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")  
  
  
# 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] 20001254 1530095 13955123

# 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  
# Network is data.frame. group.comid indexes a Network  
# and net.comid are their asociated COMID's  
# 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

str(rmd\_netdelin)

## List of 3  
## $ Network :'data.frame': 2168 obs. of 5 variables:  
## ..$ group.comid: Factor w/ 3 levels "20001254","1530095",..: 1 1 1 1 1 1 1 1 1 1 ...  
## ..$ net.comid : Factor w/ 2168 levels "19998756","19998760",..: 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 [1:2168] 1 1 1 1 1 1 1 1 1 1 ...  
## ..$ net.id : int [1:2168] 1 1 1 1 1 1 1 1 1 1 ...  
## $ Nested\_COMIDs: NULL  
## $ SF\_Obj :Classes 'sf' and 'data.frame': 2168 obs. of 6 variables:  
## ..$ COMID : int [1:2168] 20001242 20001206 20001196 20001194 20001186 20001200 20001202 20001198 20001922 20001166 ...  
## ..$ group.comid: chr [1:2168] "20001254" "20001254" "20001254" "20001254" ...  
## ..$ VPUID : chr [1:2168] "11" "11" "11" "11" ...  
## ..$ Meas : num [1:2168] 1 1 1 1 1 1 1 1 1 1 ...  
## ..$ net.id : num [1:2168] 1 1 1 1 1 1 1 1 1 1 ...  
## ..$ geometry :sfc\_LINESTRING of length 2168; first list element: XYZM [1:14, 1:4] -103 -103 -103 -103 -103 ...  
## ..- 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 also "snap" user defined points to nearest NHDPlusV2 flowline  
# prep sample points  
ExLoc <- read.csv("Sample\_Locations.csv")  
head(ExLoc)

## SiteName StreamName N W VPU  
## 1 CC2 Carrizo Creek 37.16442 -103.03109 11  
## 2 CC3 Carrizo Creek 37.13483 -103.01728 11  
## 3 MC1 Jimmy Creek 34.81536 -98.58271 11  
## 4 MC2 Jimmy Creek 34.79720 -98.58433 11  
## 5 MC3 Medicine Creek 34.77091 -98.58141 11  
## 6 KR1 Upper Kiamichi River 34.67789 -94.46922 11

# Locations must be renamed as follows, kind of annoying  
ExLoc <- ExLoc[,c("SiteName","W","N")]  
names(ExLoc) <- c("SITE\_ID","X","Y")  
  
# finding closest COMID  
sam\_pts <- net\_comid(sample\_points = ExLoc, CRS = 4269,  
 nhdplus\_path = getwd(), vpu = 11, maxdist = 200)

## 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

## Warning: attribute variables are assumed to be spatially constant  
## throughout all geometries

head(sam\_pts)

## SITE\_ID X Y snap\_dist snap\_x snap\_y M  
## 1 KR1 -94.46922 34.67789 21.6230948 -94.46928 34.67808 0.5929081  
## 2 KR2 -94.48624 34.67746 31.9095267 -94.48644 34.67770 0.2757556  
## 3 KR3 -94.53500 34.66721 0.9497305 -94.53501 34.66721 0.9803696  
## 4 MC2 -98.58433 34.79720 26.9978682 -98.58452 34.79702 0.9688412  
## 5 MC1 -98.58271 34.81536 26.5007801 -98.58299 34.81543 0.6551104  
## 6 MC3 -98.58141 34.77091 64.8570852 -98.58090 34.77132 0.9226447  
## COMID GNIS\_NAME vpu ApproxTOTDASQKM STREAMORDE  
## 1 587332 Kiamichi River 11 1.9431 1  
## 2 587892 Kiamichi River 11 9.1620 2  
## 3 587392 Kiamichi River 11 23.9598 3  
## 4 673192 Jimmy Creek 11 8.3781 1  
## 5 673192 Jimmy Creek 11 8.3781 1  
## 6 673264 Medicine Creek 11 112.2642 3

# value added attribute queries for NHDPlusV2  
# should be able to interchange sam\_pts and rmd\_netdelin in all following functions  
# 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 20001254 20001254 11 0 0.042855 0  
## 2 2 1530095 1530095 11 0 0.467379 0  
## 3 3 13955123 13955123 11 0 0.253673 0  
## NLCD21PC NLCD22PC NLCD23PC NLCD24PC NLCD31PC NLCD41PC NLCD42PC  
## 1 0.319550 0.001386 0.000528 0.000000 0.071656 0.000198 0.769875  
## 2 6.778735 11.561708 6.787133 1.684686 1.092596 2.429413 41.501320  
## 3 3.618244 0.655072 0.171048 0.090196 0.494329 0.499061 1.885614  
## NLCD43PC NLCD51PC NLCD52PC NLCD71PC NLCD72PC NLCD73PC NLCD74PC NLCD81PC  
## 1 0.000000 0 10.08333 85.21635 0 0 0 0.003827  
## 2 0.039326 0 9.65873 16.47646 0 0 0 0.011198  
## 3 0.106644 0 15.88658 44.40494 0 0 0 0.000000  
## NLCD82PC  
## 1 3.333498  
## 2 0.023662  
## 3 31.514062

# climate variables follow world clim, bioclim variables and were calculated from 1971-2001 PRISM  
# where necessary units are in temp 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 20001254 11 -9998 12.284088 8.440834 07  
## 2 2 1530095 11 -9998 6.725901 7.904562 07  
## 3 3 13955123 11 -9998 14.214751 8.502498 07  
## warm\_mo\_t cold\_mo cold\_mo\_t diff\_t warm\_q\_t warm\_q  
## 1 23.86272 01 1.016131 22.84659 22.7972640025855 06,07,08  
## 2 18.20654 01 -3.144276 21.35081 16.8982990699108 06,07,08  
## 3 25.70590 01 2.569704 23.13620 24.671011163345 06,07,08  
## cold\_q\_t cold\_q MISSDATAA.y PRECIPV wet\_mo wet\_mo\_p dry\_mo  
## 1 1.98993884180584 12,01,02 -9998 412.5028 08 72.65802 01  
## 2 -2.47232131355707 12,01,02 -9998 535.9319 08 89.50091 01  
## 3 3.69223857312809 12,01,02 -9998 506.4704 06 79.07203 01  
## dry\_mo\_p seasonality\_p wet\_q\_p wet\_q dry\_q\_p dry\_q dry\_q\_t  
## 1 8.78936 0.6823947 194.8507 06,07,08 27.54158 12,01,02 1.989939  
## 2 12.78031 0.5892279 227.4259 06,07,08 44.49445 12,01,02 -2.472321  
## 3 13.38404 0.5732462 210.9519 06,07,08 46.38533 12,01,02 3.692239  
## wet\_q\_t warm\_q\_p cold\_q\_p  
## 1 22.79726 64.95023 9.180527  
## 2 16.89830 75.80862 14.831484  
## 3 24.67101 70.31729 15.461776

# flow variables were calculated using the Mean Annual and Mean Monthly flow estimates from NHDPlusV2 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 20001254 11 19.04311 0.006 0 0.014  
## 2 2 1530095 11 93.99321 0.016 0 0.042  
## 3 3 13955123 11 24.66691 0.001 0 0.003  
## covMMQ0001E V0001E minMMV0001E maxMMV0001E covMMV0001E  
## 1 1.178460 0.37665 0.30839 0.41543 9.462309  
## 2 1.033141 0.54046 0.30839 0.69580 3.530139  
## 3 1.307341 0.35476 0.30839 0.39149 11.351676

# network scale topology: counts headwaters, nodes, trib juntions, edges  
# catchment area and total length and drainage density  
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 20001254 11 1 5 140 139 279 20001254 9  
## 2 2 1530095 11 1 5 140 139 279 1530095 34  
## 3 3 13955123 11 1 5 351 350 701 13955123 84  
## AreaSQKM LengthKM drain.den  
## 1 2728.026 1106.296 0.4055299  
## 2 1350.252 930.833 0.6893772  
## 3 16393.324 3995.297 0.2437149

# net\_hort determines horton laws for networks  
# produces a list: topology are means for each stream order  
# horton est and the estimated hortonian ratios  
rmd\_nethort <- net\_hort(netdelin = rmd\_netdelin, vpu = "11", nhdplus\_path = getwd())  
#str(rmd\_nethort)  
  
# net sinu gives sinusity and slope 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 1527767 1530095 2135.1868 m 2042.6388 m 1.045308 281311  
## 2 1527769 1530095 518.3390 m 497.6721 m 1.041527 270026  
## 3 1527771 1530095 2306.6579 m 1700.1350 m 1.356750 279709  
## 4 1527773 1530095 552.0238 m 549.7025 m 1.004223 271748  
## 5 1527775 1530095 1363.4853 m 1318.6346 m 1.034013 277869  
## 6 1527777 1530095 1730.9645 m 1645.1657 m 1.052152 278695  
## MinElevSM SlopeNHDPlus  
## 1 273236 0.04068010  
## 2 268283 0.03364864  
## 3 270026 0.04493271  
## 4 270026 0.03119565  
## 5 271748 0.05042009  
## 6 271748 0.04391276

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

## group.comid x  
## 1 13955123 1.199603  
## 2 1530095 1.098479  
## 3 20001254 1.218043

# net\_conflu results are given for each confluence  
# ?net\_conflu  
# this takes a while - there is a bug - forced end - do not run.  
#rmd\_netconflu <- net\_conflu(netdelin = rmd\_netdelin,  
 # nhdplus\_path = getwd(),  
 # vpu = "11")