india_monsoon

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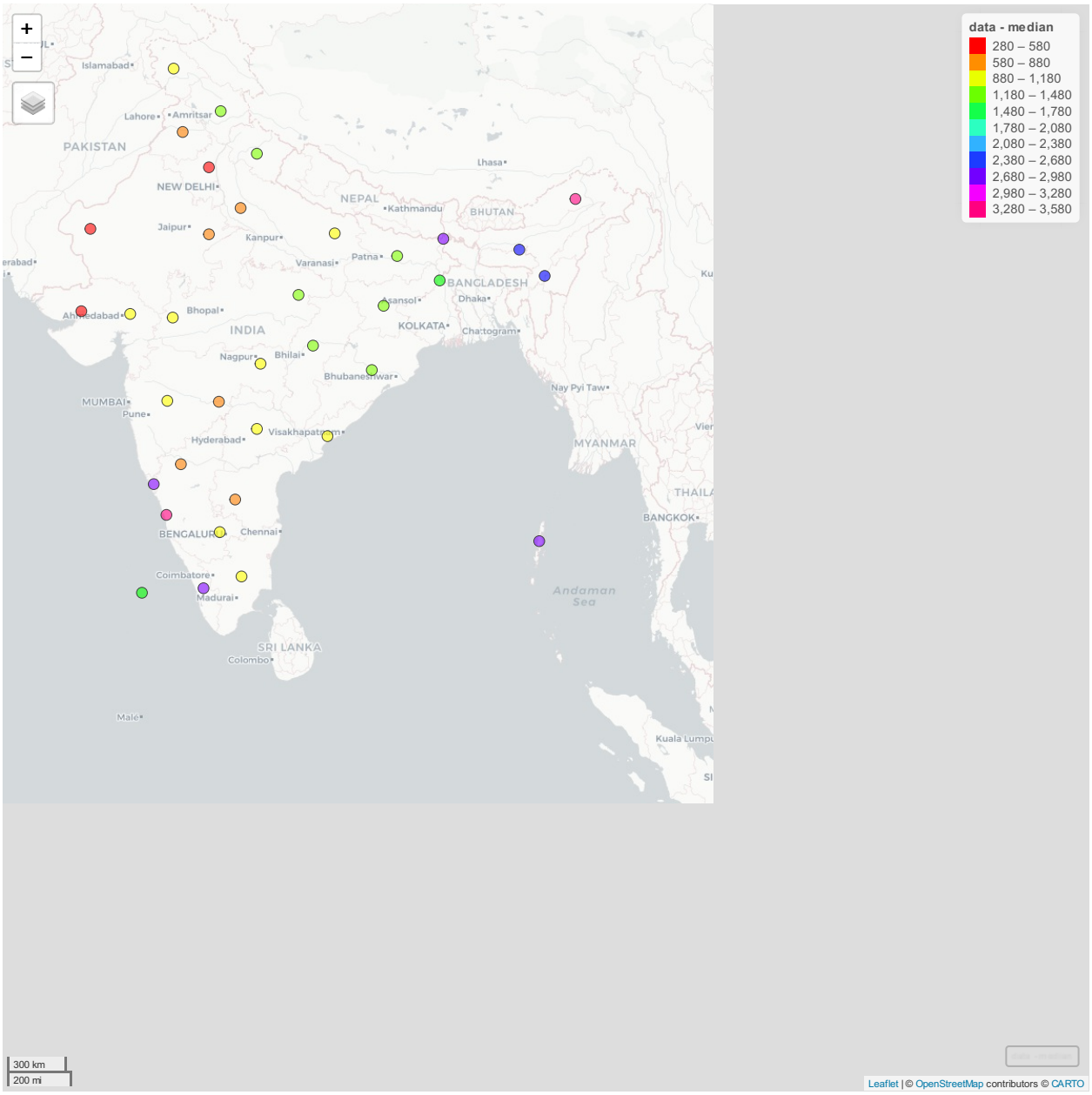
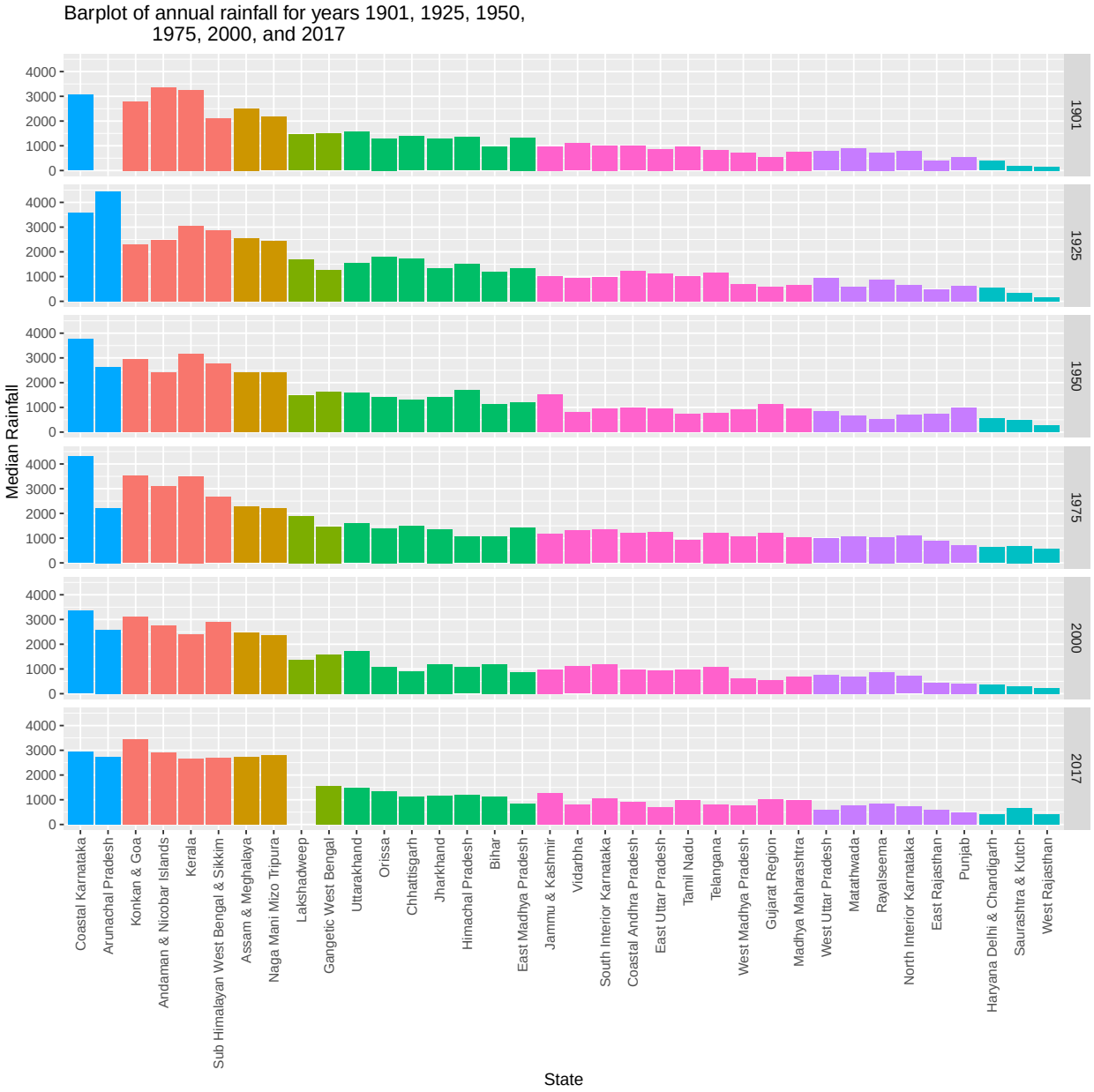
Install and load packages:

```
### Read in rainfall data (annual per Indian state from 1901-2017)
rains <- read.csv("data/india_rains.csv") %>%
         select(-Name,-Jan.Feb,-Mar.May,-June.September,-Oct.Dec)

### Compute median and variance in annual rainfall per state
meds <- rains %>%
        group_by(SUBDIVISION) %>%
        summarise_at(vars(ANNUAL), list(median=median, variance=var))
meds$stdev <- sqrt(meds$variance)
meds$stdev.norm <- meds$stdev / meds$median
meds.order <- meds$SUBDIVISION[order(meds$median, decreasing = TRUE)]
```

```
### Plot sampling locations on map, color by median annual rainfall
### At the top left, click the layers button below the zoom function.
### Select "Esri.WorldImagery" to see the satellite view.
latlong <- rains %>%
           select(SUBDIVISION, Latitude, Longitude) %>%
           distinct() %>%
           left_join(meds, by="SUBDIVISION")

minmed <- meds$median %>% min() %>% floor()
maxmed <- meds$median %>% max() %>% ceiling() + 300
breaks <- seq(from=minmed, to=maxmed, by=300)
ranges <- length(breaks)
colors <- rainbow(n = ranges)
india  <- mapview(latlong, xcol = "Longitude", ycol = "Latitude", crs = 4269,
                  grid = FALSE, zcol="median", col.regions = colors, at = breaks)
india
```




```
mapshot(india, file = "figures/india.png")
saveWidget(india@map, file="figures/india.html")
```




```
## Saving 10 x 10 in image

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## [[1]]
```
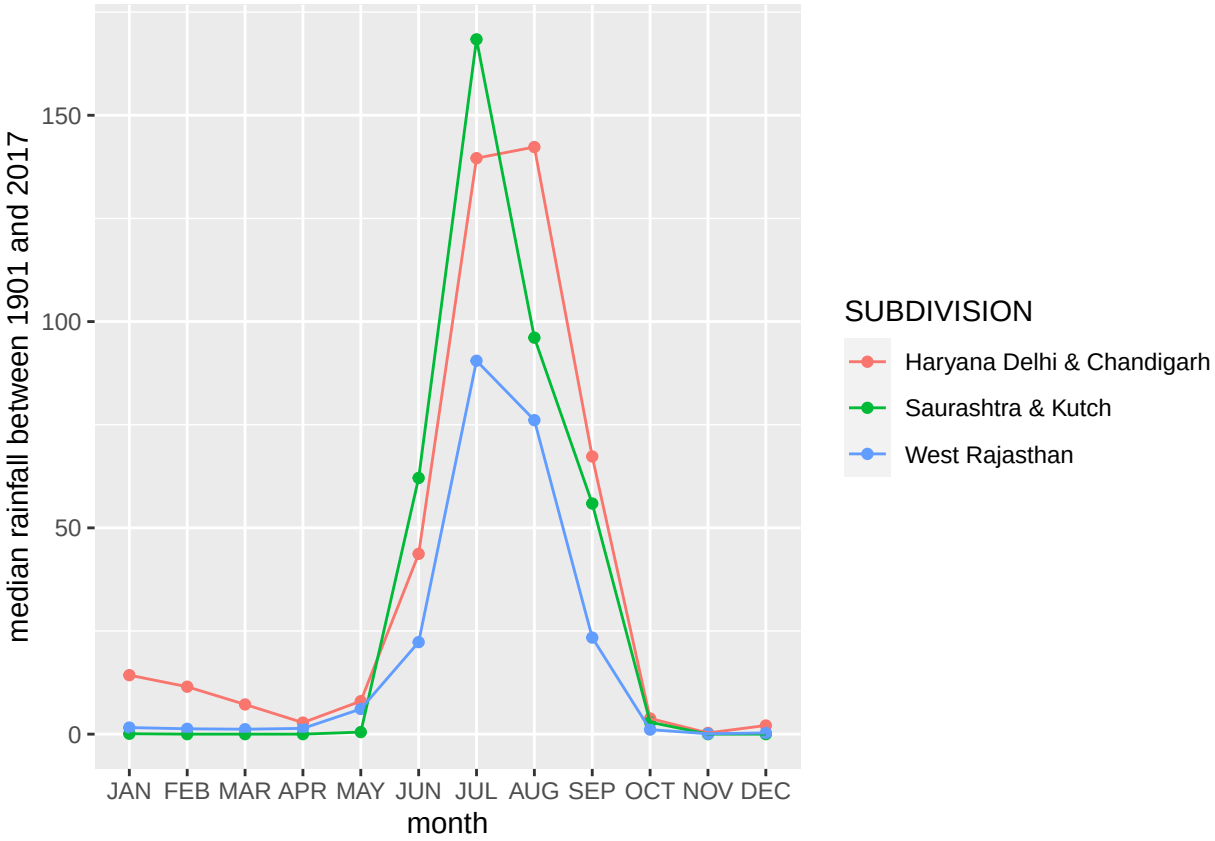
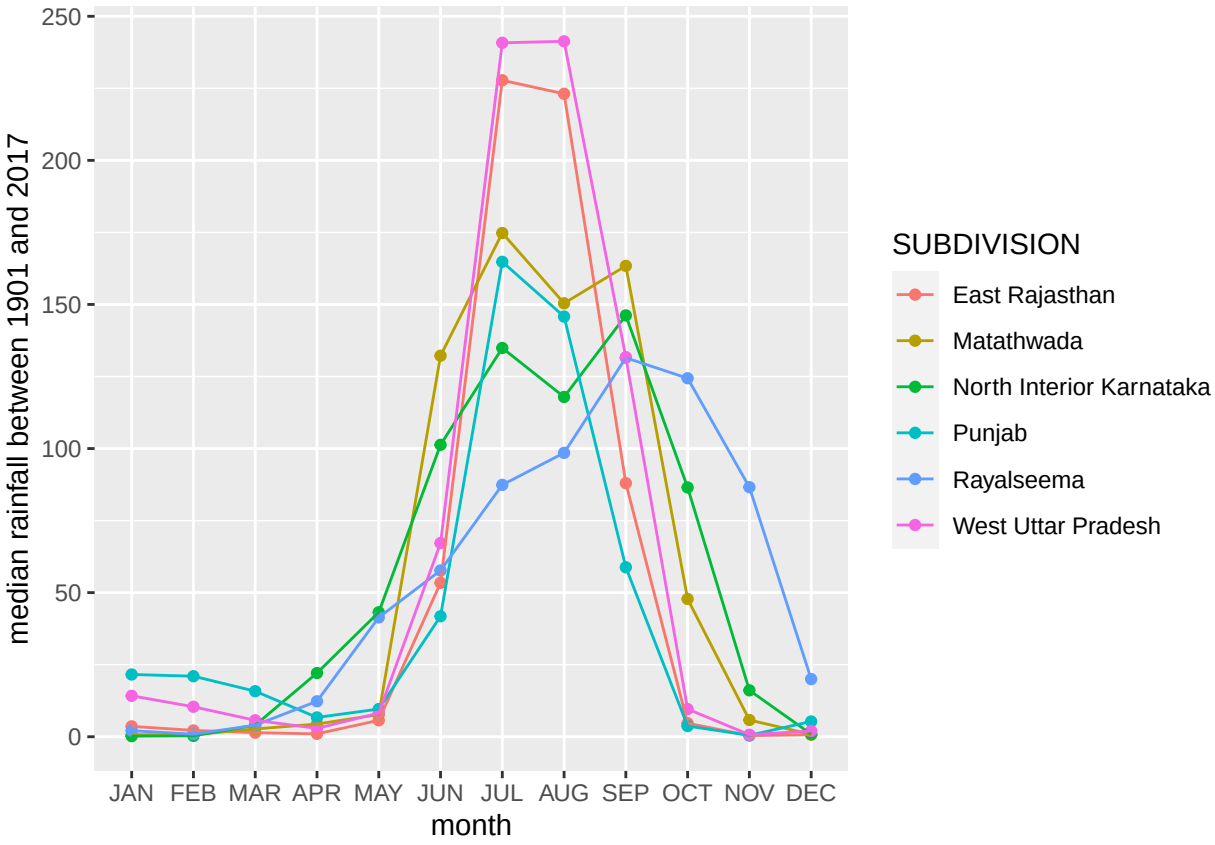
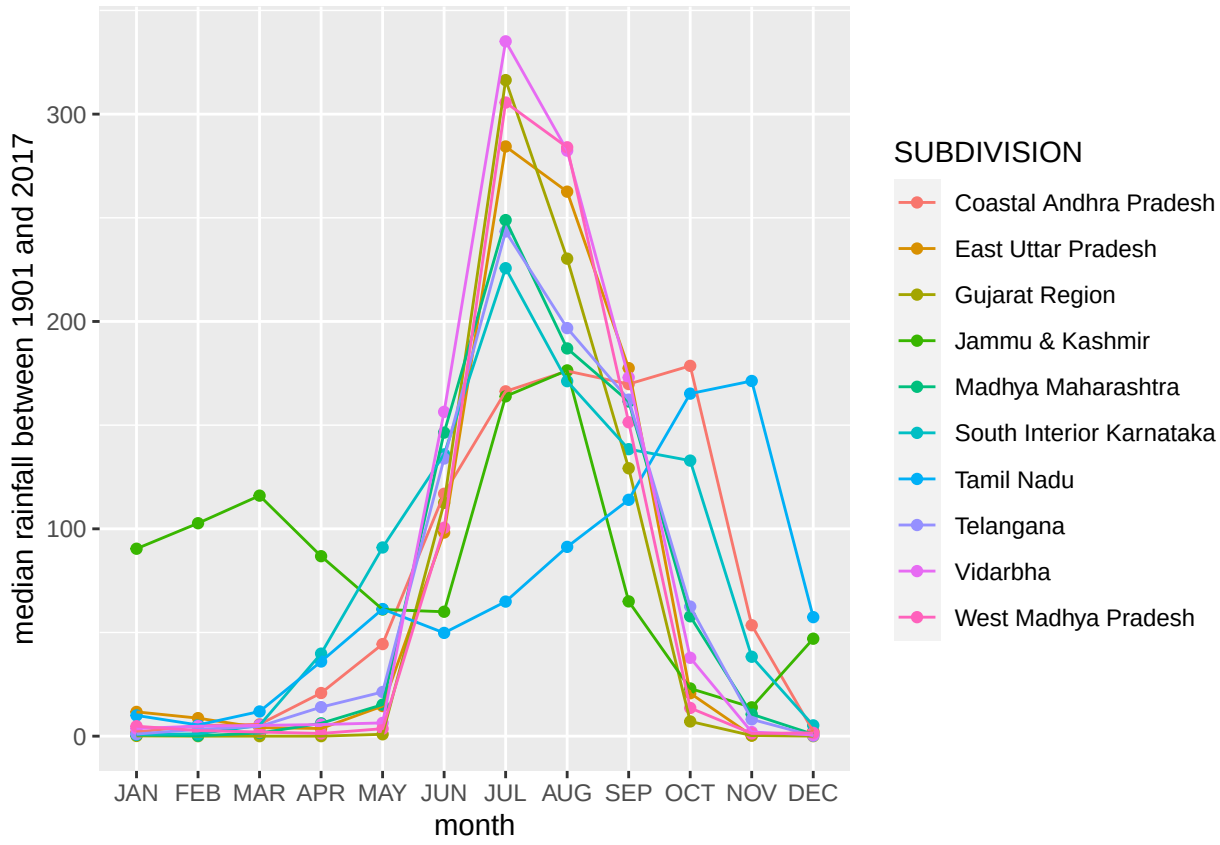


median rainfall between 1901 and 2017
150
100
50
0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
month
SUBDIVISION
Haryana Delhi & Chandigarh
Saurashtra & Kutch
West Rajasthan

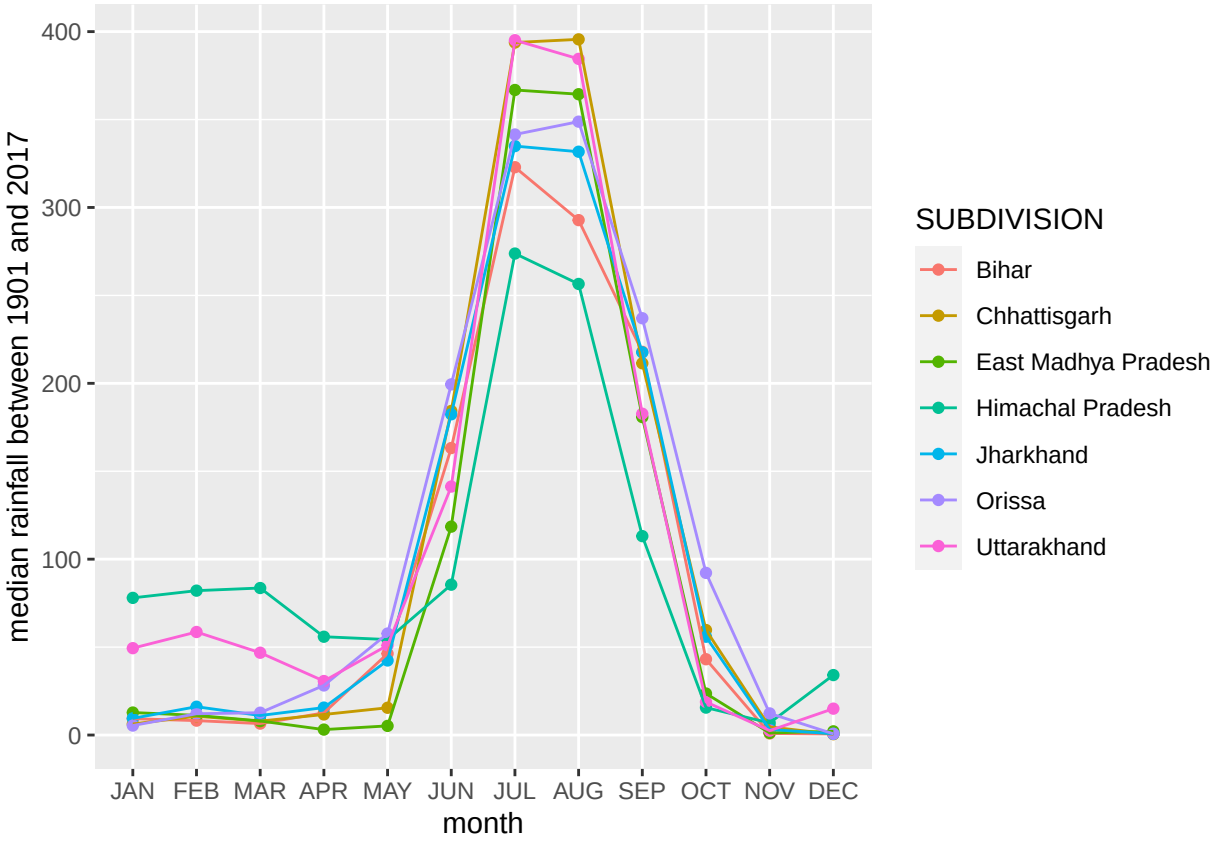
```
##
## [[2]]
```


250
200
150
100
50
0
median rainfall between 1901 and 2017
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
month
SUBDIVISION
East Rajasthan
Matathwada
North Interior Karnataka
Punjab
Rayalseema
West Uttar Pradesh

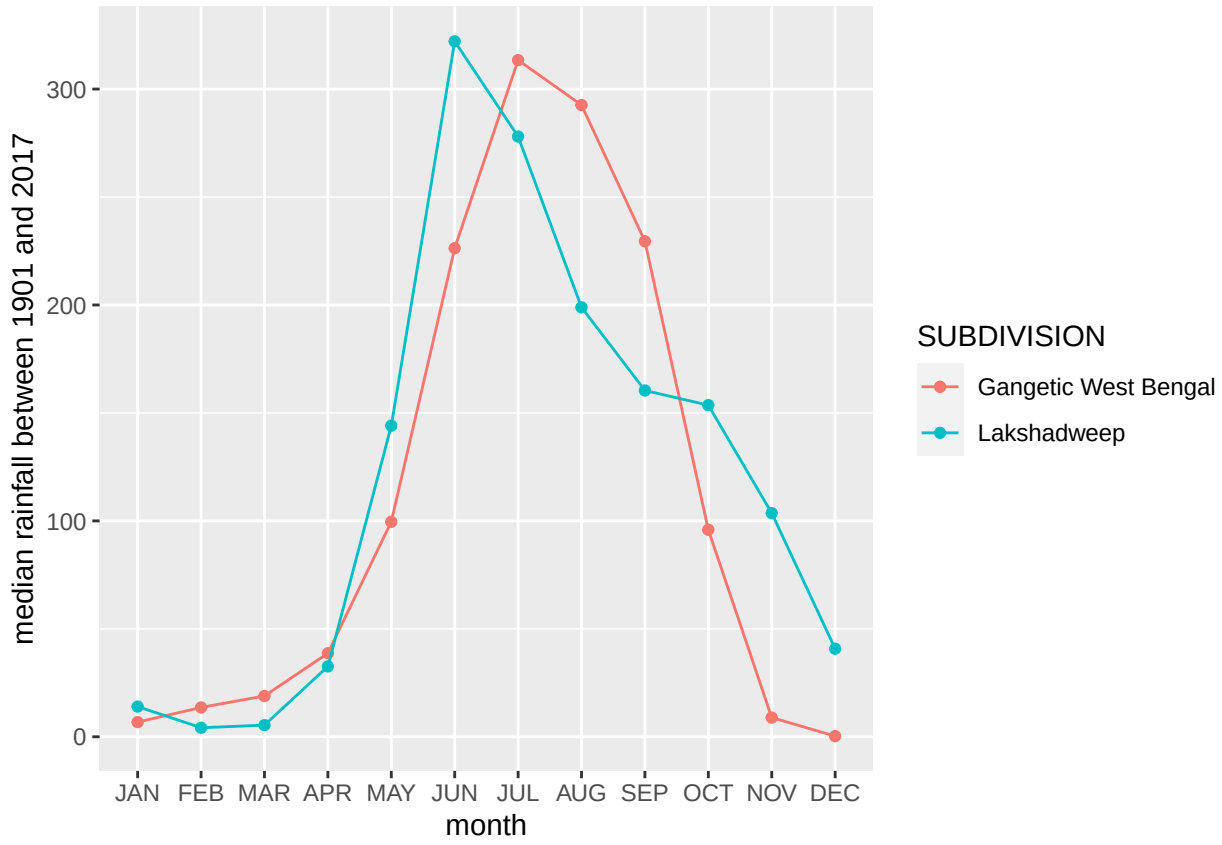
```
##
## [[3]]
```


median rainfall between 1901 and 2017
300
200
100
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
month
SUBDIVISION
Coastal Andhra Pradesh
East Uttar Pradesh
Gujarat Region
Jammu & Kashmir
Madhya Maharashtra
South Interior Karnataka
Tamil Nadu
Telangana
Vidarbha
West Madhya Pradesh

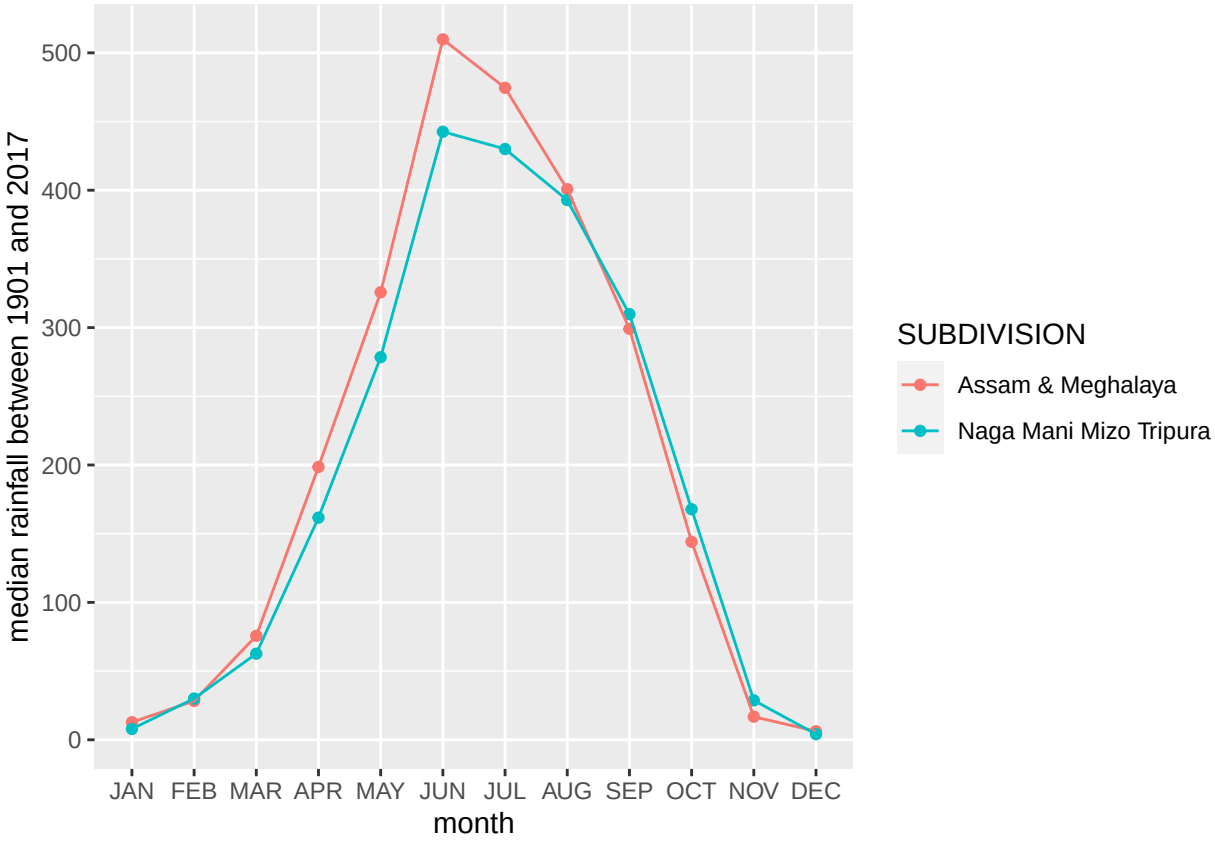
```
##
## [[4]]
```


median rainfall between 1901 and 2017
400
300
200
100
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
month
SUBDIVISION
Bihar
Chhattisgarh
East Madhya Pradesh
Himachal Pradesh
Jharkhand
Orissa
Uttarakhand

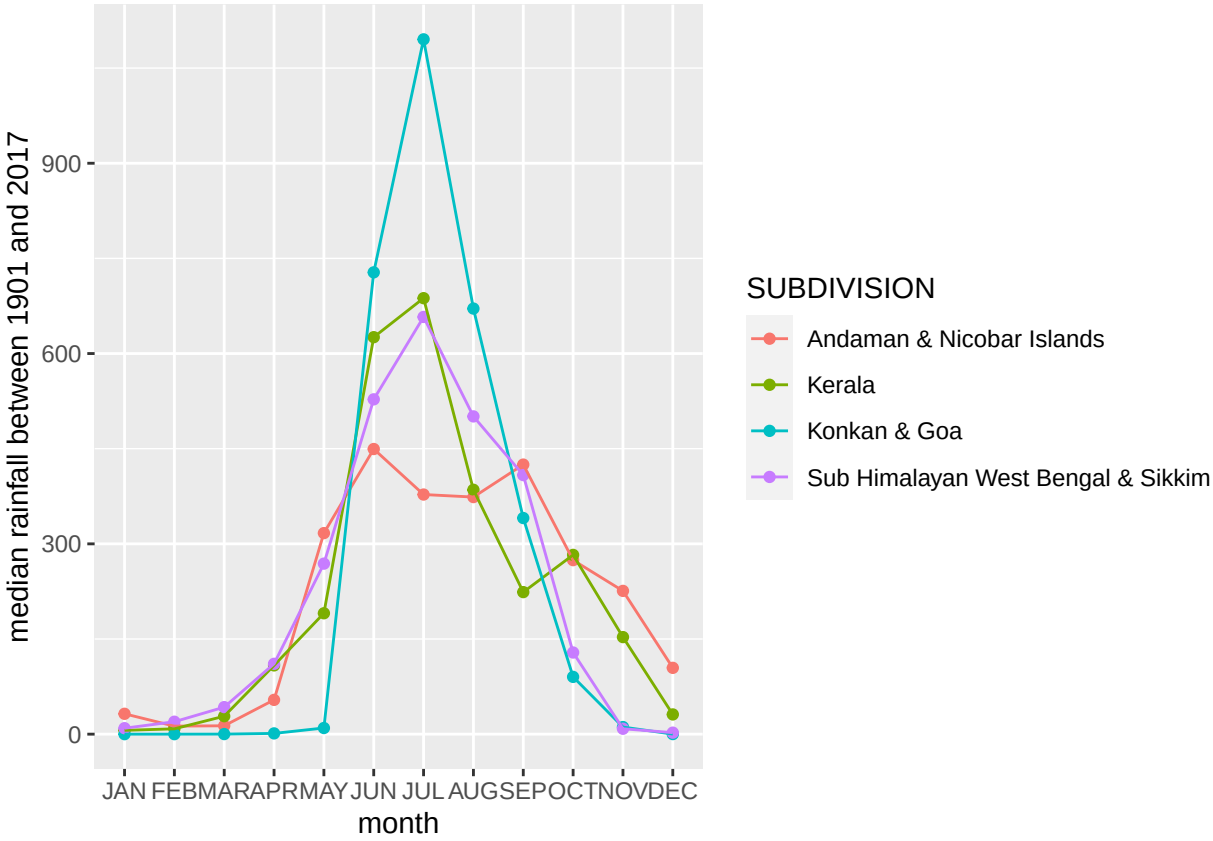
```
##
## [[5]]
```


median rainfall between 1901 and 2017
300
200
100
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
month
SUBDIVISION
Gangetic West Bengal
Lakshadweep

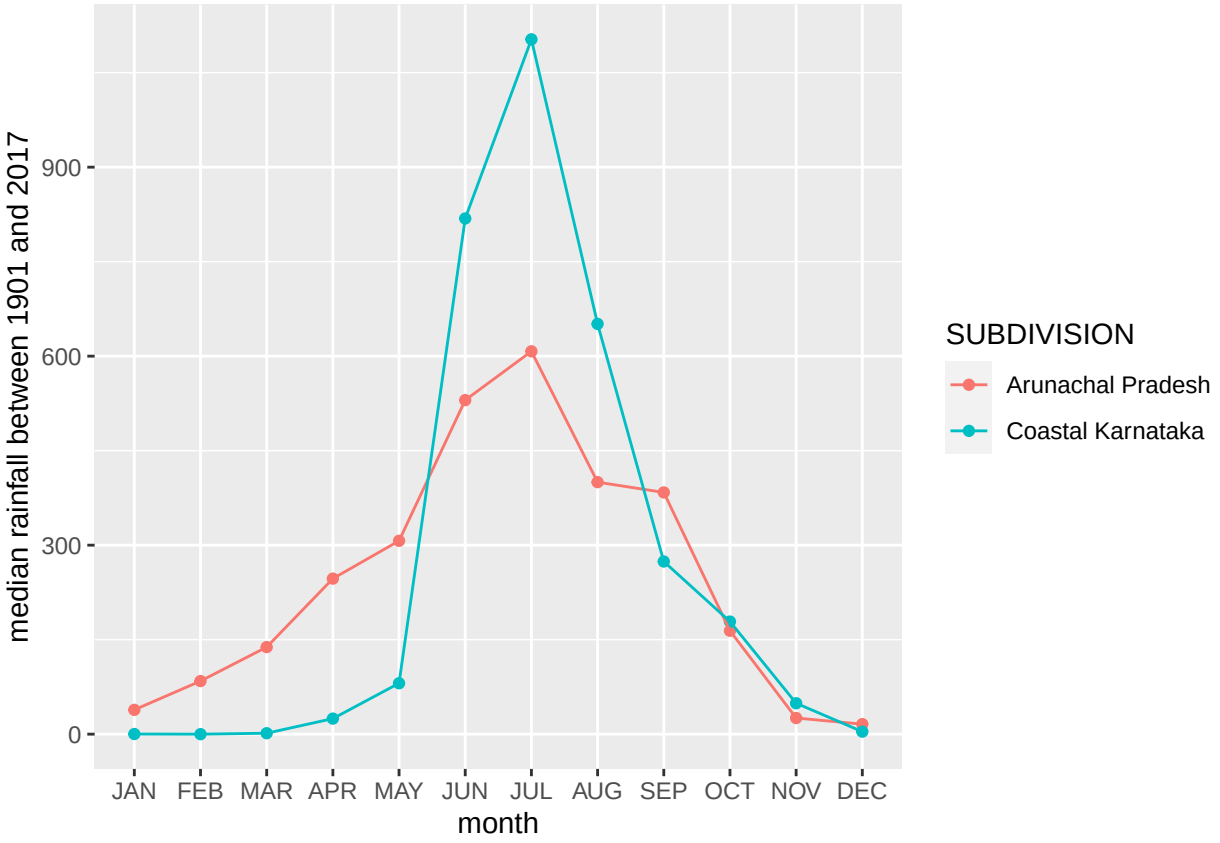
```
##
## [[6]]
```


median rainfall between 1901 and 2017
500
400
300
200
100
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
month
SUBDIVISION
Assam & Meghalaya
Naga Mani Mizo Tripura

```
##
## [[7]]
```


median rainfall between 1901 and 2017
900
600
300
0
JAN FEBMARAPRMAY JUN JUL AUGSEPOCTNOVDEC
month
SUBDIVISION
Andaman & Nicobar Islands
Kerala
Konkan & Goa
Sub Himalayan West Bengal & Sikkim

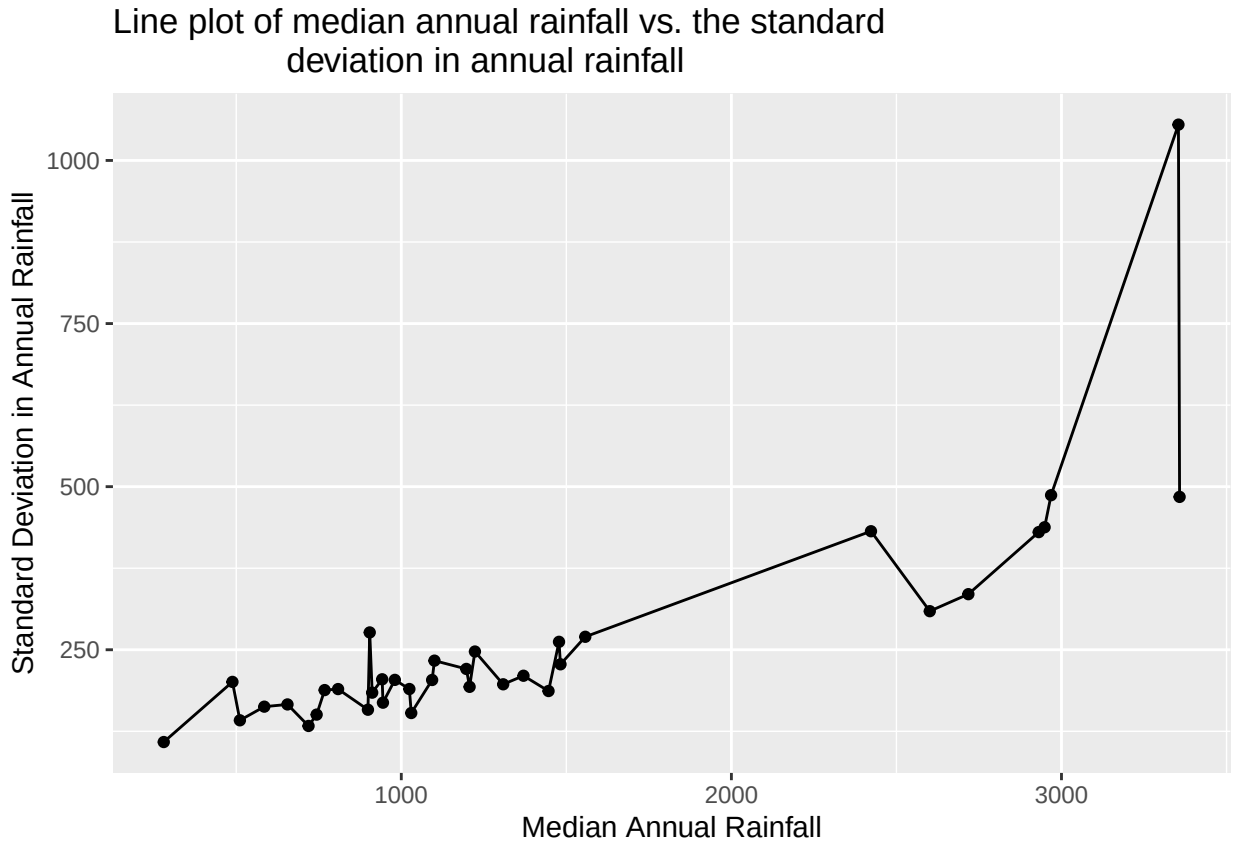
```
##
## [[8]]
```




```
### Comparison of median annual rainfall and the standard deviation in annual rainfall
# Non-normalized
nnorms <- ggplot(data=meds, aes(x=median, y=stdev)) +
                geom_line() +
                geom_point() +
                labs(x = "Median Annual Rainfall",
                     y = "Standard Deviation in Annual Rainfall",
                 title = "Line plot of median annual rainfall vs. the standard
                 deviation in annual rainfall")
ggsave("figures/lineplot_median_stdev_rainfall.png", nnorms)
```

```
## Saving 6.5 x 4.5 in image
```

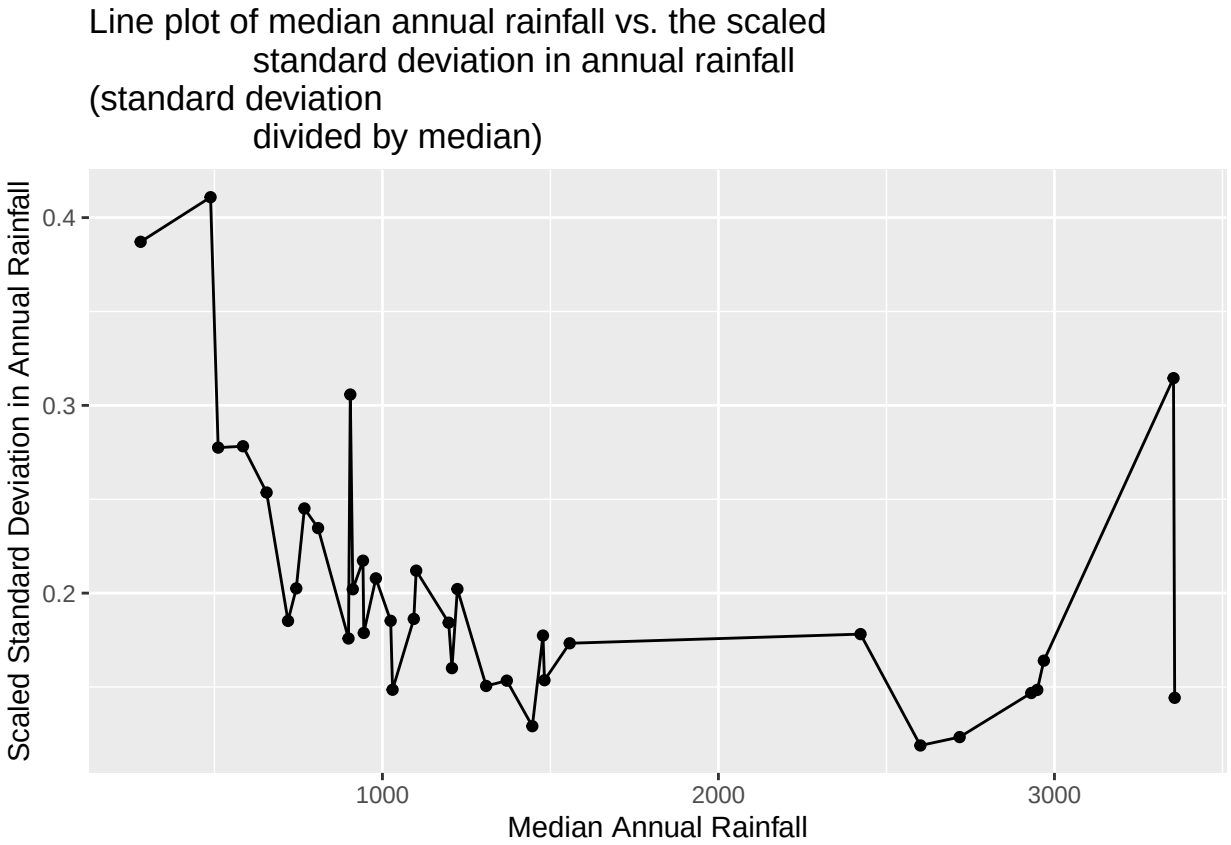
```
nnorms
```




```
# Normalized
norms <- ggplot(data=meds, aes(x=median, y=stdev.norm)) +
                geom_line() +
                geom_point() +
                labs(x = "Median Annual Rainfall",
                     y = "Scaled Standard Deviation in Annual Rainfall",
                 title = "Line plot of median annual rainfall vs. the scaled
                 standard deviation in annual rainfall\n(standard deviation
                 divided by median)")
ggsave("figures/lineplot_median_norm_stdev_rainfall.png", norms)
```

```
## Saving 6.5 x 4.5 in image
```

```
norms
```


Line plot of median annual rainfall vs. the scaled standard deviation in annual rainfall (standard deviation divided by median)
Scaled Standard Deviation in Annual Rainfall
0.4
0.3
0.2
1000
2000
3000
Median Annual Rainfall