Precipitation Data

This is code to explore and tidy precipitation data downloaded from the NOAA National Center for Environmental Information website for rain gauges in Wailupe watershed, Maunalua Bay Region

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NOTE: Figures will be hidden from knitted markdown.

Code setup

```
##Load Packages
library(tidyverse)
library(lubridate)
library(stringr)
library(tseries)

## Read in files
## These are the original datasets downloaded from NOAA NCEIS.
## Wailupe and Hawaii Kai are 15 min data sets, 77 and 08 indicate
## from which years the data encompasses.
rain_dat_77 = read.csv("NOAA_WailupeHawaiiKai_77.csv")
rain_dat_08 = read.csv("NOAA_WailupeHawaiiKai_08.csv")


##Use lubridate to clean up the dates and times
rain_dat_77$DATE <- ymd(rain_dat_77$DATE)
rain_dat_08$DATE <- ymd(rain_dat_08$DATE)
```

Data Tidying

Tidy up the data to make it a little easier to work with. This code creates a new dataframe from the orifical dataset. Here we are only looking at the Wailupe gauge. Columns were renamed and data was filtered to remove flags.

```
wailupe_tidy_77 <- rain_dat_77 %>%
  rename(station = STATION, station_name = STATION_NAME, elevation = ELEVATION,
         lat = LATITUDE, lon = LONGITUDE, date = DATE, time = TIME, qgag = QGAG,
         qgag_flag = Measurement.Flag, qgag_qual = Quality.Flag, qgag_units = Units,
         qpcp = QPCP, qpcp_flag = Measurement.Flag.1, qpcp_qual = Quality.Flag.1,
         qpcp_units = Units.1) %>% #renames columns
  filter(station_name == "WAILUPE VALLEY SCHOOL 723.6 HI US") %>% #filter to Wailupe gauge only
  filter(qpcp != "-9999",
         qpcp != "999",
         qpcp != "999.99",
```

```
          qpcp_flag != "g",
          qpcp_flag != "{",
          qpcp_flag != "}",
          qpcp_flag != "[",
          qpcp_flag != "]",
          qgag != "-9999.00",
          qgag != "-9999",
          qgag_flag != "g",
          qgag_flag != "V",
          qgag_flag != "P",
          qgag_flag != "{",
          qgag_flag != "}",
          qgag_flag != "[",
          qgag_flag != "]") ## removes all flagged data
```

Look at Wailupe Dataset in a daily format to explore total rainfall over a 24 hour periode

```
wailupe_daily_77 <- wailupe_tidy_77 %>%
  group_by(date) %>%
  summarize(
    daily_pcp = sum(qpcp),
    daily_vol = sum(qgag)) ## gives total summed precip data per day. HT is given in inches.
```

Look at the timeseries of daily Wailupe Data

```
##TS TIME

wailupe_daily_77$date <- ymd(wailupe_daily_77$date)

wailupe_ts <- wailupe_daily_77 %>%
  ts(daily_gag, start=c(1996, 1), end=c(2014, 12), frequency=12)

plot(wailupe_ts)
```

```
######################### standard ggplot

wailupe_plot_pcp <- ggplot(wailupe_daily_77, aes(date, daily_pcp)) +
  geom_line()

wailupe_plot_pcp
```

```
######################### refined ggplot

wailupe_ts_plot <- wailupe_daily_77 %>%
  ggplot(aes(x=date, y=daily_pcp)) +
  geom_col(fill = "dodgerblue4", position = "dodge") +
  labs(x= "Year", y= "Precipitation (inches)") +
  #scale_y_continuous()+
  #scale_x_date(limits= as.Date(c("1996-01-04","2013-12-24")),
  #breaks= seq("1996-01-04","2013-12-24", by= 5),expand= c(0,0))+
  theme_classic()

wailupe_ts_plot
```

Now search for 2 year, 24 hour storm events

```
##Search for 2 year, 24 hour storm events (4.78 inches plus/minus 4.12-5.57 inches
##90% confidence interval)

wailupe_investigate_1 <- wailupe_daily_77 %>%
  filter(daily_pcp > "4.12",
         daily_pcp < "5.57")

## Storms that fall in this range are on:
# 2004-01-02
# 2005-01-29
# 2010-12-19

## Look at scatter of qpcp vs qgag
scatterplot <- ggplot(wailupe_daily_77, aes(x= daily_pcp, y = daily_vol)) +
                        geom_point()

scatterplot
```

Choosing a representative storm

Awesome. The data is tidied and explored, now we need to pull out a good calibration sub-dataset to feed into our model. To do this, Natalie will filter by year, and see the percentage of data present per year (#days in data/365). Then, she will choose a representative dataset from the resulting subset.

```
######################
wailupe_05_investigate <- wailupe_tidy_77 %>%
  filter(date >"2005-1-1",
         date <"2005-12-31") %>%
  summarize(
    days_05 = length(date),
    annual_percent = (days_05/365)*100)

######################
wailupe_06_investigate <- wailupe_tidy_77 %>%
  filter(date >"2006-1-1",
         date <"2006-12-31") %>%
  summarize(
    days_06 = length(date),
    annual_percent = (days_06/365)*100)

######################
wailupe_07_investigate <- wailupe_tidy_77 %>%
  filter(date >"2007-1-1",
         date <"2007-12-31") %>%
  summarize(
    days_07 = length(date),
    annual_percent = (days_07/365)*100)

######################

wailupe_08_investigate <- wailupe_tidy_77 %>%
  filter(date >"2008-1-1",
         date <"2008-12-31") %>%
  summarize(
```

```
    days_08 = length(date),
    annual_percent = (days_08/365)*100
                )

#################

wailupe_09_investigate <- wailupe_tidy_77 %>%
  filter(date >"2009-1-1",
         date <"2009-12-31") %>%
  summarize(
    days_09 = length(date),
    annual_percent = (days_09/365)*100
  )

#################
wailupe_10_investigate <- wailupe_tidy_77 %>%
  filter(date >"2010-1-1",
         date <"2010-12-31") %>%
  summarize(
    days_10 = length(date),
    annual_percent = (days_10/365)*100
  )

#################
wailupe_11_investigate <- wailupe_tidy_77 %>%
  filter(date >"2011-1-1",
         date <"2011-12-31") %>%
  summarize(
    days_11 = length(date),
    annual_percent = (days_11/365)*100
  )
#################
wailupe_12_investigate <- wailupe_tidy_77 %>%
  filter(date >"2012-1-1",
         date <"2012-12-31") %>%
  summarize(
    days_12 = length(date),
    annual_percent = (days_12/365)*100
  )

#################
wailupe_13_investigate <- wailupe_tidy_77 %>%
  filter(date >"2013-1-1",
         date <"2013-12-31") %>%
  summarize(
    days_13 = length(date),
    annual_percent = (days_13/365)*100
  )
```

The more recent data (Since 2008) has better reporting. Now, filter years with targeted storm events. DISCHARGE DATA IS FROM 10/25/08-2019, so in order to properly calibrate the SWMM model a storm needs to be within these dates.

```r
## filter dataset from 2008-2014
wailupe_daily_08_14 <- wailupe_daily_77 %>%
  filter(date > "2008-01-01",
         date < "2014-12-31")

## look at histogram plot to investigate storm frequency over given time period
hist <- ggplot(wailupe_daily_08_14, aes(x= daily_pcp)) +
  geom_histogram()

hist
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

```r
############### 2008

wailupe_08 <- wailupe_daily_77 %>%
  filter(date >"2008-10-25",
         date <"2008-12-31")

wailupe_plot_08 <- ggplot(wailupe_08, aes(date, daily_pcp)) +
  geom_col() +
  xlab("Date") +
  ylab("Precipitation (inches)")

wailupe_plot_08
```

```r
############### 2009

wailupe_09 <- wailupe_daily_77 %>%
  filter(date >"2009-01-01",
         date <"2009-12-31")

wailupe_plot_09 <- ggplot(wailupe_09, aes(date, daily_pcp)) +
  geom_col() +
  xlab("Date") +
  ylab("Precipitation (inches)")

wailupe_plot_09
```

```r
############### 2010

wailupe_10 <- wailupe_daily_77 %>%
  filter(date >"2010-01-01",
         date <"2010-12-31")

wailupe_plot_10 <- ggplot(wailupe_10, aes(date, daily_pcp)) +
  geom_col() +
  xlab("Date") +
  ylab("Precipitation (inches)")

wailupe_plot_10
```

```r
############### 2013

wailupe_13 <- wailupe_daily_77 %>%
```

```
  filter(date >"2013-01-01",
         date <"2013-12-31")

wailupe_plot_13 <- ggplot(wailupe_13, aes(date, daily_pcp)) +
  geom_col() +
  xlab("Date") +
  ylab("Precipitation (inches)")

wailupe_plot_13
```

```
##Plot selected storm events, export as .csv for SWMM input and .jpeg for visualization)

#####

wailupe_storm_10 <- wailupe_tidy_77 %>%
  filter(date > "2010-12-18",
         date < "2010-12-20")

wailupe_storm_10$datetime10 <- as.POSIXct(paste0("2010-12-19 ", wailupe_storm_10$time),
                                          tz = "GMT")

storm_plot_10 <- wailupe_storm_10 %>%
  ggplot(aes(x=datetime10, y=qpcp)) +
  geom_col(fill = "dodgerblue4") +
  labs(x= "Time (hour)", y= "Precipitation (inches)") +
  scale_y_continuous(limits= c(0,0.5), breaks= seq(0,0.5, by= .1),expand= c(0,0))+
  scale_x_datetime(date_labels = "%H:%M", date_breaks = "2 hour")+
  theme_classic()

storm_plot_10
```

```
ggsave("storm_plot_10.pdf", width = 6, height =4)
ggsave("storm_plot_10.png", width = 6, height =4)

write.csv(wailupe_storm_10, file = "wailupe_storm_20101219_r.csv")
```

Isolate another smaller storm event with associated discharge data for model validation

```
#2009 storm @ 2.8 inches
wailupe_storm_09 <- wailupe_tidy_77 %>%
  filter(date >"2009-03-13",
         date <"2009-03-15")

wailupe_storm_09$datetime09 <- as.POSIXct(paste0("2009-03-14",wailupe_storm_09$time),
                                          tz = "GMT")

storm_plot_09 <- wailupe_storm_09 %>%
  ggplot(aes(x=datetime09, y=qpcp)) +
  geom_col(fill = "dodgerblue4") +
  labs(x= "Time (hour)", y= "Precipitation (inches)") +
  scale_y_continuous(limits= c(0,0.5), breaks= seq(0,0.5, by= .1),expand= c(0,0))+
  scale_x_datetime(date_labels = "%H:%M", date_breaks = "1 hour")+
  theme_classic()

storm_plot_09
```

```r
ggsave("storm_plot_09.pdf", width = 6, height =4)
ggsave("storm_plot_09.png", width = 6, height =4)

write.csv(wailupe_storm_09, file = "wailupe_storm_20090314_r.csv")
```