# Soils & Discharge Merged

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*17 novembre 2016*

## Purpose

This file merges outlet data with soil data to plot cumulative exported and remaining S-metolachlor mass. The nearest soil sample date for each transect is used to match the initial time ("ti") of the sampling discharge period. This is most adequate merging location given that samples took place shortly before relaunching the automatic sampler.

Note that week numbers for water and soils are offset by one. I.e. Week 1 soils influence/regulate Week 2's water sample results.

Imports:

- **WeeklyHydroContam_R.csv**
- **WeeklySoils_Rng.csv**

Generates:

- **WeekSoilHydroCont_R.csv**
- **MassBalance_R.csv**

## Required R-packages:

```
library("plyr")
library("dplyr")
```

## Working directory

```
# setwd("D:/Documents/these_pablo/Alteckendorf2016/R")
# setwd("/Users/DayTightChunks/Documents/PhD/Routput/Alteck/R")
# setwd("D:/Documents/these_pablo/Alteckendorf2016/00_TransparencyFolder")
getwd()
```

```
## [1] "/Users/DayTightChunks/Documents/PhD/HydrologicalMonitoring"
```

# Lab parameters

```
# Initial signature measured in tank
initialDelta = d13Co = -32.253
```

## Import files

```
outlet = read.csv2("Data/WeeklyHydroContam_R.csv", header = T)
outlet$ti <- as.POSIXct(outlet$ti, "%Y-%m-%d %H:%M", tz = "EST")
sum(is.na(outlet$ti))
```

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

```
names(outlet)
```

```
##   [1] "ti"                     "WeekSubWeek"
##   [3] "tf"                     "iflux"
##   [5] "fflux"                  "changeflux"
##   [7] "maxQ"                   "minQ"
##   [9] "dryHrsIni"              "dryHrsMax"
##  [11] "dryHrsAve"              "noEventHrsIni"
##  [13] "noEventHrsMax"          "noEventHrsAve"
##  [15] "Duration.Hrs"           "chExtreme"
##  [17] "Peak"                   "Markers"
##  [19] "TimeDiff"               "AveDischarge.m3.h"
##  [21] "Volume.m3"              "Sampled.Hrs"
##  [23] "Sampled"                "CumRain.mm"
##  [25] "RainInt.mmhr"           "Conc.mug.L"
##  [27] "Conc.SD"                "Vol.SPE.L"
##  [29] "Conc.in500uL"           "OXA_mean"
##  [31] "OXA_SD"                 "ESA_mean"
##  [33] "ESA_SD"                 "N.x"
##  [35] "diss.d13C"              "SD.d13C"
##  [37] "N_d13C.diss"            "MES.mg.L"
##  [39] "MES.sd"                 "MO.mg.L"
##  [41] "Conc.Solids.mug.gMES"   "Conc.Solids.ug.gMES.SD"
##  [43] "N.y"                    "filt.d13C"
##  [45] "filt.SD.d13C"           "DD13C.diss"
##  [47] "DD13C.filt"             "ExpMES.Kg"
##  [49] "DissSmeto.mg"           "DissSmeto.mg.SD"
##  [51] "DissSmeto.g"            "DissSmeto.g.SD"
##  [53] "DissOXA.mg"             "DissOXA.mg.SD"
##  [55] "DissOXA.g"              "DissOXA.g.SD"
##  [57] "DissESA.mg"             "DissESA.mg.SD"
##  [59] "DissESA.g"              "DissESA.g.SD"
##  [61] "FiltSmeto.mg"           "FiltSmeto.mg.SD"
##  [63] "FiltSmeto.g"            "FiltSmeto.g.SD"
##  [65] "TotSMout.mg"            "TotSMout.mg.SD"
##  [67] "TotSMout.g"             "TotSMout.g.SD"
##  [69] "FracDiss"               "FracFilt"
##  [71] "MELsm.g"                "MELsm.g.SD"
##  [73] "CumOutDiss.g"           "CumOutFilt.g"
##  [75] "CumOutSmeto.g"          "CumOutMELsm.g"
##  [77] "Appl.Mass.g"            "Appl.Mass.g.OT"
##  [79] "Appl.Mass.g.N"          "Appl.Mass.g.T"
##  [81] "Appl.Mass.g.S"          "Appl.Mass.g.N.OT"
##  [83] "Appl.Mass.g.T.OT"       "Appl.Mass.g.S.OT"
##  [85] "iniCo.ug.g.N"           "iniCo.ug.g.T"
##  [87] "iniCo.ug.g.S"           "timeSinceApp"
##  [89] "timeSinceApp.N"         "timeSinceApp.T"
##  [91] "timeSinceApp.S"         "Appl.Mass.g.NoSo"
##  [93] "timeSinceApp.NoSo"      "CumAppMass.g"
```

```
##  [95] "CumAppMass.g.OT"        "CumAppMass.g.N"
##  [97] "CumAppMass.g.T"         "CumAppMass.g.S"
##  [99] "CumAppMass.g.N.OT"      "CumAppMass.g.T.OT"
## [101] "CumAppMass.g.S.OT"      "BalMassDisch.g"
## [103] "prctMassOut"            "FracDeltaOut"
## [105] "Events"                 "Weeks"
## [107] "Event"
```

```
# Select variables from Water dataset
outlet <- outlet[, c("ti", "WeekSubWeek", "Event", "Duration.Hrs",
                     "timeSinceApp", "timeSinceApp.NoSo",
                     "timeSinceApp.N",  "timeSinceApp.T",  "timeSinceApp.S",
                     "diss.d13C", "SD.d13C",
                     "CumOutDiss.g", "CumOutFilt.g",
                     "TotSMout.g", "TotSMout.g.SD" ,
                     "MELsm.g", "MELsm.g.SD",
                     "Appl.Mass.g" , "Appl.Mass.g.OT",
                     "CumAppMass.g", "CumAppMass.g.N", "CumAppMass.g.T", "CumAppMass.g.S",
                     "CumAppMass.g.OT", "CumAppMass.g.N.OT", "CumAppMass.g.T.OT", "CumAppMass.g.S.OT",
                     "iniCo.ug.g.N",  "iniCo.ug.g.T", "iniCo.ug.g.S",
                     "CumOutSmeto.g", "CumOutMELsm.g")]
print("Water")
```

```
## [1] "Water"
```

```
names(outlet)
```

```
##  [1] "ti"                "WeekSubWeek"       "Event"
##  [4] "Duration.Hrs"      "timeSinceApp"      "timeSinceApp.NoSo"
##  [7] "timeSinceApp.N"    "timeSinceApp.T"    "timeSinceApp.S"
## [10] "diss.d13C"         "SD.d13C"           "CumOutDiss.g"
## [13] "CumOutFilt.g"      "TotSMout.g"        "TotSMout.g.SD"
## [16] "MELsm.g"           "MELsm.g.SD"        "Appl.Mass.g"
## [19] "Appl.Mass.g.OT"    "CumAppMass.g"      "CumAppMass.g.N"
## [22] "CumAppMass.g.T"    "CumAppMass.g.S"    "CumAppMass.g.OT"
## [25] "CumAppMass.g.N.OT" "CumAppMass.g.T.OT" "CumAppMass.g.S.OT"
## [28] "iniCo.ug.g.N"      "iniCo.ug.g.T"      "iniCo.ug.g.S"
## [31] "CumOutSmeto.g"     "CumOutMELsm.g"
```

```
soils = read.csv2("Data/WeeklySoils_Rng.csv", header =T) # Corrected with only ngC > 2.0
names(soils)
```

```
##  [1] "ID"                  "Transect"            "Wnum"
##  [4] "Date.Soil"           "Date.ti"             "Conc.mug.g.dry.soil"
##  [7] "Conc.ComSoil.SD"     "Mass.Soil.g"         "theta.prct"
## [10] "N_compsoil"          "comp.d13C"           "comp.d13C.SD"
## [13] "N_isoComp"           "prctError"           "DD13C.comp"
## [16] "comp.IMP.d13C"       "MassSoil.g"          "MassSoil.g.SD"
## [19] "Area.N"              "Area.T"              "Area.S"
```

```
soils$Date.ti <- as.POSIXct(soils$Date.ti, "%Y-%m-%d %H:%M", tz = "EST")
#soils$Date.ti <- as.POSIXct(soils$Date.ti, "%d/%m/%Y %H:%M", tz = "EST")
sum(is.na(soils$Date.ti))
```

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

```
print("Soils")
```

```
## [1] "Soils"
```

```
str(soils)
```

```
## 'data.frame':    51 obs. of  21 variables:
##  $ ID                 : Factor w/ 51 levels "AW-N-0","AW-N-0x",..: 2 19 36 1 18 35 3 20 37 10 ...
##  $ Transect           : Factor w/ 3 levels "N","S","T": 1 2 3 1 2 3 1 2 3 1 ...
##  $ Wnum               : int  -1 -1 -1 0 0 0 1 1 1 2 ...
##  $ Date.Soil          : Factor w/ 17 levels "03/05/2016 13:10",..: 13 13 13 16 16 16 3 3 3 7 ...
##  $ Date.ti            : POSIXct, format: "2016-03-25 00:04:00" "2016-03-25 00:04:00" ...
##  $ Conc.mug.g.dry.soil: num  0.0686 0.076 0.0438 1.0376 3.738 ...
##  $ Conc.ComSoil.SD    : num  0.01029 0.0114 0.00657 0.15563 0.5607 ...
##  $ Mass.Soil.g        : num  NA NA NA NA NA ...
##  $ theta.prct         : num  NA NA NA NA NA ...
##  $ N_compsoil         : int  NA NA NA NA NA NA 3 3 3 3 ...
##  $ comp.d13C          : num  NA NA NA NA NA ...
##  $ comp.d13C.SD       : num  NA NA NA NA NA ...
##  $ N_isoComp          : int  NA NA NA NA NA NA 3 3 3 3 ...
##  $ prctError          : num  NA NA NA NA NA ...
##  $ DD13C.comp         : num  NA NA NA NA NA ...
##  $ comp.IMP.d13C      : num  NA NA NA NA NA ...
##  $ MassSoil.g         : num  102.6 82.2 16.8 1551.5 4039.4 ...
##  $ MassSoil.g.SD      : num  15.39 16.8 3.79 232.72 826.25 ...
##  $ Area.N             : num  101722 101722 101722 101722 101722 ...
##  $ Area.T             : num  39247 39247 39247 39247 39247 ...
##  $ Area.S             : num  1e+05 1e+05 1e+05 1e+05 1e+05 ...
```

## Get soil concentrations for each transect for merging horizontally

```
# North
soils.N <- subset(soils, soils$Transect == "N")
soils.N <- soils.N[, c("Date.ti",
                       "MassSoil.g", "MassSoil.g.SD",
                       "Conc.mug.g.dry.soil",
                       "comp.d13C", "comp.d13C.SD", # "comp.d13C.SE",
                       "ID",
                       "Area.N", "Area.T", "Area.S" #,
                       # "Area_Nt", "Area_Tt", "Area_St"
                       )]

colnames(soils.N) <- c("ti",
                       "MassSoil.g.North", "MassSoil.g.SD.North",
                       "Conc.mug.g.dry.soil.N",
                       "comp.d13C.North", "comp.d13C.SD.North", # "comp.d13C.SE.North",
                       "ID.N",
                       "Area.N", "Area.T", "Area.S"#,
                       #"Area.Nt", "Area.Tt", "Area.St"
                       )

# Talweg
soils.T <- subset(soils, soils$Transect == "T")
soils.T <- soils.T[, c("Date.ti",
                       "MassSoil.g", "MassSoil.g.SD",
```

```
                        "Conc.mug.g.dry.soil",
                        "comp.d13C", "comp.d13C.SD", # "comp.d13C.SE",
                        "ID")]

colnames(soils.T) <- c("ti",
                        "MassSoil.g.Talweg", "MassSoil.g.SD.Talweg",
                        "Conc.mug.g.dry.soil.T",
                        "comp.d13C.Talweg", "comp.d13C.SD.Talweg", # "comp.d13C.SE.Talweg",
                        "ID.T" )

# South
soils.S <- subset(soils, soils$Transect == "S")
soils.S <- soils.S[, c("Date.ti",
                        "MassSoil.g", "MassSoil.g.SD",
                        "Conc.mug.g.dry.soil",
                        "comp.d13C", "comp.d13C.SD", # "comp.d13C.SE",
                        "ID" )]
colnames(soils.S) <- c("ti",
                        "MassSoil.g.South", "MassSoil.g.SD.South",
                        "Conc.mug.g.dry.soil.S",
                        "comp.d13C.South", "comp.d13C.SD.South", # "comp.d13C.SE.South",
                        "ID.S" )
```

## Total Catchment Mass, Bulk Mass and Bulk Isotopes

Bulk isotopes are calculated based on the following:

$$\delta_{bulk} = \frac{M_{North}}{M_{tot}}\delta_{North} + \frac{M_{Talweg}}{M_{tot}}\delta_{Talweg} + \frac{M_{South}}{M_{tot}}\delta_{South}$$

Bulk mass (not currently used) is a proxy for the potential mass that can be discharged at a give time. It is calculated based on the pondered mass from each transect area and the proportion of that area in relation to the entire catchment such that:

$$M_{bulk} = \frac{A_{North}}{A_{tot}}M_{North} + \frac{A_{Talweg}}{A_{tot}}M_{Talweg} + \frac{A_{South}}{A_{tot}}M_{South}$$

$$C_{bulk} = \frac{A_{North}}{A_{tot}}C_{North} + \frac{A_{Talweg}}{A_{tot}}C_{Talweg} + \frac{A_{South}}{A_{tot}}C_{South}$$

```
library(zoo)
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
class(outlet$ti)
```

```
## [1] "POSIXct" "POSIXt"
```

```r
class(soils.T$ti)
```

```
## [1] "POSIXct" "POSIXt"
```

```r
soilsOut <- merge(outlet, soils.N, by = "ti", all = T)
soilsOut <- merge(soilsOut, soils.T, by = "ti", all = T)
soilsOut <- merge(soilsOut, soils.S, by = "ti", all = T)

soilsOut$DD13C.North <- soilsOut$comp.d13C.North - initialDelta
soilsOut$DD13C.Talweg <- soilsOut$comp.d13C.Talweg - initialDelta
soilsOut$DD13C.South <- soilsOut$comp.d13C.South - initialDelta

# Total mass in catchment
soilsOut$CatchMassSoil.g <-
  soilsOut$MassSoil.g.North +
  soilsOut$MassSoil.g.Talweg +
  soilsOut$MassSoil.g.South

soilsOut$CatchMassSoil.g.SD <- (
  ( soilsOut$MassSoil.g.SD.North^2 +
      soilsOut$MassSoil.g.SD.South^2 +
      soilsOut$MassSoil.g.SD.Talweg^2
    )/3
  )^0.5

# Approximate initial mass for first 6 observation (before recording composite soils)
#soilsOut$CatchMassSoil.g[1:6] <- ifelse(is.na(soilsOut$CatchMassSoil.g),
#                                        soilsOut$CumAppMass.g-soilsOut$CumOutMELsm.g,
#                                        soilsOut$CatchMassSoil.g)


#soilsOut$BulkMass.g <-
#  soilsOut$MassSoil.g.North*(soilsOut$Area.N/(soilsOut$Area.N+soilsOut$Area.T+soilsOut$Area.S)) +
#  soilsOut$MassSoil.g.Talweg*(soilsOut$Area.T/(soilsOut$Area.N+soilsOut$Area.T+soilsOut$Area.S)) +
#  soilsOut$MassSoil.g.South*(soilsOut$Area.S/(soilsOut$Area.N+soilsOut$Area.T+soilsOut$Area.S))

# Bulk catchment isotopes
soilsOut$BulkCatch.d13 <-
  (soilsOut$MassSoil.g.North/soilsOut$CatchMassSoil.g)*soilsOut$comp.d13C.North +
  (soilsOut$MassSoil.g.Talweg/soilsOut$CatchMassSoil.g)*soilsOut$comp.d13C.Talweg +
  (soilsOut$MassSoil.g.South/soilsOut$CatchMassSoil.g)*soilsOut$comp.d13C.South

soilsOut$BulkCatch.d13.SD <-
  (soilsOut$MassSoil.g.North/soilsOut$CatchMassSoil.g)*soilsOut$comp.d13C.SD.North +
  (soilsOut$MassSoil.g.Talweg/soilsOut$CatchMassSoil.g)*soilsOut$comp.d13C.SD.Talweg +
  (soilsOut$MassSoil.g.South/soilsOut$CatchMassSoil.g)*soilsOut$comp.d13C.SD.South

soilsOut$DD13.Bulk <-  (soilsOut$BulkCatch.d13 - (d13Co))

# Bulk catchment concentrations
soilsOut$Area.Catchment <- soilsOut$Area.N + soilsOut$Area.T + soilsOut$Area.S

soilsOut$BulkCatch.Conc <-
  (soilsOut$Area.N/soilsOut$Area.Catchment)*soilsOut$Conc.mug.g.dry.soil.N +
```

```
  (soilsOut$Area.T/soilsOut$Area.Catchment)*soilsOut$Conc.mug.g.dry.soil.T +
  (soilsOut$Area.S/soilsOut$Area.Catchment)*soilsOut$Conc.mug.g.dry.soil.S

soilsOut$iniCo.Bulk <-
  soilsOut$iniCo.ug.g.N*(soilsOut$Area.N/soilsOut$Area.Catchment) +
  soilsOut$iniCo.ug.g.T*(soilsOut$Area.T/soilsOut$Area.Catchment) +
  soilsOut$iniCo.ug.g.S*(soilsOut$Area.S/soilsOut$Area.Catchment)
```

```
print("Merged Soils and Outlet by ti")
```

```
## [1] "Merged Soils and Outlet by ti"
```

```
str(soilsOut)
```

```
## 'data.frame':    52 obs. of  64 variables:
##  $ ti                   : POSIXct, format: "2016-03-25 00:04:00" "2016-03-25 12:04:00" ...
##  $ WeekSubWeek          : Factor w/ 51 levels "W0-0x","W0-1",..: 1 2 3 4 5 6 26 27 28 29 ...
##  $ Event                : int  0 0 0 1 1 1 2 2 2 3 ...
##  $ Duration.Hrs         : num  12 82.5 37.6 27.3 23.1 ...
##  $ timeSinceApp         : num  0.5 3.9 5.5 6.6 7.6 11.6 12.6 14 20.6 2.2 ...
##  $ timeSinceApp.NoSo    : num  0.5 3.9 5.5 6.6 7.6 11.6 12.6 14 20.6 2.2 ...
##  $ timeSinceApp.N       : num  0.5 3.9 5.5 6.6 7.6 11.6 12.6 14 20.6 2.2 ...
##  $ timeSinceApp.T       : num  0.5 3.9 5.5 6.6 7.6 11.6 12.6 14 20.6 2.2 ...
##  $ timeSinceApp.S       : num  0.5 3.9 5.5 6.6 7.6 11.6 12.6 14 20.6 2.2 ...
##  $ diss.d13C            : num  NA NA NA -31.5 -31.7 ...
##  $ SD.d13C              : num  NA NA NA 0.115 0.153 ...
##  $ CumOutDiss.g         : num  0.00354 0.02815 0.19818 2.84809 5.2051 ...
##  $ CumOutFilt.g         : num  0.00345 0.0069 0.01263 0.01571 0.01923 ...
##  $ TotSMout.g           : num  0.00699 0.02806 0.17577 2.65298 2.36052 ...
##  $ TotSMout.g.SD        : num  0.000216 0.00137 0.005284 0.07989 0.048432 ...
##  $ MELsm.g              : num  1.65 11.44 6.13 54.26 49.6 ...
##  $ MELsm.g.SD           : num  0.537 3.729 1.835 15.13 6.441 ...
##  $ Appl.Mass.g          : num  31670 0 0 0 0 ...
##  $ Appl.Mass.g.OT       : num  24477 0 0 0 0 ...
##  $ CumAppMass.g         : num  31670 31670 31670 31670 31670 ...
##  $ CumAppMass.g.N       : num  8429 8429 8429 8429 8429 ...
##  $ CumAppMass.g.T       : num  6904 6904 6904 6904 6904 ...
##  $ CumAppMass.g.S       : num  16337 16337 16337 16337 16337 ...
##  $ CumAppMass.g.OT      : num  24477 24477 24477 24477 24477 ...
##  $ CumAppMass.g.N.OT    : num  8429 8429 8429 8429 8429 ...
##  $ CumAppMass.g.T.OT    : num  2727 2727 2727 2727 2727 ...
##  $ CumAppMass.g.S.OT    : num  13321 13321 13321 13321 13321 ...
##  $ iniCo.ug.g.N         : num  8.46 8.46 8.46 8.46 8.46 ...
##  $ iniCo.ug.g.T         : num  7.09 7.09 7.09 7.09 7.09 ...
##  $ iniCo.ug.g.S         : num  12.4 12.4 12.4 12.4 12.4 ...
##  $ CumOutSmeto.g        : num  0.00699 0.03505 0.21082 2.8638 5.22432 ...
##  $ CumOutMELsm.g        : num  1.65 13.09 19.22 73.48 123.07 ...
##  $ MassSoil.g.North     : num  103 NA NA 1551 NA ...
##  $ MassSoil.g.SD.North  : num  15.4 NA NA 232.7 NA ...
##  $ Conc.mug.g.dry.soil.N: num  0.0686 NA NA 1.0376 NA ...
##  $ comp.d13C.North      : num  NA NA NA NA NA NA -31.4 NA NA -31.2 ...
##  $ comp.d13C.SD.North   : num  NA NA NA NA NA ...
##  $ ID.N                 : Factor w/ 51 levels "AW-N-0","AW-N-0x",..: 2 NA NA 1 NA NA 3 NA NA 10 ...
##  $ Area.N               : num  101722 NA NA 101722 NA ...
##  $ Area.T               : num  39247 NA NA 39247 NA ...
```

```
##  $ Area.S               : num  1e+05 NA NA 1e+05 NA ...
##  $ MassSoil.g.Talweg    : num  16.8 NA NA 359.3 NA ...
##  $ MassSoil.g.SD.Talweg : num  3.79 NA NA 80.85 NA ...
##  $ Conc.mug.g.dry.soil.T: num  0.0438 NA NA 0.9342 NA ...
##  $ comp.d13C.Talweg     : num  NA NA NA NA NA ...
##  $ comp.d13C.SD.Talweg  : num  NA NA NA NA NA ...
##  $ ID.T                 : Factor w/ 51 levels "AW-N-0","AW-N-0x",..: 36 NA NA 35 NA NA 37 NA NA 44 .
##  $ MassSoil.g.South     : num  82.2 NA NA 4039.4 NA ...
##  $ MassSoil.g.SD.South  : num  16.8 NA NA 826.2 NA ...
##  $ Conc.mug.g.dry.soil.S: num  0.076 NA NA 3.738 NA ...
##  $ comp.d13C.South      : num  NA NA NA NA NA ...
##  $ comp.d13C.SD.South   : num  NA NA NA NA NA ...
##  $ ID.S                 : Factor w/ 51 levels "AW-N-0","AW-N-0x",..: 19 NA NA 18 NA NA 20 NA NA 27 .
##  $ DD13C.North          : num  NA NA NA NA NA ...
##  $ DD13C.Talweg         : num  NA NA NA NA NA ...
##  $ DD13C.South          : num  NA NA NA NA NA ...
##  $ CatchMassSoil.g      : num  202 NA NA 5950 NA ...
##  $ CatchMassSoil.g.SD   : num  13.3 NA NA 497.8 NA ...
##  $ BulkCatch.d13        : num  NA NA NA NA NA ...
##  $ BulkCatch.d13.SD     : num  NA NA NA NA NA ...
##  $ DD13.Bulk            : num  NA NA NA NA NA ...
##  $ Area.Catchment       : num  241215 NA NA 241215 NA ...
##  $ BulkCatch.Conc       : num  0.0676 NA NA 2.143 NA ...
##  $ iniCo.Bulk           : num  9.86 NA NA 9.86 NA ...
```

```
write.csv2(soilsOut,
           'Data/MassBalance_R.csv', row.names = F)
```

# Plot

```
library("ggplot2")
library("scales")
library("reshape2")
library("cowplot")
```

```
##
## Attaching package: 'cowplot'
```

```
## The following object is masked from 'package:ggplot2':
##
##     ggsave
```

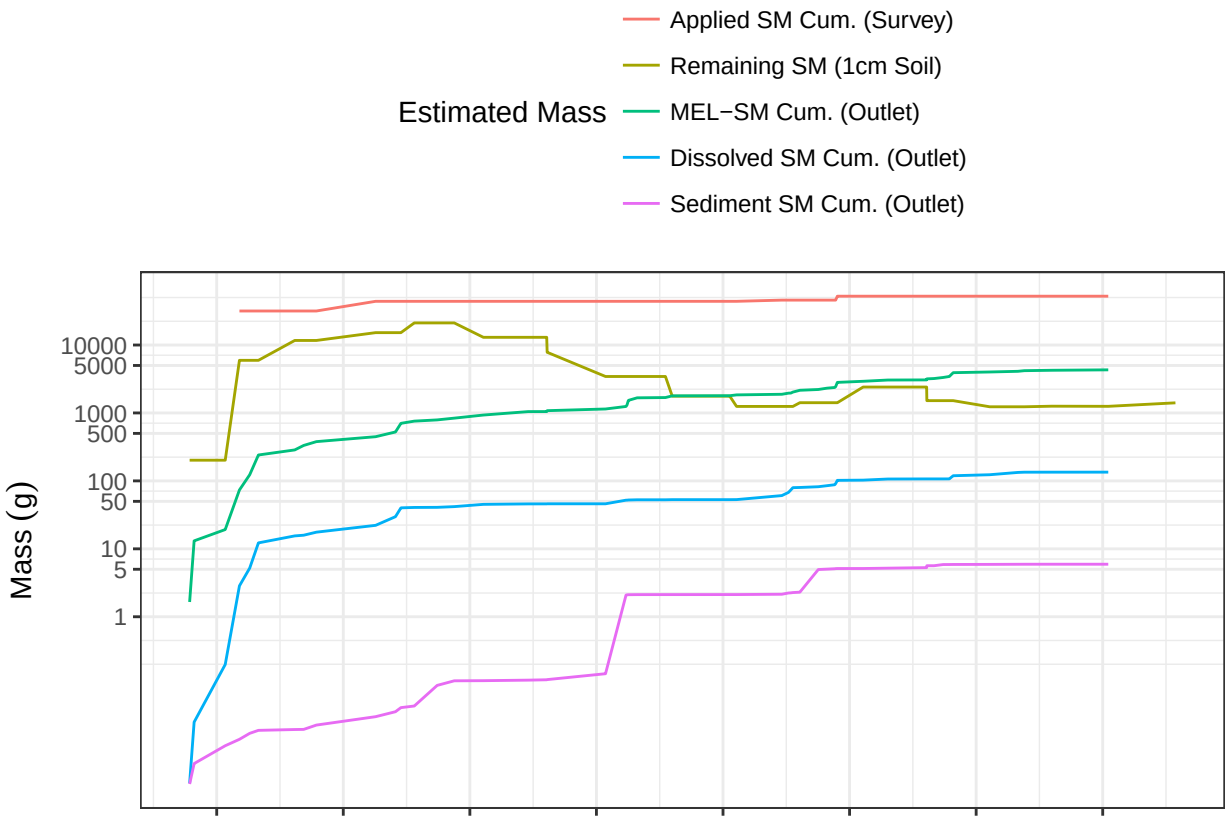
```
# Melt data set
##Subset the necessary columns
soilsRemainMass <- soilsOut[, c("ti" ,"CumAppMass.g", "CumOutDiss.g", "CumOutFilt.g", "CumOutMELsm.g" ,
soilsRemainMass$CumAppMass.g[1:3] <- NA

# Replace Catchment Mass's NA with the most recent non-NA prior to it (assumes no degradation).
# Purpose: To match continuous outlet time array
soilsRemainMass$CatchMassSoil.g <- na.locf(soilsRemainMass$CatchMassSoil.g)
# soilsRemainMass <- na.omit(soilsRemainMass)

##Then rearrange your data frame
```

```
remainMassMolten = melt(soilsRemainMass, id=c("ti"))

# View(remainMassMolten)

pg <- remainMassMolten

# Change variable names:
levels(pg$variable)[levels(pg$variable)=="CumAppMass.g"] <- "Applied SM Cum. (Survey)"
levels(pg$variable)[levels(pg$variable)=="CumOutMELsm.g"] <- "MEL-SM Cum. (Outlet)"
levels(pg$variable)[levels(pg$variable)=="CatchMassSoil.g"] <- "Remaining SM (1cm Soil)"

levels(pg$variable)[levels(pg$variable)=="CumOutDiss.g"] <- "Dissolved SM Cum. (Outlet)"
levels(pg$variable)[levels(pg$variable)=="CumOutFilt.g"] <- "Sediment SM Cum. (Outlet)"

# Change the order:
levels(pg$variable)
```

```
## [1] "Applied SM Cum. (Survey)"   "Dissolved SM Cum. (Outlet)"
## [3] "Sediment SM Cum. (Outlet)"  "MEL-SM Cum. (Outlet)"
## [5] "Remaining SM (1cm Soil)"
```

```
pg$variable <- factor(pg$variable, levels = c("Applied SM Cum. (Survey)",  "Remaining SM (1cm Soil)", "

pgSimple <- pg[which(pg$variable != ("Dissolved SM Cum. (Outlet)") & pg$variable != ("Sediment SM Cum.
# names(pg)[names(pg)=="variable"]  <- "Estimated Mass"

massBalTop <- ggplot(pg) +
  geom_line(aes(x=ti, y=value, group = variable, color=variable)) +

  # Themes and axes
  theme_bw() +
  theme(# axis.text.x=element_text(angle = 45, hjust = 1),
        axis.text.x=element_blank(),
        axis.title.x=element_blank(),
        legend.position="top"

        )+
  labs(color = "Estimated Mass") +
  guides(col = guide_legend(ncol = 1)) +  # Sets legend parameters

  # xlab("Date") +
  scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
  ylab(expression(paste("Mass ", {(g)}))) +
  # scale_y_continuous(breaks = c(100, 5000, 10000, 20000), limits = c(100, 20000) )
  scale_y_continuous(trans=log_trans(), breaks=c(1,5,10,50,100,500,1000,5000, 10000))
massBalTop
```

```
## Warning: Removed 7 rows containing missing values (geom_path).
```




```
massBalBottom <- ggplot(pg) +
  geom_line(aes(x=ti, y=value, color=variable)) +

  # Themes and axes
  theme_bw() +
  theme(axis.text.x=element_text(angle = 45, hjust = 1),
        #axis.text.x=element_blank(),
        #axis.title.x=element_blank(),
        legend.position="none"
        )+
  # guides(col = guide_legend(nrows = 2)) +  # Sets legend parameters
  xlab("Date") +
  scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
  ylab(expression(paste("Mass. S-Meto.  ", {(g)}))) +
  scale_y_continuous(breaks = c(1, 25, 50, 100), limits = c(0, 100) )


massBal = plot_grid(massBalTop, massBalBottom, ncol = 1, nrow = 2, align = "v")
```

```
## Warning: Removed 7 rows containing missing values (geom_path).
```

```
## Warning: Removed 64 rows containing missing values (geom_path).
```

```
massBal_MEL <- ggplot(pgSimple) +
  geom_line(aes(x=ti, y=value, group = variable, color=variable)) +

  # Themes and axes
  theme_bw() +
  theme(# axis.text.x=element_text(angle = 45, hjust = 1),
```

```
        #axis.text.x=element_blank(),
        #axis.title.x=element_blank(),
        legend.position="top"
        )+
  labs(color = "Estimated Mass") +
  guides(col = guide_legend(ncol = 3)) +  # Sets legend parameters

  # xlab("Date") +
  scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
  ylab(expression(paste("Mass ", {(g)})))

massBal_MEL
```

```
## Warning: Removed 5 rows containing missing values (geom_path).
```