SNT\_Examples.R

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# example workflow for StreamNetworkTools  
  
# install devtools if not already  
# install.packages(devtools)  
library("devtools")

## Warning: package 'devtools' was built under R version 3.4.4

# install StreamNetworkTools from github repository  
# install\_git("https://github.com/dkopp3/StreamNetworkTools\_git.git", subdir = "StreamNetworkTools")  
library(StreamNetworkTools)  
  
#check SNT package help for avaialble functions  
help(package ="StreamNetworkTools")  
  
# to begin download NHDPlusV2 data for Vector Processing Unit (VPU) of interest  
# here we are using VPU 11 which includes Arkansas, Red and White River basins  
# check function documentation for further details  
# setwd to example folder - where NHDPlusV2 data will be downloaded  
  
setwd("C:/Users/Darin/Dropbox/Dissertation/Chapter\_2\_StreamNetworkTools/StreamNetworkTools\_git/Example\_Data")  
  
# check documentation  
# net\_nhdplus  
# can download all available data for vpu but sppecified only files needed to run streamNetworkTools  
# this can be time consuming, be patient it only has to be done once  
# data for VPU is already present in example data folder  
  
#net\_nhdplus(nhdplus\_path = getwd(), download = "http",  
 # vpu = 11, files = c("NHDPlusAttributes", "NHDSnapshot",  
 # "NHDPlusCatchment", "VPUAttributeExtension",  
 # "VogelExtension", "EROMExtension"),  
 # zip\_7 = "C:/Program Files/7-Zip")  
  
# can run with for loop to download all VPU in CONUS  
# recommend running overnight  
  
#vpus<- c("01","02","03N","03S","03W","04","05","06","07","08","09","10U",  
 # "10L","11","12","13","14","15","16","17","18")  
  
# for (i in vpus){  
 # net\_nhdplus(nhdplus\_path = getwd(), download = "http",  
 # vpu = i, files = c("NHDPlusAttributes", "NHDSnapshot",  
 # "NHDPlusCatchment", "VPUAttributeExtension",  
 # "VogelExtension", "EROMExtension"),  
 # zip\_7 = "C:/Program Files/7-Zip")  
#}  
  
# net\_sample randomly selects comid's of specified stream order from a vector processing unit  
# below identifies 3, fifth order comid's from VPU 11  
  
rmd\_comid <- net\_sample(nhdplus\_path = getwd(), vpu = "11", ws\_order = 5, n = 3)  
print(rmd\_comid)

## [1] 705826 19934867 13990473

# net\_delin queries all COMID's upsteam comid's from root  
# inpput group\_comids must be character  
rmd\_netdelin <- net\_delin(group\_comid = as.character(rmd\_comid),  
 nhdplus\_path = getwd(),  
 vpu = "11")

## Reading layer `NHDFlowline' from data source `C:\Users\Darin\Dropbox\Dissertation\Chapter\_2\_StreamNetworkTools\StreamNetworkTools\_git\Example\_Data\NHDPlus\NHDPlusMS\NHDPlus11\NHDSnapshot\Hydrography' using driver `ESRI Shapefile'  
## Simple feature collection with 213620 features and 14 fields  
## geometry type: LINESTRING  
## dimension: XYZM  
## bbox: xmin: -106.5936 ymin: 31.21435 xmax: -90.15551 ymax: 39.38232  
## epsg (SRID): 4269  
## proj4string: +proj=longlat +datum=NAD83 +no\_defs

# output is list of 3  
str(rmd\_netdelin)

## List of 3  
## $ Network :'data.frame': 2078 obs. of 5 variables:  
## ..$ group.comid: Factor w/ 3 levels "705826","19934867",..: 1 1 1 1 1 1 1 1 1 1 ...  
## ..$ net.comid : Factor w/ 2078 levels "704586","704588",..: 1 2 3 4 5 6 7 8 9 10 ...  
## ..$ vpu : Factor w/ 1 level "11": 1 1 1 1 1 1 1 1 1 1 ...  
## ..$ M : num [1:2078] 1 1 1 1 1 1 1 1 1 1 ...  
## ..$ net.id : int [1:2078] 1 1 1 1 1 1 1 1 1 1 ...  
## $ Nested\_COMIDs: NULL  
## $ SF\_Obj :Classes 'sf' and 'data.frame': 2078 obs. of 6 variables:  
## ..$ COMID : int [1:2078] 705826 705818 705694 705664 705654 705634 705624 706598 705542 705536 ...  
## ..$ group.comid: chr [1:2078] "705826" "705826" "705826" "705826" ...  
## ..$ VPUID : chr [1:2078] "11" "11" "11" "11" ...  
## ..$ Meas : num [1:2078] 1 1 1 1 1 1 1 1 1 1 ...  
## ..$ net.id : num [1:2078] 1 1 1 1 1 1 1 1 1 1 ...  
## ..$ geometry :sfc\_LINESTRING of length 2078; first list element: XYZM [1:11, 1:4] -96.2 -96.2 -96.2 -96.2 -96.2 ...  
## ..- attr(\*, "sf\_column")= chr "geometry"  
## ..- attr(\*, "agr")= Factor w/ 3 levels "constant","aggregate",..: NA NA NA NA NA  
## .. ..- attr(\*, "names")= chr [1:5] "COMID" "group.comid" "VPUID" "Meas" ...

# can write network as shapefile with  
library(sf)

## Warning: package 'sf' was built under R version 3.4.4

## Linking to GEOS 3.6.1, GDAL 2.2.3, proj.4 4.9.3

write\_sf(rmd\_netdelin$SF\_Obj, paste(getwd(),"/rmd\_netdelin.shp", sep = ""))

## Warning in abbreviate\_shapefile\_names(obj): Field names abbreviated for  
## ESRI Shapefile driver

# value added attribute queries for NHDPlusV2  
# landcover percentage are for sub-catchments  
rmd\_netlc <- net\_lc(netdelin = rmd\_netdelin, vpu = "11", nhdplus\_path = getwd())  
# field headings follow https://www.mrlc.gov/nlcd11\_leg.php  
head(rmd\_netlc)

## net.id group.comid.x group.comid.y vpu MISSDATAA NLCD11PC NLCD12PC  
## 1 1 705826 705826 11 0 0.696823 0  
## 2 2 19934867 19934867 11 0 2.153897 0  
## 3 3 13990473 13990473 11 0 0.144916 0  
## NLCD21PC NLCD22PC NLCD23PC NLCD24PC NLCD31PC NLCD41PC NLCD42PC  
## 1 3.372037 0.238229 0.071137 0.019918 0.200605 51.806951 1.841492  
## 2 2.569133 2.076524 0.136005 0.012896 0.028026 13.388480 53.016780  
## 3 1.816238 0.041759 0.006362 0.002159 0.423368 0.354966 0.985115  
## NLCD43PC NLCD51PC NLCD52PC NLCD71PC NLCD72PC NLCD73PC NLCD74PC  
## 1 0.000000 0 0.019286 26.809836 0 0 0  
## 2 3.552460 0 8.094093 2.669546 0 0 0  
## 3 0.104996 0 55.007238 30.814557 0 0 0  
## NLCD81PC NLCD82PC  
## 1 13.989899 0.920825  
## 2 8.039931 0.036279  
## 3 0.000000 9.959761

# climate variables follow world clim, bioclim variables and were calculated from 1971-2001 PRISM  
# where necessary units are in tempp in deg C and ppt in mm  
rmd\_netclim <- net\_clim (nhdplus\_path = getwd(), vpu = "11", netdelin = rmd\_netdelin)  
head(rmd\_netclim)

## net.id group.comid vpu MISSDATAA.x TEMPV seasonality\_t warm\_mo  
## 1 1 705826 11 -9998 16.47833 8.652224 07  
## 2 2 19934867 11 -9998 17.19649 7.853232 07  
## 3 3 13990473 11 -9998 16.09084 8.574514 07  
## warm\_mo\_t cold\_mo cold\_mo\_t diff\_t warm\_q\_t warm\_q  
## 1 27.91378 01 3.874762 24.03902 26.9091515270865 06,07,08  
## 2 27.47276 01 5.872584 21.60018 26.6893045612873 06,07,08  
## 3 27.62496 01 4.098384 23.52658 26.5594821492057 06,07,08  
## cold\_q\_t cold\_q MISSDATAA.y PRECIPV wet\_mo wet\_mo\_p dry\_mo  
## 1 5.45062902856782 12,01,02 -9998 1093.1108 05 147.18842 01  
## 2 7.28806018232201 12,01,02 -9998 1362.7151 11 136.71576 08  
## 3 5.34808932211643 12,01,02 -9998 592.3493 06 88.59351 01  
## dry\_mo\_p seasonality\_p wet\_q\_p wet\_q dry\_q\_p dry\_q dry\_q\_t  
## 1 50.38008 0.3265497 371.2367 04,05,06 177.74167 12,01,02 5.450629  
## 2 77.49223 0.1557842 380.5230 10,11,12 267.91935 07,08,09 26.103743  
## 3 18.08430 0.5240224 226.1469 05,06,07 65.02709 12,01,02 5.348089  
## wet\_q\_t warm\_q\_p cold\_q\_p  
## 1 20.82361 83.60596 59.24722  
## 2 12.29682 99.97652 115.43143  
## 3 24.57697 68.51440 21.67570

# flow variables were calculated using the Mean Annual and Mean Monthly EROM  
rmd\_netflow <- net\_flow(nhdplus\_path = getwd(), vpu = "11", netdelin = rmd\_netdelin)  
head(rmd\_netflow)

## net.id group.comid vpu RUNOFFVC MAQ0001E minMMQ0001E maxMMQ0001E  
## 1 1 705826 11 246.0341 177.225 38.275 320.760  
## 2 2 19934867 11 474.0126 1.721 0.314 8.946  
## 3 3 13990473 11 28.8797 0.013 0.000 0.026  
## covMMQ0001E V0001E minMMV0001E maxMMV0001E covMMV0001E  
## 1 1.3682590 1.38933 0.78742 1.78960 3.140682  
## 2 0.8912998 0.60271 0.42765 1.01460 3.453205  
## 3 1.5168199 0.48893 0.30839 0.56926 6.235584

# network scale topology  
rmd\_netclac <- net\_calc(netdelin = rmd\_netdelin, vpu = "11", nhdplus\_path = getwd())  
head(rmd\_netclac)

## net.id COMID vpu M WS.ord head.h2o trib.jun reach.cnt diver.cnt NA  
## 1 1 705826 11 1 5 209 208 417 705826 8  
## 2 2 19934867 11 1 5 145 144 289 19934867 51  
## 3 3 13990473 11 1 5 171 170 341 13990473 232  
## AreaSQKM LengthKM drain.den  
## 1 569.3265 728.314 1.2792554  
## 2 523.4373 636.600 1.2161915  
## 3 3084.1281 1563.365 0.5069066

# net\_hort M values are not included here  
rmd\_nethort <- net\_hort(netdelin = rmd\_netdelin, vpu = "11", nhdplus\_path = getwd())  
str(rmd\_nethort)

## List of 2  
## $ topology :'data.frame': 15 obs. of 5 variables:  
## ..$ group.comid: Factor w/ 3 levels "705826","19934867",..: 1 1 1 1 1 2 2 2 2 2 ...  
## ..$ str\_ord : int [1:15] 1 2 3 4 5 1 2 3 4 5 ...  
## ..$ str\_num : int [1:15] 209 46 8 3 1 145 34 9 3 1 ...  
## ..$ str\_len : num [1:15] 2.2 2.3 12.3 12.7 22.9 ...  
## ..$ str\_area : num [1:15] 1.82 1.92 7.61 8.3 13.9 ...  
## $ Horton\_est:'data.frame': 3 obs. of 8 variables:  
## ..$ COMID: Factor w/ 3 levels "705826","19934867",..: 1 2 3  
## ..$ ohm : int [1:3] 4 4 4  
## ..$ Rb : num [1:3] 4.25 3.66 4.51  
## ..$ Rb.r2: num [1:3] 0.989 0.996 0.997  
## ..$ Rl : num [1:3] 2 1.45 2.43  
## ..$ Rl.r2: num [1:3] 0.819 0.808 0.828  
## ..$ Ra : num [1:3] 1.81 1.32 2.32  
## ..$ Ra.r2: num [1:3] 0.837 0.625 0.82

# net sinu gives values for each reach (comid) within a network  
rmd\_netsinu <- net\_sinu (netdelin = rmd\_netdelin, nhdplus\_path = getwd(), vpu = "11")

## Warning: package 'bindrcpp' was built under R version 3.4.4

head(rmd\_netsinu)

## net.comid group.comid tot.len str.len sinuosity MaxElevSM  
## 1 704586 705826 575.156 m 547.2009 m 1.051087 26806  
## 2 704588 705826 3434.614 m 2935.0834 m 1.170193 28630  
## 3 704590 705826 1549.236 m 1461.7208 m 1.059871 26985  
## 4 704592 705826 4118.652 m 3315.8033 m 1.242128 26780  
## 5 704594 705826 1134.234 m 915.5378 m 1.238872 26772  
## 6 704596 705826 1904.930 m 1841.0118 m 1.034719 25705  
## MinElevSM SlopeNHDPlus  
## 1 26156 0.01529411  
## 2 24524 0.01250304  
## 3 24524 0.01757857  
## 4 24485 0.00578522  
## 5 24679 0.02124873  
## 6 23784 0.01094586

# can be aggregated as a network mean  
mean.sinu <- aggregate(rmd\_netsinu[,"sinuosity"],  
 by = list(group.comid = rmd\_netsinu[,"group.comid"]),  
 mean)  
head(mean.sinu)

## group.comid x  
## 1 13990473 1.114830  
## 2 19934867 1.190541  
## 3 705826 1.315362

# net\_conflu resullts are given by each confluence  
# this takes a while - ended  
#rmd\_netconflu <- net\_conflu(netdelin = rmd\_netdelin,  
 # nhdplus\_path = getwd(),  
 # vpu = "11")