

Sub-weekly Discharge - Alteck 2016, Part I

PAZ

25 octobre 2016

Purpose

This file computes average discharge and total volume discharged per sub-week (sampled and non-sampled).

Imports:

- **Alteck2016Debit_smooth_R.csv**

Generates:

- **WeeklyHydro_R.csv**

which is a file with discharge data summarized by sub-week.

Columns in **WeeklyHydro_R.csv** include:

1. Week-SubWeek ID
2. Average Discharge
3. Volume discharged
4. Elapsed hours per subweek
5. Marker indicating whether the subweek was sampled or not.

To see the variables in this file see the end of this document.

Required R-packages:

```
# Date-time functions
library(chron)
```

Working directory

```
# setwd("D:/Documents/these_pablo/Alteckendorf2016/R")
# setwd("/Users/DayTightChunks/Documents/PhD/Routput/Alteck/R")
getwd()
```

```
## [1] "D:/Documents/these_pablo/Alteckendorf2016/HydrologicalMonitoring"
```

Import smooth (and sampler merged) discharge data

```
debitAlt = read.csv2("Data/hydroAlteck2016_R.csv", header = TRUE)
head(debitAlt)
```

```
##      DateCheck.S      Date      DateCheck Q.m3Hrs  Qna
## 1 25/03/2016 00:04 2016-03-25 00:04:00 25/03/2016 00:04    1.192 1.192
## 2 25/03/2016 00:06 2016-03-25 00:06:00 25/03/2016 00:06    1.212 1.212
## 3 25/03/2016 00:08 2016-03-25 00:08:00 25/03/2016 00:08    1.195 1.195
## 4 25/03/2016 00:10 2016-03-25 00:10:00 25/03/2016 00:10    1.219 1.219
```

```
## 5 25/03/2016 00:12 2016-03-25 00:12:00 25/03/2016 00:12 1.217 1.217
## 6 25/03/2016 00:14 2016-03-25 00:14:00 25/03/2016 00:14 1.230 1.230
## Qapprox Qinterp Q.HW1 Q.HW2 sampleQ Type
## 1 1.192 1.192 1.248600 1.182 NA Discharge
## 2 1.212 1.212 1.237280 1.15424267729696 NA Discharge
## 3 1.195 1.195 1.232224 1.17062590682503 NA Discharge
## 4 1.219 1.219 1.224779 1.15615409458726 NA Discharge
## 5 1.217 1.217 1.223623 1.17724053690379 NA Discharge
## 6 1.230 1.230 1.222299 1.17698892559366 NA Discharge
```

```
tail(debitAlt)
```

```
## DateCheck.S Date DateCheck Q.m3Hrs Qna
## 78754 12/07/2016 10:10 2016-07-12 10:10:00 12/07/2016 10:10 2.224 2.224
## 78755 12/07/2016 10:12 2016-07-12 10:12:00 12/07/2016 10:12 2.260 2.260
## 78756 12/07/2016 10:14 2016-07-12 10:14:00 12/07/2016 10:14 2.223 2.223
## 78757 12/07/2016 10:16 2016-07-12 10:16:00 12/07/2016 10:16 2.101 2.101
## 78758 12/07/2016 10:18 2016-07-12 10:18:00 12/07/2016 10:18 2.059 2.059
## 78759 12/07/2016 10:20 2016-07-12 10:20:00 12/07/2016 10:20 2.007 2.007
## Qapprox Qinterp Q.HW1 Q.HW2 sampleQ Type
## 78754 2.224 2.224 2.145201 2.09646551274142 NA Discharge
## 78755 2.260 2.260 2.160961 2.17734152373787 NA Discharge
## 78756 2.223 2.223 2.180769 2.21674008593281 NA Discharge
## 78757 2.101 2.101 2.189215 2.18552592249578 NA Discharge
## 78758 2.059 2.059 2.171572 2.07040134001013 NA Discharge
## 78759 2.007 2.007 2.149058 2.02286344936347 NA Discharge
```

Convert Date column to a readable Date-time object

```
class(debitAlt$Date)
```

```
## [1] "factor"
```

```
debitAlt$Date = as.POSIXct(strptime(debitAlt$Date, "%Y-%m-%d %H:%M", tz="EST"))
sum(is.na(debitAlt$Date))
```

```
## [1] 0
```

Choose the discharge variable to calculate sub-weekly averages

```
# Remove all unnecessary columns
debitAlt = debitAlt[,c("Date", "Q.HW1")]
head(debitAlt)
```

```
## Date Q.HW1
## 1 2016-03-25 00:04:00 1.248600
## 2 2016-03-25 00:06:00 1.237280
## 3 2016-03-25 00:08:00 1.232224
## 4 2016-03-25 00:10:00 1.224779
## 5 2016-03-25 00:12:00 1.223623
## 6 2016-03-25 00:14:00 1.222299
```

Define the sub-week sample dates

During the 2016 campaign some periods where not sampled because the automatic sampler either experienced malfunction or the capacity was reached before intervention. Interventioned took place on a weekly basis.

1. Extract subsets where sampling was conducted.
2. Extract subsets where sampling was not conducted.

```
# Define the Weekly discharge subsets
W00 <- subset(debitAlt,
              Date < as.POSIXct('2016-03-25 12:04:00' , tz="EST") ) # Not sampled

W01 <- subset(debitAlt,
              Date >= as.POSIXct('2016-03-25 12:04:00' , tz="EST") &
              Date < as.POSIXct('2016-03-28 22:37:00' , tz="EST"))

W02 <- subset(debitAlt,
              Date >= as.POSIXct('2016-03-28 22:37:00' , tz="EST") &
              Date <= as.POSIXct('2016-03-30 12:17:00' , tz="EST")) # Not sampled

W11 <- subset(debitAlt,
              Date >= as.POSIXct('2016-03-30 12:17:00' , tz="EST") &
              Date <= as.POSIXct('2016-03-31 15:35:00' , tz="EST"))
W12 <- subset(debitAlt,
              Date >= as.POSIXct('2016-03-31 15:35:00' , tz="EST") &
              Date <= as.POSIXct('2016-04-01 14:45:00' , tz="EST"))

# W13
W13 <- subset(debitAlt,
              Date >= as.POSIXct('2016-04-01 14:45:00' , tz="EST") &
              Date <= as.POSIXct('2016-04-05 15:07:00' , tz="EST")) # Not sampled

W21 <- subset(debitAlt,
              Date >= as.POSIXct('2016-04-05 15:07:00' , tz="EST") &
              Date <= as.POSIXct('2016-04-06 14:51:00' , tz="EST"))
W22 <- subset(debitAlt,
              Date >= as.POSIXct('2016-04-06 14:51:00' , tz="EST") &
              Date < as.POSIXct('2016-04-08 00:38:00' , tz="EST"))

# W23 not sampled
W23 <- subset(debitAlt,
              Date >= as.POSIXct('2016-04-08 00:38:00' , tz="EST") &
              Date < as.POSIXct('2016-04-14 13:51:00' , tz="EST"))

W31 <- subset(debitAlt,
              Date >= as.POSIXct('2016-04-14 13:51:00' , tz="EST") &
              Date < as.POSIXct('2016-04-16 18:32:00' , tz="EST"))

W32 <- subset(debitAlt,
              Date >= as.POSIXct('2016-04-16 18:32:00' , tz="EST") &
              Date < as.POSIXct('2016-04-17 09:02:00' , tz="EST"))

###
W32.1 <- subset(debitAlt,
                Date >= as.POSIXct('2016-04-17 09:02:00' , tz="EST") &
                Date < as.POSIXct('2016-04-18 20:30:00' , tz="EST")) # Not sampled
```

```

W33 <- subset(debitAlt,
  Date >= as.POSIXct('2016-04-18 20:30:00' , tz="EST") &
  Date < as.POSIXct('2016-04-21 09:11:00' , tz="EST"))

W41 <- subset(debitAlt,
  Date >= as.POSIXct('2016-04-21 09:11:00' , tz="EST") &
  Date < as.POSIXct('2016-04-23 06:37:00' , tz="EST"))

W42 <- subset(debitAlt,
  Date >= as.POSIXct('2016-04-23 06:37:00' , tz="EST") &
  Date < as.POSIXct('2016-04-26 11:50:00' , tz="EST")) # Not sampled

W51 <- subset(debitAlt,
  Date >= as.POSIXct('2016-04-26 11:50:00' , tz="EST") &
  Date < as.POSIXct('2016-05-01 10:46:00' , tz="EST"))

W52 <- subset(debitAlt,
  Date >= as.POSIXct('2016-05-01 10:46:00' , tz="EST") &
  Date < as.POSIXct('2016-05-03 12:02:00' , tz="EST"))

##
W53 <- subset(debitAlt,
  Date >= as.POSIXct('2016-05-03 12:02:00' , tz="EST") &
  Date < as.POSIXct('2016-05-03 13:09:00' , tz="EST")) # Not sampled

W61 <- subset(debitAlt,
  Date >= as.POSIXct('2016-05-03 13:09:00' , tz="EST") &
  Date < as.POSIXct('2016-05-10 00:05:00' , tz="EST"))

W62 <- subset(debitAlt,
  Date >= as.POSIXct('2016-05-10 00:05:00' , tz="EST") &
  Date < as.POSIXct('2016-05-12 06:33:00' , tz="EST"))
W63 <- subset(debitAlt,
  Date >= as.POSIXct('2016-05-12 06:33:00' , tz="EST") &
  Date < as.POSIXct('2016-05-12 09:12:00' , tz="EST"))
W64 <- subset(debitAlt,
  Date >= as.POSIXct('2016-05-12 09:12:00' , tz="EST") &
  Date < as.POSIXct('2016-05-12 12:52:00' , tz="EST"))

##
W65 <- subset(debitAlt,
  Date >= as.POSIXct('2016-05-12 12:52:00' , tz="EST") &
  Date < as.POSIXct('2016-05-13 12:05:00' , tz="EST")) # Not sampled

W71 <- subset(debitAlt,
  Date >= as.POSIXct('2016-05-13 12:05:00' , tz="EST") &
  Date < as.POSIXct('2016-05-16 15:11:00' , tz="EST"))

##
W72 <- subset(debitAlt,
  Date >= as.POSIXct('2016-05-16 15:11:00' , tz="EST") &
  Date <= as.POSIXct('2016-05-17 09:16:00' , tz="EST")) # Not sampled

W81 <- subset(debitAlt,

```

```

        Date >= as.POSIXct('2016-05-17 09:16:00' , tz="EST") &
        Date <= as.POSIXct('2016-05-23 18:02:00' , tz="EST"))
##
W82 <- subset(debitAlt,
        Date >= as.POSIXct('2016-05-23 18:02:00' , tz="EST") &
        Date <= as.POSIXct('2016-05-24 12:00:00' , tz="EST")) # Not sampled

W91 <- subset(debitAlt,
        Date >= as.POSIXct('2016-05-24 12:00:00' , tz="EST") &
        Date <= as.POSIXct('2016-05-29 12:09:00' , tz="EST"))
W92 <- subset(debitAlt,
        Date >= as.POSIXct('2016-05-29 12:09:00' , tz="EST") &
        Date < as.POSIXct('2016-05-30 05:48:00' , tz="EST"))
W93 <- subset(debitAlt,
        Date >= as.POSIXct('2016-05-30 05:48:00' , tz="EST") &
        Date < as.POSIXct('2016-05-30 12:11:00' , tz="EST"))
W94 <- subset(debitAlt,
        Date >= as.POSIXct('2016-05-30 12:11:00' , tz="EST") &
        Date < as.POSIXct('2016-05-30 17:28:00' , tz="EST"))
##
W95 <- subset(debitAlt,
        Date >= as.POSIXct('2016-05-30 17:28:00' , tz="EST") &
        Date < as.POSIXct('2016-05-31 12:00:00' , tz="EST")) # Not sampled

W101 <- subset(debitAlt,
        Date >= as.POSIXct('2016-05-31 12:00:00' , tz="EST") &
        Date < as.POSIXct('2016-06-02 12:57:00' , tz="EST"))
W102 <- subset(debitAlt,
        Date >= as.POSIXct('2016-06-02 12:57:00' , tz="EST") &
        Date < as.POSIXct('2016-06-03 12:05:00' , tz="EST"))
W103 <- subset(debitAlt,
        Date >= as.POSIXct('2016-06-03 12:05:00' , tz="EST") &
        Date < as.POSIXct('2016-06-04 08:35:00' , tz="EST"))
W104 <- subset(debitAlt,
        Date >= as.POSIXct('2016-06-04 08:35:00' , tz="EST") &
        Date < as.POSIXct('2016-06-04 11:00:00' , tz="EST"))
W105 <- subset(debitAlt,
        Date >= as.POSIXct('2016-06-04 11:00:00' , tz="EST") &
        Date < as.POSIXct('2016-06-04 15:31:00' , tz="EST"))
#
W106 <- subset(debitAlt,
        Date >= as.POSIXct('2016-06-04 15:31:00' , tz="EST") &
        Date <= as.POSIXct('2016-06-07 12:00:00' , tz="EST")) # Not sampled

W111 <- subset(debitAlt,
        Date >= as.POSIXct('2016-06-07 12:00:00' , tz="EST") &
        Date <= as.POSIXct('2016-06-10 05:25:00' , tz="EST"))
W112 <- subset(debitAlt,
        Date > as.POSIXct('2016-06-10 05:25:00' , tz="EST") &
        Date < as.POSIXct('2016-06-14 12:34:00' , tz="EST"))
W113 <- subset(debitAlt,
        Date >= as.POSIXct('2016-06-14 12:34:00' , tz="EST") &
        Date < as.POSIXct('2016-06-14 13:06:00' , tz="EST"))

```

```

W121 <- subset(debitAlt,
  Date > as.POSIXct('2016-06-14 13:06:00' , tz="EST") &
  Date < as.POSIXct('2016-06-15 08:14:00' , tz="EST"))
W122 <- subset(debitAlt,
  Date > as.POSIXct('2016-06-15 08:14:00' , tz="EST") &
  Date < as.POSIXct('2016-06-16 08:21:00' , tz="EST"))
W123 <- subset(debitAlt,
  Date > as.POSIXct('2016-06-16 08:21:00' , tz="EST") &
  Date < as.POSIXct('2016-06-17 00:49:00' , tz="EST"))

W124 <- subset(debitAlt,
  Date > as.POSIXct('2016-06-17 00:49:00' , tz="EST") &
  Date <= as.POSIXct('2016-06-17 11:05:00' , tz="EST"))
#
W125 <- subset(debitAlt,
  Date > as.POSIXct('2016-06-17 00:49:00' , tz="EST") &
  Date < as.POSIXct('2016-06-21 12:00:00' , tz="EST")) # Not sampled

W131 <- subset(debitAlt,
  Date >= as.POSIXct('2016-06-21 12:00:00' , tz="EST") &
  Date < as.POSIXct('2016-06-24 14:51:00' , tz="EST"))
W132 <- subset(debitAlt,
  Date > as.POSIXct('2016-06-24 14:51:00' , tz="EST") &
  Date < as.POSIXct('2016-06-25 07:49:00' , tz="EST"))
W133 <- subset(debitAlt,
  Date > as.POSIXct('2016-06-25 07:49:00' , tz="EST") &
  Date < as.POSIXct('2016-06-28 08:55:00' , tz="EST"))
W141 <- subset(debitAlt,
  Date > as.POSIXct('2016-06-28 08:55:00' , tz="EST") &
  Date <= as.POSIXct('2016-07-04 14:41:00' , tz="EST"))

W151 <- subset(debitAlt,
  Date > as.POSIXct('2016-07-04 14:41:00' , tz="EST") &
  Date <= as.POSIXct('2016-07-12 10:20:00' , tz="EST"))

```

Calculate sampled & non-sampled hrs.

1. Create a list made up of each subset data.frame

```
# Create a list of matrices
```

```

weeks = list(W01,
  W11,
  W12,
  W21, W22,
  W31, W32, W33,
  W41,
  W51, W52,
  W61, W62, W63, W64,
  W71,
  W81,
  W91, W92, W93, W94,
  W101, W102, W103, W104, W105,

```

```
W111, W112, W113,
W121, W122, W123, W124,
W131, W132, W133,
W141,
W151)
```

```
weeksNS = list(W00, W02, W13, W21, W32.1, W42, W53, W65, W72, W82, W95, W106, W125)
```

2. Create a function to calculate the time difference between the last and first date-entry of each subset.

```
hoursInWeek = function(x){
  as.numeric(difftime(x[nrow(x),1], x[1,1], units = "hours"), units = "hours")
}
```

Here “x” is a matrix (i.e. data.frame object) with number of rows = nrow. The *difftime* function uses the last index-value (t2) - first index-value (t1)

The *difftime* syntax: matrix[last_row, first_column], matrix[first_row, first_column] -> t2 - t1

3. Get total hours for each subset (data.frame) with the *sapply* function

```
sampledHrsList = sapply(weeks, hoursInWeek)
nonSampledHrsList = sapply(weeksNS, hoursInWeek)
```

```
nonSampledHrsList
```

```
## [1] 11.96667 37.63333 96.33333 23.70000 35.43333 77.16667 1.10000
## [8] 23.20000 18.06667 17.96667 18.50000 68.46667 107.13333
```

Here, the function *sapply* returns a list of outputs based on the created function we pass to it. The syntax: *sapply*(object, function to apply on each object).

4. Get volume discharged.

Same as above, we create first a function and then use *sapply*. Note that the discharge data in $[m^3h^{-1}]$ has an interval of 2 minutes. So we multiply each entry of the discharge column by 2 and convert to hrs.

```
#  $m^3/h * 2 min * 1h/60min = m^3$ 
volMinute = function(x) {
  (x[,2] * 2/60)
}
```

```
volMinuteList = sapply(weeks, volMinute)
volMinuteListNS = sapply(weeksNS, volMinute)
```

5. Check results

```
# first matrix in the weeks list (note: matrix has two rows)
# weeks[[1]]

# access the first matrix in the list, the second element in THAT list.
volMinuteList[[1]][[2]]
```

```
## [1] 0.03755018
```

6. Get total volume for each subset (i.e. each subweek)

```
totalDischarge = function(x){
  sum(x)
}
```

```

volumesList = supply(volMinuteList, totalDischarge)
volumesListNS = supply(volMinuteListNS, totalDischarge)

# Check volumes for the non-sample list:
volumesListNS

## [1] 14.41714 48.34827 877.37700 346.15602 1786.10736 486.76267
## [7] 13.33031 2627.31247 160.76996 78.12190 887.97251 3395.52590
## [13] 3553.06430

```

7. Create an average discharge list for each entry result above

```

AveDischarge = volumesList/sampledHrsList
AveDischargeNS = volumesListNS/nonSampledHrsList

```

8. Put all data together into a new data.frame structure.

```

# Sampled data frame

ID = c("W0-1", "W1-1", "W1-2",
       "W2-1", "W2-2",
       "W3-1", "W3-2", "W3-3", "W4-1",
       "W5-1", "W5-2",
       "W6-1", "W6-2", "W6-3", "W6-4",
       "W7-1",
       "W8-1",
       "W9-1", "W9-2", "W9-3", "W9-4",
       "W10-1", "W10-2", "W10-3", "W10-4", "W10-5",
       "W11-1", "W11-2", "W11-3",
       "W12-1", "W12-2", "W12-3", "W12-4",
       "W13-1", "W13-2", "W13-3",
       "W14-1",
       "W15-1")

Sampled = rep("Sampled", length(ID))

WeeklyDischarge = as.data.frame(ID)
WeeklyDischarge$AveDischarge.m3.h = AveDischarge
WeeklyDischarge$Volume.m3 = volumesList
WeeklyDischarge$Sampled.Hrs = sampledHrsList
WeeklyDischarge$Sampled = Sampled

# Not sampled data frame

IDns = c("W0-0x", "W0-2x", "W1-3x", "W2-3x", "W3-2.1x", "W4-2x",
        "W5-3x", "W6-5x", "W7-2x", "W8-2x",
        "W9-5x", "W10-6x", "W12-5x")

SampledNS = rep("Not Sampled", length(IDns))

WeeklyDischargeNS = as.data.frame(IDns)
WeeklyDischargeNS$AveDischarge.m3.h = AveDischargeNS
WeeklyDischargeNS$Volume.m3 = volumesListNS

```



```

WeeklyDischargeNS$Sampled.Hrs = nonSampledHrsList
WeeklyDischargeNS$Sampled = SampledNS
colnames(WeeklyDischargeNS)[1] <- "ID"

# Bind both data frames

WeeklyHydro = rbind(WeeklyDischarge, WeeklyDischargeNS)
WeeklyHydro$ID = as.character(WeeklyHydro$ID)
WeeklyHydro = with(WeeklyHydro, WeeklyHydro[order(ID),])

head(WeeklyHydro)

```

```

##      ID AveDischarge.m3.h Volume.m3 Sampled.Hrs      Sampled
## 39 W0-0x          1.204775   14.41714    11.96667 Not Sampled
##  1  W0-1          1.213511  100.15508    82.53333   Sampled
## 40 W0-2x          1.284719   48.34827    37.63333 Not Sampled
##  2  W1-1         14.316647  390.36726    27.26667   Sampled
##  3  W1-2         15.529299  359.24445    23.13333   Sampled
## 41 W1-3x          9.107720  877.37700    96.33333 Not Sampled

```

Save files

```

VolNS = sum(WeeklyDischargeNS$Volume.m3)
VolS = sum(WeeklyDischarge$Volume.m3)
print("% Not sampled: ")

```

```
## [1] "% Not sampled: "
```

```
VolNS/(VolNS+VolS)*100
```

```
## [1] 35.60444
```

```

write.csv2(WeeklyHydro,
            'D:/Documents/these_pablo/Alteckendorf2016/R/WeeklyHydro_R.csv', row.names = F)
write.csv2(WeeklyHydro,
            'Data/WeeklyHydro_R.csv', row.names = F)

```