

Package Demo: rainfreq

Gopi Goteti

May 22, 2014

This vignette first provides an overview of the rainfall frequency estimates from the National Weather Service (NWS)¹ followed by some examples on how to obtain and plot the data using the *rainfreq* package.

1 Overview of Rainfall/Precipitation Frequency Estimates from NWS

Rainfall frequency estimates for the USA from the NOAA National Weather Service's (NWS) division of Hydrometeorological Design Studies Center (HDSC) are often used in the the design of dams and other hydraulic structures and also in environmental planning and management. Data from NOAA NWS is available in various formats, including a user interface to extract the desired information. However, there is a lot of data and it is available in raw format as a large number of 1-km resolution GIS files.

The *rainfreq* package provides functionality to access 1-km rainfall frequency estimates in GIS format provided by the NWS' PF Data Server². The goal of the *rainfreq* package is to make the retrieval and analysis of this GIS data easier. Moreover, *rainfreq* also comes with datasets on record point rainfall measurements provided by NWS³.

2 Using *rainfreq*

After installing the package, load the package along with *RCurl* (for data extraction) and *SDMTools*, *raster* and *maps* for GIS analysis and graphics.

```
> require(rainfreq)
> require(RCurl)
> require(SDMTools)
> require(raster)
> require(maps)
```

¹Rainfall frequency estimates for the USA from the NWS Hydrometeorological Design Studies Center (HDSC) <http://hdsc.nws.noaa.gov/hdsc/pfds/index.html>

²http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_gis.html

³http://www.nws.noaa.gov/oh/hdsc/record_precip/record_precip.html

The main function provided by *rainfreq* is *extract_freq*. This could be used to extract data for any desired region. The default invocation of *extract_freq* gets the 100-year 24-hour rainfall for the Southeast USA.

```
> x_se <- extract_freq()
> print(x_se)

class      : RasterLayer
dimensions : 1480, 1796, 2658080 (nrow, ncol, ncell)
resolution : 0.008333, 0.008333 (x, y)
extent     : -94.92497, -79.9589, 24.45833, 36.79117 (xmin, xmax, ymin, ymax)
coord. ref.: NA
data source: in memory
names      : layer
values     : 6596, 16976 (min, max)
```

In order to obtain the 1000-year 48-hour rainfall for the Midwest, change *region_name*, *storm_RP* and *storm_duration* arguments accordingly.

```
> x_mw <- extract_freq(region_name = "mw", storm_RP = 1000, storm_duration = "48h")
> print(x_mw)

class      : RasterLayer
dimensions : 1934, 3239, 6264226 (nrow, ncol, ncell)
resolution : 0.008333, 0.008333 (x, y)
extent     : -109.3667, -82.37608, 33.30833, 49.42436 (xmin, xmax, ymin, ymax)
coord. ref.: NA
data source: in memory
names      : layer
values     : 2804, 19478 (min, max)
```

Similarly, in order to obtain the 10-yr 6-hour rainfall for Hawaii, change the *region_name*, *storm_RP* and *storm_duration* arguments accordingly.

```
> x_hi <- extract_freq(region_name = "hi", storm_RP = 10, storm_duration = "6h")
> print(x_hi)

class      : RasterLayer
dimensions : 800, 1310, 1048000 (nrow, ncol, ncell)
resolution : 0.004166667, 0.004166667 (x, y)
extent     : -160.2625, -154.8042, 18.90833, 22.24167 (xmin, xmax, ymin, ymax)
coord. ref.: NA
data source: in memory
names      : layer
values     : 1557, 11917 (min, max)
```

One could also obtain the record storm measurements provided by NWS using *rainfreq*.

```

> data(rain_max_usa)
> head(rain_max_usa)

  Duration Amount_in Amount_mm              Location    Lat    Lon
1    1-min     1.23      31      Unionville, Maryland 38.800 -76.133
2    5-min     2.03      52 Alamogordo Creek, New Mexico 34.661 -104.387
3   15-min     3.95     100      Galveston, Texas 29.290 -94.790
4   30-min     7.00     178      Cambridge, Ohio 40.001 -81.578
5   42-min    12.00     305      Holt, Missouri 39.450 -94.333
6    1-hr    13.80     351 Burnsville 6 WNW, West Virginia 38.883 -80.770

  Start_Date Estimate
1 1956-07-04
2 1960-06-05
3 1871-06-04
4 1914-07-16
5 1947-06-22
6 1943-08-04      Yes

> data(rain_max_world)
> head(rain_max_world)

  Duration Amount_in Amount_mm              Location    Lat    Lon
1    1-min     1.23      31 Unionville, Maryland, USA 38.80 -76.13
2    3-min     1.75      44  Haughton Grove, Jamaica 18.33 -77.98
3    5-min     2.48      63   Porto Bello, Panama  9.55 -79.65
4    8-min     4.96     126 Fussen, Bavaria, Germany 47.87  12.17
5   15-min     7.80     198   Plumb Point, Jamaica 17.93 -76.78
6   20-min     8.10     206 Curtea-de-Arges, Romania 45.12 -24.42

  Start_Date Estimate
1 1956-07-04
2 1925-09-30
3 1911-11-29
4 1920-05-25
5 1916-05-12
6 1889-07-07

```

3 Graphics

The output from *extract_freq* is designed to be consistent with the "RasterLayer" class of the *SDMTools* package. This consistency enables the use of GIS functions for analysis and graphics provided by *SDMTools* and related packages.

Before plotting the data, convert the data to appropriate units. The original units are in 1000th inches, so multiply by 0.001 to get rainfall in inches.

```

> x_se <- x_se * 0.001
> x_mw <- x_mw * 0.001
> x_hi <- x_hi * 0.001

```

Here is a plot of the three rainfall estimates obtained so far. State boundaries are added for spatial reference.

```
> # southeast
> plot(x_se, breaks = c(6, 9, 12, 15, 18),
+      col = c("red", "yellow", "green", "blue"),
+      main = "100-year 24-hour Rainfall for Southeast USA (inches)")
> map('state', region = c('florida', 'arkansas', 'louisiana', 'mississippi',
+                          'alabama', 'georgia'), add = TRUE)
> # midwest
> plot(x_mw, breaks = c(2, 5, 10, 15, 20),
+      col = c("red", "yellow", "green", "blue"),
+      main = "1000-year 48-hour Rainfall for Midwest USA (inches)")
> map('state', region = c('colorado', 'north dakota', 'south dakota', 'nebraska',
+                          'oklahoma', 'minnesota', 'iowa', 'missouri',
+                          'wisconsin', 'michigan'), add = TRUE)
> # hawaii
> plot(x_hi, breaks = c(1, 3, 6, 9, 12),
+      col = c("red", "yellow", "green", "blue"),
+      main = "10-year 6-hour Rainfall for Hawaii (inches)")
```

4 Future Work

The *extract_freq* function's regional selection criterion does not include US territories such as Puerto Rico and Guam. Future updates would incorporate these regions. Also, functionality could be added to extract the upper and lower limits of the confidence intervals on frequency estimates. Currently, data for Texas and Pacific Northwest is not available from NWS; when such data becomes available, *rainfreq* would be updated accordingly.

100-year 24-hour Rainfall for Southeast USA (inches)

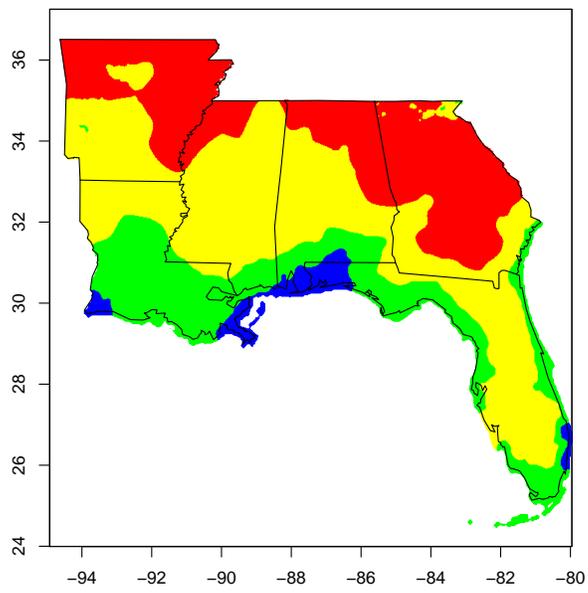


Figure 1: Rainfall amounts for selected frequency and duration periods - Southeast USA.

1000-year 48-hour Rainfall for Midwest USA (inches)

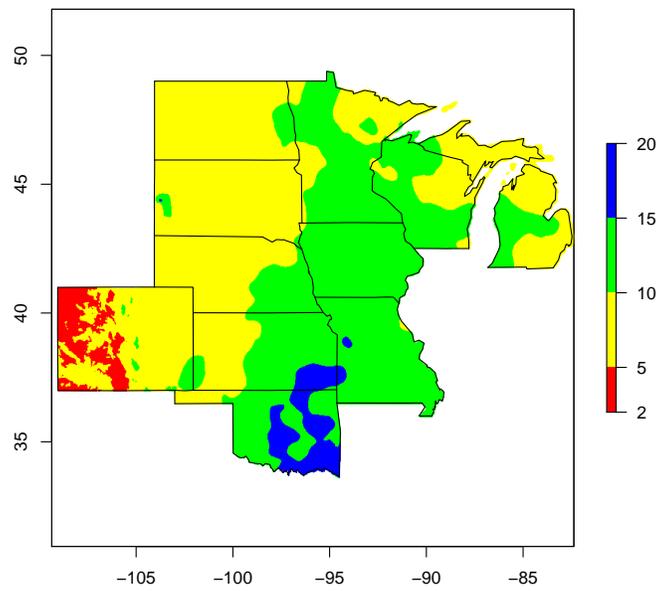


Figure 2: Rainfall amounts for selected frequency and duration periods - Midwest USA.

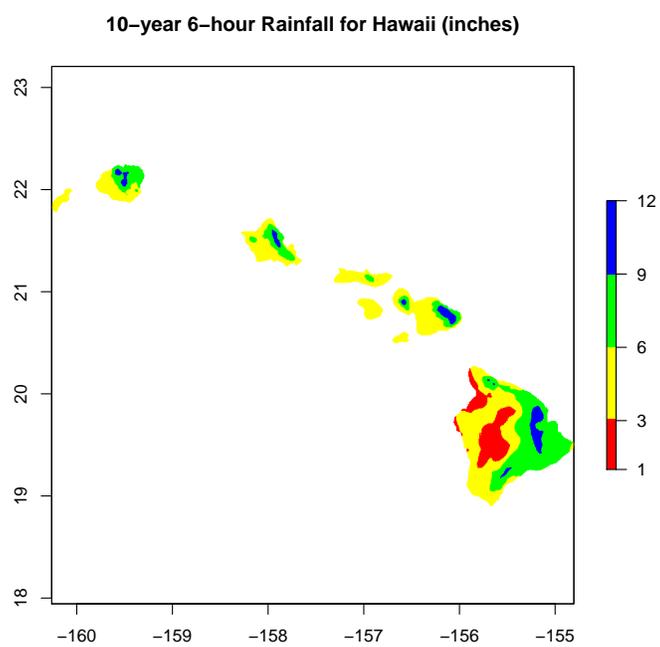


Figure 3: Rainfall amounts for selected frequency and duration periods - Hawaii.