, INDEX = df$EVTGROUP, FUN = sum, na.rm = TRUE)
PropDmgAmt <-tapply(X = df$PROPDMGAMT, INDEX = df$EVTGROUP, FUN = sum, na.rm = TRUE)
CropDmgAmt <-tapply(X = df$CROPDMGAMT, INDEX = df$EVTGROUP, FUN = sum, na.rm = TRUE)
```

### 0.0.3 Results

- Rank Event Groups by the number of Population Fatalities.

```
(Fatalities <-sort(x = Fatalities, decreasing = TRUE))
```

##	Tornado	Heat	Flash Flood
##	5658	3138	1018
##	Lightning	Rip Current	Flood
##	817	577	501
##	High Wind	Extreme Cold/Wind Chill	Avalanche
##	293	287	225
##	WinterStorm	Thunderstorm Wind	Hurricane Typhoon
##	217	199	135
##	Heavy Snow	Strong Wind	High Surf
##	129	111	104
##	Blizzard	Heavy Rain	Wind Chill
##	101	98	95
##	Ice Storm	Wildfire	Tropical Storm
##	89	75	66
##	Winter Weather	Tsunami	Storm Surge
##	61	33	24
##	Dust Storm	Hail	Dense Fog
##	22	20	18
##	Marine Strong Wind	Sleet Marine Thunderstorm Wind	
##	14	12	10
##	Waterspout	Coastal Flood	Dust Devil
##	6	3	2
##	Forst/Freeze	Marine High Wind	Dense Smoke
##	1	1	0

```
##           Drought           Freezing Fog           Funnel Cloud
##           0              0              0
##   Lake-Effect Snow   Lakeshore Flood           Marine Hail
##           0              0              0
##           Seiche           Tides   Tropical Depression
##           0              0              0
##   Volcanic Ash
##           0
```

- Rank the Event Groups by the number of Population Injuries.

```
(Injuries <-sort(x = Injuries, decreasing = TRUE))
```

```
##           Tornado           Heat           Flood
##           91364          9224          6808
##   Lightning   Thunderstorm Wind   Ice Storm
##           5232          2402          1992
##   Flash Flood           High Wind           Hail
##           1785          1471          1466
##   WinterStorm   Hurricane Typhoon   Heavy Snow
##           1353          1333          1034
##   Wildfire           Blizzard           Winter Weather
##           911           805           538
##   Rip Current           Dust Storm           Tropical Storm
##           529           440           383
##   Dense Fog           Strong Wind   Extreme Cold/Wind Chill
##           342           301           255
##   Heavy Rain           Avalanche           High Surf
##           255           170           156
##   Tsunami           Waterspout           Dust Devil
##           129           72           43
##   Storm Surge           Sleet Marine Thunderstorm Wind
##           43           38           26
##   Marine Strong Wind           Wind Chill           Coastal Flood
##           22           12           7
##   Drought           Forst/Freeze           Funnel Cloud
##           4           3           3
##   Marine High Wind           Dense Smoke           Freezing Fog
##           1           0           0
##   Lake-Effect Snow   Lakeshore Flood           Marine Hail
##           0           0           0
##   Seiche           Tides   Tropical Depression
##           0           0           0
##   Volcanic Ash
##           0
```

- Plot the Top 3 Event Groups by Fatalities and Injuries.

```
par(mfrow = c(2,1))
barplot(Fatalities[1:3], ylab = "Total Fatalities")
barplot(Injuries[1:3], ylab = "Total Injuries")
```

- Rank the Event Groups by the amount of Property & Crop Damage.

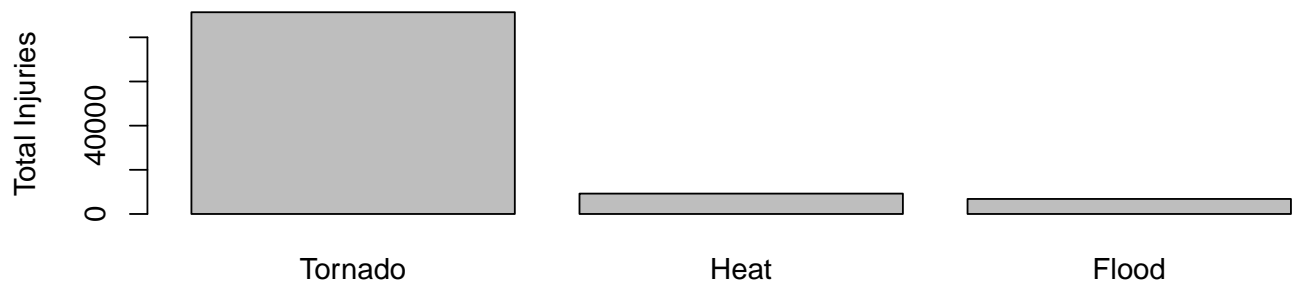
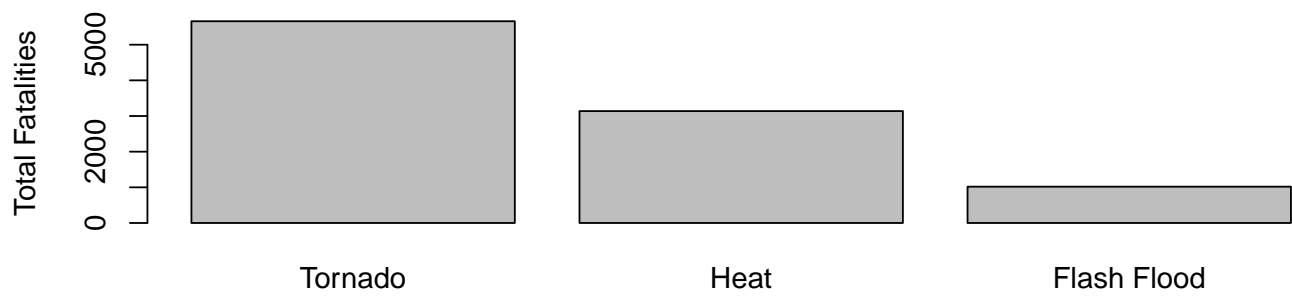


Figure 1:

```
(PropDmgAmt <-sort(x = PropDmgAmt, decreasing = TRUE))
```

##	Flood	Hurricane Typhoon	Tornado
##	145223640907	85356410010	58552151864
##	Storm Surge	Flash Flood	Hail
##	47964724000	17414680872	16021900956
##	Tropical Storm	WinterStorm	High Wind
##	7714390550	6748997251	6003352990
##	Thunderstorm Wind	Wildfire	Ice Storm
##	5431305978	4865614000	3945527860
##	Heavy Rain	Drought	Heavy Snow
##	3230998140	1046106000	953697140
##	Lightning	Blizzard	Coastal Flood
##	935452427	659713950	279600560
##	Strong Wind	Tsunami	High Surf
##	177674240	144062000	89955000
##	Extreme Cold/Wind Chill	Waterspout	Lake-Effect Snow
##	76385400	60730200	40115000
##	Winter Weather	Heat	Forst/Freeze
##	27298000	20325750	10995000
##	Sleet	Tides	Dense Fog
##	10366500	9745150	9674000
##	Lakeshore Flood	Dust Storm	Avalanche
##	7540000	5599000	3721800
##	Freezing Fog	Wind Chill	Tropical Depression
##	2182000	2040000	1737000
##	Marine High Wind	Seiche	Dust Devil
##	1297010	980000	719130
##	Volcanic Ash	Marine Thunderstorm Wind	Marine Strong Wind
##	500000	436400	418330
##	Funnel Cloud	Rip Current	Dense Smoke
##	194600	163000	100000
##	Marine Hail		
##	4000		

```
(CropDmgAmt <-sort(x = CropDmgAmt, decreasing = TRUE))
```

##	Drought	Flood	Hurricane Typhoon
##	13972566000	5912155450	5516117800
##	Ice Storm	Hail	Flash Flood
##	5022113500	3111633870	1437163150
##	Extreme Cold/Wind Chill	Forst/Freeze	Heat
##	1313023000	1202186000	904469280
##	Heavy Rain	Tropical Storm	High Wind
##	795752800	694896000	686301900
##	Thunderstorm Wind	Tornado	Wildfire
##	634694380	417461520	295972800
##	Heavy Snow	Blizzard	Strong Wind
##	134673100	112060000	69953500
##	WinterStorm	Winter Weather	Lightning
##	32444000	15000000	12092090
##	Dust Storm	Storm Surge	Wind Chill
##	3600000	855000	600000
##	Marine Thunderstorm Wind	Tsunami	Avalanche
##	50000	20000	0
##	Coastal Flood	Dense Fog	Dense Smoke
##	0	0	0

##	Dust Devil	Freezing Fog	Funnel Cloud
##	0	0	0
##	High Surf	Lake-Effect Snow	Lakeshore Flood
##	0	0	0
##	Marine Hail	Marine High Wind	Marine Strong Wind
##	0	0	0
##	Rip Current	Seiche	Sleet
##	0	0	0
##	Tides	Tropical Depression	Volcanic Ash
##	0	0	0
##	Waterspout		
##	0		

- Plot the Top 3 Event Groups by the amount of Property & Crop Damage.

```
par(mfrow = c(1,1))
barplot(PropDmgAmt[1:3]/1000000000, ylab = "Total Property Damage - $Billions")
```

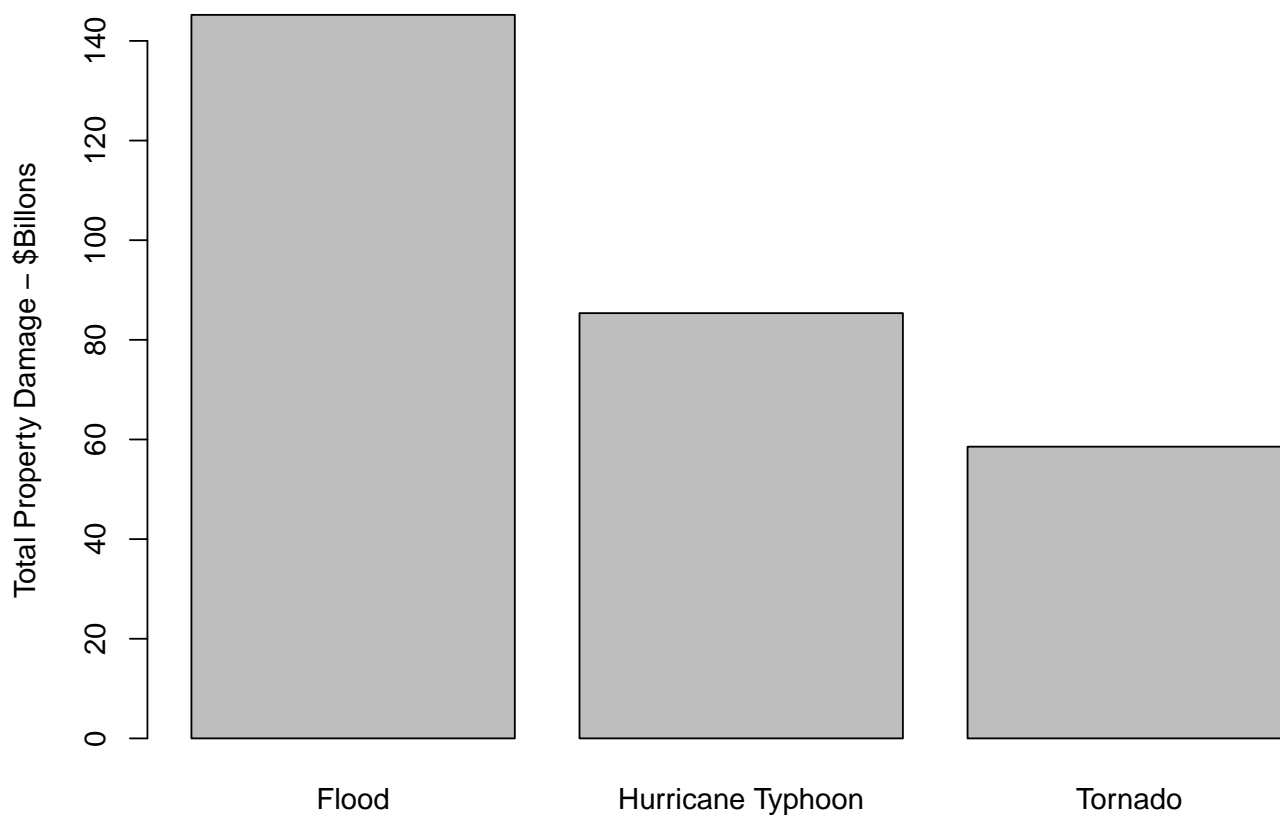


Figure 2:

```
barplot(CropDmgAmt[1:3]/1000000000, ylab = "Total Crop Damage - $Billions")
```



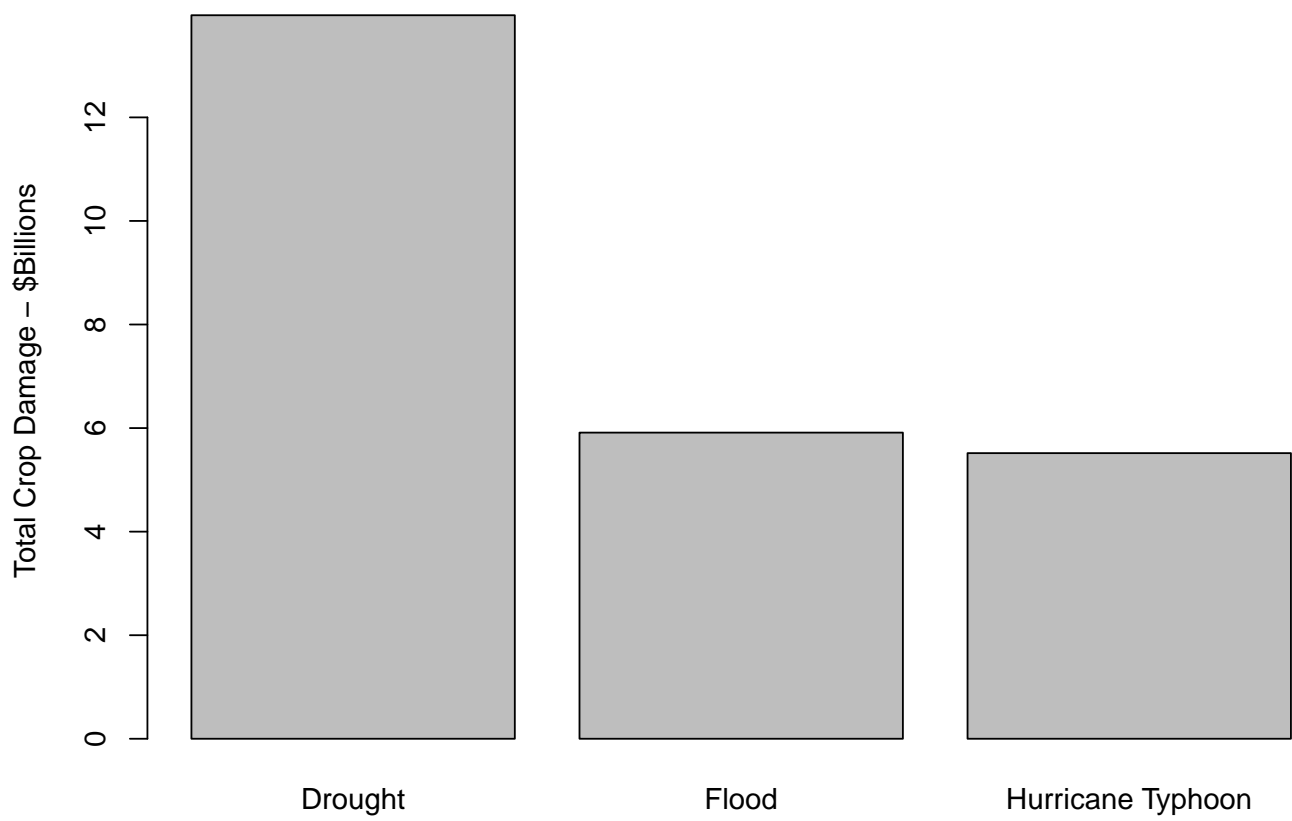


Figure 3: