Package 'nhdplusTools'

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Type Package

Title NHDPlus Tools

Version 0.5.5

Description Tools for traversing and working with National Hydrography Dataset Plus (NHDPlus) data. All methods implemented in 'nhdplusTools' are available in the NHDPlus documentation available from the US Environmental Protection Agency <https://www.epa.gov/waterdata/basic-information>.

URL https://usgs-r.github.io/nhdplusTools/
https://github.com/usgs-r/nhdplusTools/

BugReports https://github.com/usgs-r/nhdplusTools/issues/

Depends R (>= 4.0)

Imports dplyr, sf, RANN, units, magrittr, jsonlite, httr, xml2, R.utils, utils, tidyr, methods, rosm, prettymapr, fst, dataRetrieval, tools, zip, pbapply

Suggests testthat, knitr, rmarkdown, markdown, ggmap, ggplot2, sp, lwgeom, devtools, codetools, data.table, parallel, s2, gifski, leaflet

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Author David Blodgett [aut, cre] (<https://orcid.org/0000-0001-9489-1710>), Mike Johnson [aut] (<https://orcid.org/0000-0002-5288-8350>), Marc Weber [ctb] (<https://orcid.org/0000-0002-9742-4744>), Josh Erickson [ctb]

Maintainer David Blodgett <dblodgett@usgs.gov>

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R topics documented:

`add_plus_network_attributes`
Add NHDPlus Network Attributes to a provided network.

Description

Given a river network with required base attributes, adds the NHDPlus network attributes: hydrosequence, levelpath, terminalpath, pathlength, down levelpath, down hydroseq, total drainage area, and terminalflag. The function implements two parallelization schemes for small and large basins respectively. If a number of cores is specified, parallel execution will be used.

Usage

```
add_plus_network_attributes(
  net,
  override = 5,
  cores = NULL,
  split_temp = NULL,
  status = TRUE
)
```

Arguments

net	data.frame containing comid, tocomid, nameID, lengthkm, and areasqkm. Additional attributes will be passed through unchanged. tocomid == 0 is the convention used for outlets. If a "weight" column is provided, it will be used in get_levelpaths otherwise, arbolate sum is calculated for the network and used as the weight.
override	numeric factor to be passed to get_levelpaths
cores	integer number of processes to spawn if run in parallel.
split_temp	character path to optional temporary copy of the network split into independent sub-networks. If it exists, it will be read from disk rather than recreated.
status	logical should progress be printed?

Value

data.frame with added attributes

Examples

```
source(system.file("extdata", "walker_data.R", package = "nhdplusTools"))

test_flowline <- prepare_nhdplus(walker_flowline, 0, 0, FALSE)

test_flowline <- data.frame(
  comid = test_flowline$COMID,
  tocomid = test_flowline$toCOMID,
  nameID = walker_flowline$GNIS_ID,
  lengthkm = test_flowline$LENGTHKM,
  areasqkm = walker_flowline$AreaSqKM)

add_plus_network_attributes(test_flowline)
```

align_nhdplus_names *Align NHD Dataset Names*

Description

this function takes any NHDPlus dataset and aligns the attribute names with those used in nhdplusTools.

Usage

```
align_nhdplus_names(x)
```

Arguments

x	a sf object of nhdplus flowlines

Value

data.frame renamed sf object

Examples

```
source(system.file("extdata/new_hope_data.R", package = "nhdplusTools"))

names(new_hope_flowline)

names(new_hope_flowline) <- tolower(names(new_hope_flowline))

new_hope_flowline <- align_nhdplus_names(new_hope_flowline)

names(new_hope_flowline)
```

calculate_arbolate_sum *Calculate Arbolate Sum*

Description

Calculates arbolate sum given a dendritic network and incremental lengths. Arbolate sum is the total length of all upstream flowlines.

Usage

```
calculate_arbolate_sum(x)
```

Arguments

x	data.frame with ID, toID, and length columns.

Value

numeric with arbolate sum.

Examples

```
library(dplyr)
source(system.file("extdata", "walker_data.R", package = "nhdplusTools"))
catchment_length <- select(walker_flowline, COMID, AreaSqKM) %>%
  right_join(prepare_nhdplus(walker_flowline, 0, 0,
                             purge_non_dendritic = FALSE, warn = FALSE), by = "COMID") %>%
  select(ID = COMID, toID = toCOMID, length = LENGTHKM)

arb_sum <- calculate_arbolate_sum(catchment_length)

catchment_length$arb_sum <- arb_sum
catchment_length$nhd_arb_sum <- walker_flowline$ArbolateSu

mean(abs(catchment_length$arb_sum - catchment_length$nhd_arb_sum))
max(abs(catchment_length$arb_sum - catchment_length$nhd_arb_sum))
```

---

calculate_total_drainage_area

Total Drainage Area

Description

Calculates total drainage area given a dendritic network and incremental areas.

Usage

```
calculate_total_drainage_area(x)
```

Arguments

x	data.frame with ID, toID, and area columns.

Value

numeric with total area.

Examples

```
library(dplyr)
source(system.file("extdata", "walker_data.R", package = "nhdplusTools"))
catchment_area <- select(walker_flowline, COMID, AreaSqKM) %>%
  right_join(prepare_nhdplus(walker_flowline, 0, 0,
                             purge_non_dendritic = FALSE, warn = FALSE), by = "COMID") %>%
  select(ID = COMID, toID = toCOMID, area = AreaSqKM)

new_da <- calculate_total_drainage_area(catchment_area)

catchment_area$totda <- new_da
catchment_area$nhdptotda <- walker_flowline$TotDASqKM

mean(abs(catchment_area$totda - catchment_area$nhdptotda))
max(abs(catchment_area$totda - catchment_area$nhdptotda))
```

---

disambiguate_flowline_indexes

Disambiguate Flowline Indexes

Description

Given a set of flowline indexes and numeric or ascii criteria, return closest match. If numeric criteria are used, the minimum difference in the numeric attribute is used for disambiguation. If ascii criteria are used, the adist function is used with the following algorithm: '1 - adist_score / max_string_length'. Comparisons ignore case.

Usage

```
disambiguate_flowline_indexes(indexes, flowpath, hydro_location)
```

Arguments

indexes	data.frame as output from get_flowline_index with more than one hydrologic location per indexed point.
flowpath	data.frame with two columns. The first should join to the COMID field of the indexes and the second should be the numeric or ascii metric such as drainage area or GNIS Name. Names of this data.frame are not used.
hydro_location	data.frame with two columns. The first should join to the id field of the indexes and the second should be the numeric or ascii metric such as drainage area or GNIS Name.. Names of this data,frame are not used.

Value

data.frame indexes deduplicated according to the minimum difference between the values in the metric columns. If two or more result in the same "minimum" value, duplicates will be returned.

Examples

```
source(system.file("extdata", "sample_flines.R", package = "nhdplusTools"))

hydro_location <- sf::st_sf(id = c(1, 2, 3),
                            geom = sf::st_sfc(list(sf::st_point(c(-76.86934, 39.49328)),
                                                   sf::st_point(c(-76.91711, 39.40884)),
                                                  sf::st_point(c(-76.88081, 39.36354))),
                                              crs = 4326),
                            totda = c(23.6, 7.3, 427.9),
                            nameid = c("Patapsco", "", "Falls Run River"))

flowpath <- dplyr::select(sample_flines,
                          comid = COMID,
                          totda = TotDASqKM,
                          nameid = GNIS_NAME,
                          REACHCODE,
                          ToMeas,
                          FromMeas)

indexes <- get_flowline_index(flowpath,
                              hydro_location,
                              search_radius = 0.2,
                              max_matches = 10)

disambiguate_flowline_indexes(indexes,
                              dplyr::select(flowpath, comid, totda),
                              dplyr::select(hydro_location, id, totda))

result <- disambiguate_flowline_indexes(indexes,
                                        dplyr::select(flowpath, comid, nameid),
                                        dplyr::select(hydro_location, id, nameid))

result[result$id == 1, ]

result[result$id == 2, ]

result[result$id == 3, ]
```

---

discover_nhdplus_id *Discover NHDPlus ID*

Description

Multipurpose function to find a COMID of interest.

Usage

```
discover_nhdplus_id(point = NULL, nldi_feature = NULL, raindrop = FALSE)
```

Arguments

point	sfc POINT including crs as created by: sf::st_sfc(sf::st_point(.. ,..), crs)
nldi_feature	list with names ‘featureSource‘ and ‘featureID‘ where ‘featureSource‘ is derived from the "source" column of the response of get_nldi_sources and the ‘featureSource‘ is a known identifier from the specified ‘featureSource‘.
raindrop	logical if TRUE will call a raindrop trace web service and return will be the same as get_raindrop_trace with direction "none".

Value

integer COMID or list containing COMID and raindrop trace.

Examples

```
point <- sf::st_sfc(sf::st_point(c(-76.874, 39.482)), crs = 4326)
discover_nhdplus_id(point)

discover_nhdplus_id(point, raindrop = TRUE)

nldi_nwis <- list(featureSource = "nwissite", featureID = "USGS-08279500")
discover_nhdplus_id(nldi_feature = nldi_nwis)
```

---

discover_nldi_characteristics

Discover Characteristics Metadata

Description

Provides access to metadata for characteristics that are returned by ‘get_nldi_characteristics()‘.

Usage

```
discover_nldi_characteristics(type = "all")
```

Arguments

type	character "all", "local", "total", or "divergence_routed".

Value

data.frame containing available characteristics

Examples

```
chars <- discover_nldi_characteristics()
names(chars)
head(chars$local, 10)
```

`download_nhdplushr` *Download NHDPlus HiRes*

Description

Download NHDPlus HiRes

Usage

```
download_nhdplushr(nhd_dir, hu_list, download_files = TRUE)
```

Arguments

`nhd_dir`	character directory to save output into
`hu_list`	character vector of hydrologic region(s) to download. Use get_huc8 to find HU codes of interest. Accepts two digit and four digit codes.
`download_files`	boolean if FALSE, only URLs to files will be returned can be hu02s and/or hu04s

Value

character Paths to geodatabases created.

Examples

```
hu <- nhdplusTools::get_huc8(sf::st_sfc(sf::st_point(c(-73, 42)), crs = 4326))

(hu <- substr(hu$huc8, 1, 2))

download_nhdplushr(tempdir(), c(hu, "0203"), download_files = FALSE)
```

download_nhdplusv2 *Download seamless National Hydrography Dataset Version 2 (NHDPlusV2)*

Description

This function downloads and decompresses staged seamless NHDPlusV2 data. The following requirements are needed: p7zip (MacOS), 7zip (windows) Please see: https://www.epa.gov/waterdata/get-nhdplus-national-hydrography-dataset-plus-data for more information and metadata about this data.

Default downloads lower-48 only. See examples for islands. No Alaska data are available.

Usage

```
download_nhdplusv2(
  outdir,
  url = paste0("https://s3.amazonaws.com/edap-nhdplus/NHDPlusV21/",
   "Data/NationalData/NHDPlusV21_NationalData_Seamless", "_Geodatabase_Lower48_07.7z"),
  progress = TRUE
)
```

Arguments

outdir	The folder path where data should be downloaded and extracted
url	the location of the online resource
progress	boolean display download progress?

Value

character path to the local geodatabase

Examples

```
## Not run:
  download_nhdplusV2("./data/nhd/")

  download_nhdplusv2(outdir = "./inst/",
      url = paste0("https://s3.amazonaws.com/edap-nhdplus/NHDPlusV21/",
                   "Data/NationalData/NHDPlusV21_NationalData_Seamless",
                   "_Geodatabase_HI_PR_VI_PI_03.7z"))

## End(Not run)
```

download_rf1 *Download the seamless Reach File (RF1) Database*

Description

This function downloads and decompresses staged RF1 data. See: https://water.usgs.gov/GIS/metadata/usgswrd/XML/erf1_2
for metadata.

Usage

```
download_rf1(
  outdir,
  url = "https://water.usgs.gov/GIS/dsdl/erf1_2.e00.gz",
  progress = TRUE
)
```

Arguments

outdir	The folder path where data should be downloaded and extracted
url	the location of the online resource
progress	boolean display download progress?

Value

character path to the local e00 file

Examples

```
## Not run:
  download_wbd("./data/rf1/")

## End(Not run)
```

download_vaa *Download nhdplusVAA data from HydroShare*

Description

downloads and caches nhdplusVAA data on your computer

Usage

```
download_vaa(
  path = get_vaa_path(updated_network),
  force = FALSE,
  updated_network = FALSE
)
```

Arguments

path	character path where the file should be saved. Default is a persistent system data as retrieved by nhdplusTools_data_dir. Also see: get_vaa_path
force	logical. Force data re-download. Default = FALSE
updated_network	logical default FALSE. If TRUE, updated network attributes from E2NHD and National Water Model retrieved from here.

Details

The VAA data is a aggregate table of information from the NHDPlusV2 elevslope.dbf(s), PlusFlowlineVAA.dbf(s); and NHDFlowlines. All data originates from the EPA NHDPlus Homepage here. To see the location of cached data on your machine use `get_vaa_path`. To view aggregate data and documentation, see here

Value

character path to cached data

---

download_wbd *Download the seamless Watershed Boundary Dataset (WBD)*

Description

This function downloads and decompresses staged seamless WBD data. Please see: https://prd-tnm.s3.amazonaws.com/StagedProducts/Hydrography/WBD/National/GDB/WBD_National_GDB.xml for metadata.

Usage

```
download_wbd(
  outdir,
  url = paste0("https://prd-tnm.s3.amazonaws.com/StagedProducts/",
    "Hydrography/WBD/National/GDB/WBD_National_GDB.zip"),
  progress = TRUE
)
```

Arguments

outdir	The folder path where data should be downloaded and extracted
url	the location of the online resource
progress	boolean display download progress?

Value

character path to the local geodatabase

Examples

```
## Not run:
  download_wbd("./data/wbd/")

## End(Not run)
```

`fix_flowdir` *Fix flow direction*

Description

If flowlines aren't digitized in the expected direction, this will reorder the nodes so they are.

Usage

```
fix_flowdir(comid, network)
```

Arguments

`comid`	The COMID of the flowline to check
`network`	The entire network to check from. Requires a "toCOMID" field.

Value

a geometry for the feature that has been reversed if needed.

Examples

```
source(system.file("extdata/sample_data.R", package = "nhdplusTools"))

fline <- sf::read_sf(sample_data, "NHDFlowline_Network")

# We add a tocomid with prepare_nhdplus
fline <- sf::st_sf(prepare_nhdplus(fline, 0, 0, 0, FALSE),
                   geom = sf::st_zm(sf::st_geometry(fline)))

# Look at the end node of the 10th line.
(n1 <- get_node(fline[10, ], position = "end"))

# Break the geometry by reversing it.
sf::st_geometry(fline)[10] <- sf::st_reverse(sf::st_geometry(fline)[10])

# Note that the end node is different now.
(n2 <- get_node(fline[10, ], position = "end"))

# Pass the broken geometry to fix_flowdir with the network for toCOMID
sf::st_geometry(fline)[10] <- fix_flowdir(fline$COMID[10], fline)
```

```
# Note that the geometry is now in the right order.
(n3 <- get_node(fline[10, ], position = "end"))

plot(sf::st_geometry(fline)[10])
plot(n1, add = TRUE)
plot(n2, add = TRUE, col = "blue")
plot(n3, add = TRUE, cex = 2, col = "red")
```

---

get_boundaries *Return RPU or VPU boundaries*

Description

Return RPU or VPU boundaries

Usage

```
get_boundaries(type = "vpu")
```

Arguments

type	character. Either "RPU" or "VPU"

Value

An object of class "sf"

---

get_DD *Navigate Downstream with Diversions*

Description

Traverse NHDPlus network downstream with diversions NOTE: This algorithm may not scale well in large watersheds. For reference, the lower Mississippi will take over a minute.

Usage

```
get_DD(network, comid, distance = NULL)
```

Arguments

network	data.frame NHDPlus flowlines including at a minimum: COMID, DnMinorHyd, DnHydroseq, and Hydroseq.
comid	integer identifier to start navigating from.
distance	numeric distance in km to limit how many COMIDs are returned. The COMID that exceeds the distance specified is returned. The longest of the diverted paths is used for limiting distance.

Value

integer vector of all COMIDs downstream of the starting COMID

Examples

```
library(sf)
start_COMID <- 11688818

source(system.file("extdata", "sample_flines.R", package = "nhdplusTools"))

DD_COMIDs <- get_DD(sample_flines, start_COMID, distance = 4)
plot(dplyr::filter(sample_flines, COMID %in% DD_COMIDs)$geom,
     col = "red", lwd = 2)

DM_COMIDs <- get_DM(sample_flines, start_COMID, distance = 4)
plot(dplyr::filter(sample_flines, COMID %in% DM_COMIDs)$geom,
     col = "blue", add = TRUE, lwd = 2)
```

---

get_DM *Navigate Downstream Mainstem*

Description

Traverse NHDPlus network downstream main stem

Usage

```
get_DM(network, comid, distance = NULL, sort = FALSE, include = TRUE)
```

Arguments

network	data.frame NHDPlus flowlines including at a minimum: COMID, LENGTHKM, DnHydroseq, and Hydroseq.
comid	integer identifier to start navigating from.
distance	numeric distance in km to limit how many COMIDs are returned. The COMID that exceeds the distance specified is returned.
sort	if TRUE, the returned COMID vector will be sorted in order of distance from the input COMID (nearest to farthest)
include	if TRUE, the input COMID will be included in the returned COMID vector

Value

integer vector of all COMIDs downstream of the starting COMID along the mainstem

Examples

```
library(sf)

source(system.file("extdata", "sample_flines.R", package = "nhdplusTools"))

plot(sample_flines$geom)
start_COMID <- 11690092
DM_COMIDs <- get_DM(sample_flines, start_COMID)
plot(dplyr::filter(sample_flines, COMID %in% DM_COMIDs)$geom,
     col = "red", add = TRUE, lwd = 3)

DM_COMIDs <- get_DM(sample_flines, start_COMID, distance = 40)
plot(dplyr::filter(sample_flines, COMID %in% DM_COMIDs)$geom,
     col = "blue", add = TRUE, lwd = 2)
```

---

get_elev_along_path *Get Elevation Along Path (experimental)*

Description

Uses a cross section retrieval web services to retrieve elevation along a path.

Usage

```
get_elev_along_path(points, num_pts, res = 1, status = TRUE)
```

Arguments

points	sf data.frame containing a point column.
num_pts	numeric number of points to retrieve along the cross section.
res	integer resolution of 3D Elevation Program data to request. Must be on of: 1, 3, 5, 10, 30, 60.
status	logical

Value

sf data.frame containing points retrieved. Names include "id", "distance_m", "elevation_m", "spatial_ref", "geometry", and ".group". .group tracks which input point each set of output points belongs to.

Examples

```
point1 <- sf::st_sfc(sf::st_point(x = c(-105.9667, 36.17602)), crs = 4326)
point2 <- sf::st_sfc(sf::st_point(x = c(-105.97768, 36.17526)), crs = 4326)
point3 <- sf::st_sfc(sf::st_point(x = c(-105.98869, 36.17450)), crs = 4326)

points <- sf::st_as_sf(c(point1, point2, point3))

(xs <- get_elev_along_path(points, 100))

if(!is.null(xs)) {
bbox <- sf::st_bbox(xs) + c(-0.005, -0.005, 0.005, 0.005)

nhdplusTools::plot_nhdplus(bbox = bbox, cache_data = FALSE)

plot(sf::st_transform(sf::st_geometry(xs), 3857), pch = ".", add = TRUE, col = "red")
plot(sf::st_transform(sf::st_sfc(point1, crs = 4326), 3857), add = TRUE)
plot(sf::st_transform(sf::st_sfc(point2, crs = 4326), 3857), add = TRUE)
plot(sf::st_transform(sf::st_sfc(point3, crs = 4326), 3857), add = TRUE)

plot(xs$distance_m, xs$elevation_m)
}
```

---

get_flowline_index *Get Flowline Index*

Description

given an sf point geometry column, return COMID, reachcode, and measure for each.

Usage

```
get_flowline_index(
  flines,
  points,
  search_radius = NULL,
  precision = NA,
  max_matches = 1
)
```

Arguments

flines	sf data.frame of type LINESTRING or MULTILINESTRING including COMID, REACHCODE, ToMeas, and FromMeas. Can be "download_nhdplusv2" and remote nhdplusv2 data will be downloaded for the bounding box surround the submitted points. NOTE: The download option may not work for large areas, use with caution.

points	sf or sfc of type POINT in analysis projection. NOTE: flines will be projected to the projection of the points layer.
search_radius	units distance for the nearest neighbor search to extend in analysis projection. If missing or NULL, and points are in a lon lat projection, a default of 0.01 degree is used, otherwise 200 m is used. Conversion to the linear unit used by the provided crs of points is attempted. See RANN nn2 documentation for more details.
precision	numeric the resolution of measure precision in the output in meters.
max_matches	numeric the maximum number of matches to return if multiple are found in search_radius

Details

Note 1: Inputs are cast into LINESTRINGS. Because of this, the measure output of inputs that are true multipart lines may be in error.

Note 2: This algorithm finds the nearest node in the input flowlines to identify which flowline the point should belong to. As a second pass, it can calculate the measure to greater precision than the nearest flowline geometry node.

Note 3: Offset is returned in units consistent with the projection of the input points.

Note 4: See 'dfMaxLength' input to sf::st_segmentize() for details of handling of precision parameter.

Note 5: "from" is downstream – 0 is the outlet "to" is upstream – 100 is the inlet

Value

data.frame with five columns, id, COMID, REACHCODE, REACH_meas, and offset. id is the row or list element in the point input.

Examples

```
source(system.file("extdata", "sample_flines.R", package = "nhdplusTools"))

point <- sf::st_sfc(sf::st_point(c(-76.87479, 39.48233)),
                    crs = 4326)

get_flowline_index(sample_flines, point)

point <- sf::st_transform(point, 5070)

get_flowline_index(sample_flines, point,
                   search_radius = units::set_units(200, "m"))

get_flowline_index("download_nhdplusv2", point)

get_flowline_index(sample_flines, point, precision = 30)

get_flowline_index(sample_flines,
```

```
                    sf::st_sfc(list(sf::st_point(c(-76.86934, 39.49328)),
                                    sf::st_point(c(-76.91711, 39.40884)),
                                    sf::st_point(c(-76.88081, 39.36354))),
                               crs = 4326),
                    search_radius = units::set_units(0.2, "degrees"),
                    max_matches = 10)
```

`get_gagesII` *Find GAGESII Features*

Description

Subsets the gagesII dataset by location (POINT), area (POLYGON), or set of IDs.

Usage

```
get_gagesII(AOI = NULL, id = NULL, t_srs = NULL, buffer = 0.5, basin = FALSE)
```

Arguments

`AOI`	sf (MULTI)POINT or (MULTI)POLYGON. An 'area of interest' can be provided as either a location (sf POINT) or area (sf POLYGON) in any Spatial Reference System.
`id`	character NWIS Gage ID(s)
`t_srs`	character (PROJ string or EPSG code) or numeric (EPSG code). A user specified - target -Spatial Reference System (SRS/CRS) for returned objects. Will default to the CRS of the input AOI if provided, and to 4326 for ID requests.
`buffer`	numeric. The amount (in meters) to buffer a POINT AOI by for an extended search. Default = 0.5
`basin`	logical should the gagesII basin also be returned? If True, return value will be a list with "site" and "basin" elements.

Details

The returned object(s) will have the same Spatial Reference System (SRS) as the input AOI. If a individual or set of IDs are used to query, then the default geoserver CRS of EPSG:4326 is preserved. In all cases, a user-defined SRS can be passed to `t_srs` which will override all previous SRS's (either input or default). All buffer and distance operations are handled internally using in EPSG:5070 Albers Equal Area projection

Value

a simple features (sf) object

get_hr_data *Get NHDPlus HiRes Data*

Description

Use to remove unwanted detail NHDPlusHR data See get_nhdplushr for examples.

Usage

```
get_hr_data(
  gdb,
  layer = NULL,
  min_size_sqkm = NULL,
  simp = NULL,
  proj = NULL,
  rename = TRUE
)
```

Arguments

gdb	character path to geodatabase to get data from.
layer	character layer name from geodatabase found with st_layers
min_size_sqkm	numeric minimum basin size to be included in the output
simp	numeric simplification tolerance in units of projection
proj	a projection specification compatible with st_crs
rename	boolean if TRUE, nhdplusTools standard attribute values will be applied.

Value

sf data.frame containing requested data

get_huc12 *Find WBD HUC 12 unit subsets*

Description

Subsets the WBD level 12 features by location (POINT), area (POLYGON), or set of IDs.

Usage

```
get_huc12(AOI = NULL, id = NULL, t_srs = NULL, buffer = 0.5)
```

Arguments

AOI	sf (MULTI)POINT or (MULTI)POLYGON. An 'area of interest' can be provided as either a location (sf POINT) or area (sf POLYGON) in any Spatial Reference System.
id	WBD HUC12 ID(s)
t_srs	character (PROJ string or EPSG code) or numeric (EPSG code). A user specified - target -Spatial Reference System (SRS/CRS) for returned objects. Will default to the CRS of the input AOI if provided, and to 4326 for ID requests.
buffer	numeric. The amount (in meters) to buffer a POINT AOI by for an extended search. Default = 0.5

Details

The returned object(s) will have the same Spatial Reference System (SRS) as the input AOI. If a individual or set of IDs are used to query, then the default geoserver CRS of EPSG:4326 is preserved. In all cases, a user-defined SRS can be passed to `t_srs` which will override all previous SRS's (either input or default). All buffer and distance operations are handled internally using in EPSG:5070 Albers Equal Area projection

Value

a simple features (sf) object

---

get_huc8 *Find WBD HUC 08 unit subsets*

Description

Subsets the WBD level 08 features by location (POINT), area (POLYGON), or set of IDs.

Usage

```
get_huc8(AOI = NULL, id = NULL, t_srs = NULL, buffer = 0.5)
```

Arguments

AOI	sf (MULTI)POINT or (MULTI)POLYGON. An 'area of interest' can be provided as either a location (sf POINT) or area (sf POLYGON) in any Spatial Reference System.
id	WBD HUC08 ID(s)
t_srs	character (PROJ string or EPSG code) or numeric (EPSG code). A user specified - target -Spatial Reference System (SRS/CRS) for returned objects. Will default to the CRS of the input AOI if provided, and to 4326 for ID requests.
buffer	numeric. The amount (in meters) to buffer a POINT AOI by for an extended search. Default = 0.5

Details

The returned object(s) will have the same Spatial Reference System (SRS) as the input AOI. If a individual or set of IDs are used to query, then the default geoserver CRS of EPSG:4326 is preserved. In all cases, a user-defined SRS can be passed to `t_srs` which will override all previous SRS's (either input or default). All buffer and distance operations are handled internally using in EPSG:5070 Albers Equal Area projection

Value

a simple features (sf) object

`get_hydro_location` *Get Hydro Location*

Description

given a flowline index, returns the hydrologic location (point) along the specific linear element referenced by the index.

Usage

```
get_hydro_location(indexes, flowpath)
```

Arguments

`indexes`	data.frame as output from get_flowline_index.
`flowpath`	data.frame with three columns: COMID, FromMeas, and ToMeas as well as geometry.

Examples

```
source(system.file("extdata", "sample_flines.R", package = "nhdplusTools"))

indexes <- get_flowline_index(sample_flines,
                  sf::st_sfc(sf::st_sfc(list(sf::st_point(c(-76.86934, 39.49328)),
                                             sf::st_point(c(-76.91711, 39.40884)),
                                             sf::st_point(c(-76.88081, 39.36354))),
                             crs = 4326)))

get_hydro_location(indexes, sample_flines)
```

get_levelpaths *Get Level Paths*

Description

Calculates level paths using the stream-leveling approach of NHD and NHDPlus. In addition to a levelpath identifier, a topological sort and levelpath outlet identifier is provided in output. If arbolate sum is provided in the weight column, this will match the behavior of NHDPlus. Any numeric value can be included in this column and the largest value will be followed when no nameID is available.

Usage

```
get_levelpaths(x, override_factor = NULL, status = FALSE, cores = NULL)
```

Arguments

x	data.frame with ID, toID, nameID, and weight columns.
override_factor	numeric factor to use to override nameID. If 'weight' is 'numeric_factor' times larger on a path, it will be followed regardless of the nameID indication.
status	boolean if status updates should be printed.
cores	numeric number of cores to use in initial path ranking calculations.

Details

1. levelpath provides an identifier for the collection of flowlines that make up the single mainstem flowpath of a total upstream aggregate catchment.
2. outletID is the catchment ID (COMID in the case of NHDPlus) for the catchment at the outlet of the levelpath the catchment is part of.
3. topo_sort is similar to Hydroseq in NHDPlus in that large topo_sort values are upstream of small topo_sort values. Note that there are many valid topological sort orders of a directed graph.

Value

data.frame with ID, outletID, topo_sort, and levelpath columns. See details for more info.

Examples

```
source(system.file("extdata", "walker_data.R", package = "nhdplusTools"))

test_flowline <- prepare_nhdplus(walker_flowline, 0, 0, FALSE)

test_flowline <- data.frame(
  ID = test_flowline$COMID,
  toID = test_flowline$toCOMID,
  nameID = walker_flowline$GNIS_ID,
```

```
  weight = walker_flowline$ArbolateSu,
  stringsAsFactors = FALSE)

get_levelpaths(test_flowline)
```

`get_nhdarea` *Find NHD Areas*

Description

Subsets NHD Area features by location (POINT), area (POLYGON), or set of IDs.

Usage

```
get_nhdarea(AOI = NULL, id = NULL, t_srs = NULL, buffer = 0.5)
```

Arguments

`AOI`	sf (MULTI)POINT or (MULTI)POLYGON. An 'area of interest' can be provided as either a location (sf POINT) or area (sf POLYGON) in any Spatial Reference System.
`id`	NHD Area COMID(s)
`t_srs`	character (PROJ string or EPSG code) or numeric (EPSG code). A user specified - target -Spatial Reference System (SRS/CRS) for returned objects. Will default to the CRS of the input AOI if provided, and to 4326 for ID requests.
`buffer`	numeric. The amount (in meters) to buffer a POINT AOI by for an extended search. Default = 0.5

Details

The returned object(s) will have the same Spatial Reference System (SRS) as the input AOI. If a individual or set of IDs are used to query, then the default geoserver CRS of EPSG:4326 is preserved. In all cases, a user-defined SRS can be passed to `t_srs` which will override all previous SRS's (either input or default). All buffer and distance operations are handled internally using in EPSG:5070 Albers Equal Area projection

Value

a simple features (sf) object

`get_nhdplus` *Get National Hydrography Dataset V2 Subsets (Multirealization)*

Description

Subsets NHDPlusV2 features by location (POINT), area (POLYGON), or set of COMIDs. Multi realizations are supported allowing you to query for flowlines, catchments, or outlets.

Usage

```
get_nhdplus(
  AOI = NULL,
  comid = NULL,
  nwis = NULL,
  realization = "flowline",
  streamorder = NULL,
  t_srs = NULL
)
```

Arguments

`AOI`	sf (MULTI)POINT or (MULTI)POLYGON. An 'area of interest' can be provided as either a location (sf POINT) or area (sf POLYGON) in any Spatial Reference System.
`comid`	numeric or character. Search for NHD features by COMID(s)
`nwis`	numeric or character. Search for NHD features by collocated NWIS identifiers
`realization`	character. What realization to return. Default is flowline and options include: outlet, flowline, catchment, and all
`streamorder`	numeric or character. Only return NHD flowlines with a streamorder greater then or equal to this value for input value and higher. Only usable with AOI and flowline realizations.
`t_srs`	character (PROJ string or EPSG code) or numeric (EPSG code). A user specified - target -Spatial Reference System (SRS/CRS) for returned objects. Will default to the CRS of the input AOI if provided, and to 4326 for ID requests.

Details

The returned object(s) will have the same Spatial Reference System (SRS) as the input AOI. If a individual or set of IDs are used to query, then the default geoserver CRS of EPSG:4326 is preserved. In all cases, a user-defined SRS can be passed to `t_srs` which will override all previous SRS's (either input or default). All buffer and distance operations are handled internally using in EPSG:5070 Albers Equal Area projection

Value

sfc a single, or list, of simple feature objects

Examples

```
point <- sf::st_sfc(sf::st_point(c(-119.845, 34.4146)), crs = 4326)
get_nhdplus(point)
get_nhdplus(point, realization = "catchment")
get_nhdplus(point, realization = "all")
get_nhdplus(comid = 101)
get_nhdplus(nwis  = c(11120000, 11120500))
area <- sf::st_as_sfc(sf::st_bbox(c(xmin = -119.8851, xmax =-119.8361,
ymax = 34.42439, ymin = 34.40473), crs = 4326))
get_nhdplus(area)
get_nhdplus(area, realization = "flowline", streamorder = 3)
```

`get_nhdplushr` *Get NHDPlus HiRes*

Description

Get NHDPlus HiRes

Usage

```
get_nhdplushr(
  hr_dir,
  out_gpkg = NULL,
  layers = c("NHDFlowline", "NHDPlusCatchment"),
  pattern = ".*GDB.gdb$",
  check_terminals = TRUE,
  overwrite = FALSE,
  keep_cols = NULL,
  ...
)
```

Arguments

`hr_dir`	character directory with geodatabases (gdb search is recursive)
`out_gpkg`	character path to write output geopackage
`layers`	character vector with desired layers to return. c("NHDFlowline", "NHDPlusCatchment") is default. Choose from: c("NHDFlowline", "NHDPlusCatchment", "NHDWaterbody", "NHDArea", "NHDLine", "NHDPlusSink", "NHDPlusWall", "NHDPoint", "NHDPlusBurnWaterbody", "NHDPlusBurnLineEvent", "HYDRO_NET_Junctions", "WBDHU2", "WBDHU4","WBDHU6", "WBDHU8" "WBDHU10", "WBDHU12", "WBDLine") Set to NULL to get all available.
`pattern`	character optional regex to select certain files in hr_dir
`check_terminals`	boolean if TRUE, run make_standalone on output.

overwrite	boolean should the output overwrite? If false and the output layer exists, it will be read and returned so this function will always return data even if called a second time for the same output. This is useful for workflows. Note that this will NOT delete the entire Geopackage. It will overwrite on a per layer basis.
keep_cols	character vector of column names to keep in the output. If NULL, all will be kept.
...	parameters passed along to get_hr_data for "NHDFlowline" layers.

Details

NHDFlowline is joined to value added attributes prior to being returned. Names are not modified from the NHDPlusHR geodatabase. Set layers to "NULL" to get all layers.

Value

sf data.frames containing output that may also be written to a geopackage for later use.

Examples

```
## Not run:
# Note this will download a lot of data to a temp directory.
# Change 'temp_dir' to your directory of choice.
temp_dir <- file.path(nhdplusTools_data_dir(), "temp_hr_cache")

download_dir <- download_nhdplushr(temp_dir, c("0302", "0303"))

get_nhdplushr(download_dir, file.path(download_dir, "nhdplus_0302-03.gpkg"))

get_nhdplushr(download_dir,
              file.path(download_dir, "nhdplus_0302-03.gpkg"),
              layers = NULL, overwrite = TRUE)

get_nhdplushr(download_dir,
              file.path(download_dir, "nhdplus_0302-03.gpkg"),
              layers = "NHDFlowline", overwrite = TRUE,
              min_size_sqkm = 10, simp = 10, proj = "+init=epsg:5070")

# Cleanup
unlink(temp_dir, recursive = TRUE)


## End(Not run)
```

---

get_nldi_basin *Get NLDI Basin Boundary*

Description

Get a basin boundary for a given NLDI feature.

Usage

```
get_nldi_basin(nldi_feature, simplify = TRUE, split = FALSE)
```

Arguments

nldi_feature	list with names ‘featureSource‘ and ‘featureID‘ where ‘featureSource‘ is derived from the "source" column of the response of dataRetrieval::get_nldi_sources() and the ‘featureID‘ is a known identifier from the specified ‘featureSource‘.
simplify	logical should response geometry be simplified for visualization and performance?
split	logical should response resolve precisely to the location of the ‘nldi_feature‘? Setting ‘TRUE‘ calls an aditional service and will be slower and less robust.

Details

Only resolves to the nearest NHDPlus catchment divide. See: https://waterdata.usgs.gov/blog/nldi-intro/ for more info on the nldi.

Value

sf data.frame with result basin boundary

Examples

```
library(sf)
library(dplyr)

nldi_nwis <- list(featureSource = "nwissite", featureID = "USGS-05428500")

site <- get_nldi_feature(nldi_nwis)

basin <- get_nldi_basin(nldi_feature = nldi_nwis)

plot(st_geometry(basin))

basin

basin2 <- get_nldi_basin(nldi_feature = nldi_nwis,
                         simplify = FALSE, split = TRUE)

length(st_coordinates(basin))
length(st_coordinates(basin2))

plot(st_geometry(st_buffer(site, units::set_units(3000, "m"))), border = NA)

plot(st_geometry(site), add = TRUE)
plot(st_geometry(basin2), add = TRUE)

plot(st_geometry(basin), border = "red", add = TRUE)
```

get_nldi_characteristics *Get Catchment Characteristics*

Description

Retrieves catchment characteristics from the Network Linked Data Index. Metadata for these characteristics can be found using ‘discover_nldi_characteristics()‘.

Usage

```
get_nldi_characteristics(nldi_feature, type = "local")
```

Arguments

nldi_feature	list with names ‘featureSource‘ and ‘featureID‘ where ‘featureSource‘ is derived from the "source" column of the response of dataRetrieval::get_nldi_sources() and the ‘featureID‘ is a known identifier from the specified ‘featureSource‘.
type	character "all", "local", "total", or "divergence_routed".

Value

data.frame contianing requested characteristics

Examples

```
chars <- get_nldi_characteristics(list(featureSource = "nwissite", featureID = "USGS-05429700"))
names(chars)
head(chars$local, 10)
```

get_nldi_feature *Get NLDI Feature*

Description

Get a single feature from the NLDI

Usage

```
get_nldi_feature(nldi_feature)
```

Arguments

nldi_feature	list with names ‘featureSource‘ and ‘featureID‘ where ‘featureSource‘ is derived from the "source" column of the response of dataRetrieval::get_nldi_sources() and the ‘featureID‘ is a known identifier from the specified ‘featureSource‘.

Value

sf data.frame with one feature

Examples

```
get_nldi_feature(list("featureSource" = "nwissite", featureID = "USGS-05428500"))
```

---

get_nldi_index *Get NLDI Index*

Description

uses the Network Linked Data Index to retrieve and estimated network location for the given point. If not within a grid cell of a flowline, will use a raindrop trace service to find the nearest downslope flowline location.

Usage

```
get_nldi_index(location)
```

Arguments

location	numeric WGS84 lon/lat pair (X, Y)

Examples

```
index <- get_nldi_index(c(-89.276, 42.988))

plot_nhdplus(bbox = sf::st_bbox(sf::st_buffer(index[1,], units::set_units(1000, "m"))))
plot(sf::st_geometry(sf::st_transform(index, 3857)), add = TRUE)
```

get_node *Get Flowline Node*

Description

Given one or more flowlines, returns a particular node from the flowline.

Usage

```
get_node(x, position = "end")
```

Arguments

x	sf data.frame with one or more flowlines
position	character either "start" or "end"

Value

sf data.frame containing requested nodes

Examples

```
source(system.file("extdata/sample_data.R", package = "nhdplusTools"))

fline <- sf::read_sf(sample_data, "NHDFlowline_Network")

start <- get_node(fline, "start")
end <- get_node(fline, "end")

plot(sf::st_zm(fline$geom),
     lwd = fline$StreamOrde, col = "blue")
plot(sf::st_geometry(start), add = TRUE)

plot(sf::st_zm(fline$geom),
     lwd = fline$StreamOrde, col = "blue")
plot(sf::st_geometry(end), add = TRUE)
```

get_nwis *Discover USGS NWIS Stream Gages*

Description

Returns a POINT feature class of active, stream network, NWIS gages for an Area of Interest. If a POINT feature is used as an AOI, then the returned sites within the requested buffer, are sorted by distance (in meters) from that POINT.

Usage

```
get_nwis(AOI = NULL, t_srs = NULL, buffer = 20000)
```

Arguments

AOI	sf (MULTI)POINT or (MULTI)POLYGON. An 'area of interest' can be provided as either a location (sf POINT) or area (sf POLYGON) in any Spatial Reference System.
t_srs	character (PROJ string or EPSG code) or numeric (EPSG code). A user specified - target -Spatial Reference System (SRS/CRS) for returned objects. Will default to the CRS of the input AOI if provided, and to 4326 for ID requests.
buffer	numeric. The amount (in meters) to buffer a POINT AOI by for an extended search. Default = 20,000. Returned results are arrange by distance from POINT AOI

Details

The returned object(s) will have the same Spatial Reference System (SRS) as the input AOI. If a individual or set of IDs are used to query, then the default geoserver CRS of EPSG:4326 is preserved. In all cases, a user-defined SRS can be passed to `t_srs` which will override all previous SRS's (either input or default). All buffer and distance operations are handled internally using in EPSG:5070 Albers Equal Area projection

Value

a simple features (sf) object

---

get_partial_length *Get Partial Flowline Length*

Description

Finds the upstream and downstream lengths along a given flowpath (flowline in nhdplus terminology). Internally, the function rescales the reach measure to a flowpath measure and applies that rescaled measure to the length of the flowpath.

Usage

```
get_partial_length(hl, net = NULL, fl = NULL)
```

Arguments

hl	list containing a hydrologic location with names reachcode and reach_meas.
net	data.frame containing a flowpath network with reachcode, frommeas, tomeas, and lengthkm attributes. Not required if 'fl' is provided.
fl	data.frame containing one flowline that corresponds to the reachcode and measure of 'hl'. Not required if 'hl' is provided.

Value

list containing ‘up‘ and ‘dn‘ elements with numeric length in km.

Examples

```
source(system.file("extdata", "walker_data.R", package = "nhdplusTools"))
hydro_location <- list(comid = 5329339,
                       reachcode = "18050005000078",
                       reach_meas = 30)

(pl <- get_partial_length(hydro_location, walker_flowline))

hydro_location <- sf::st_sf(hydro_location,
                     geom = nhdplusTools::get_hydro_location(data.frame(hydro_location),
                                                             walker_flowline))

net <- navigate_network(hydro_location,
                        mode = "DM", network = walker_flowline,
                        distance_km = 4, trim_start = TRUE)

plot(sf::st_geometry(walker_flowline[walker_flowline$COMID == hydro_location$comid,]))
plot(sf::st_geometry(hydro_location), add = TRUE)
plot(sf::st_geometry(net), add = TRUE, col = "blue", lwd = 2)

sf::st_length(net)
pl$dn
```

---

get_pathlength *Get Path Length*

Description

Generates the main path length to a basin’s terminal path.

Usage

```
get_pathlength(x)
```

Arguments

x	data.frame with ID, toID, length columns.

Value

data.frame containing levelpaths for each ID

Examples

```
source(system.file("extdata", "walker_data.R", package = "nhdplusTools"))

fl <- dplyr::select(prepare_nhdplus(walker_flowline, 0, 0),
                    ID = COMID, toID = toCOMID, length = LENGTHKM)

get_pathlength(fl)
```

---

get_path_lengths *Get Path Lengths*

Description

Given a network and set of IDs, finds path lengths between all identified flowpath outlets. This algorithm finds distance between outlets regardless of flow direction.

Usage

```
get_path_lengths(outlets, network, cores = 1, status = FALSE)
```

Arguments

outlets	vector of IDs from data.frame
network	data.frame with ID, toID, and lengthkm attributes.
cores	integer number of cores to use for parallel computation.
status	logical print status and progress bars?

Value

data.frame containing the distance between pairs of network outlets. For a network with one terminal outlet, the data.frame will have ‘nrow(network)^2‘ rows.

Examples

```
source(system.file("extdata", "walker_data.R", package = "nhdplusTools"))
fline <- walker_flowline

outlets <- c(5329303, 5329357, 5329317, 5329365, 5329435, 5329817)

# Add toCOMID
fline <- nhdplusTools::get_tocomid(fline, add = TRUE)

fl <- dplyr::select(fline, ID = comid, toID = tocomid, lengthkm)

path_lengths <- get_path_lengths(outlets, fl)

outlet_geo <- sf::st_sf(
```

```
  dplyr::left_join(data.frame(ID = outlets),
                   dplyr::select(fline, ID = comid), by = "ID"))

sf::st_geometry(outlet_geo) <- sf::st_geometry(nhdplusTools::get_node(outlet_geo))

plot(sf::st_geometry(fl))
plot(sf::st_geometry(outlet_geo), add = TRUE)
```

`get_pfaf` *Get Pfafstetter Codes (Experimental)*

Description

Determines Pfafstetter codes for a dendritic network with total drainage area, levelpath, and topo_sort attributes.

Usage

```
get_pfaf(x, max_level = 2, status = FALSE)
```

Arguments

`x`	sf data.frame with ID, toID, totda, outletID, topo_sort, and levelpath attributes.
`max_level`	integer number of pfaf levels to attempt to calculate. If the network doesn't have resolution to support the desired level, unexpected behavior may occur.
`status`	boolean print status or not

Value

data.frame with ID and pfaf columns.

Examples

```
library(dplyr)
source(system.file("extdata/nhdplushr_data.R", package = "nhdplusTools"))
hr_flowline <- align_nhdplus_names(hr_data$NHDFlowline)

fl <-  select(hr_flowline, COMID, AreaSqKM) %>%
  right_join(prepare_nhdplus(hr_flowline, 0, 0,
                             purge_non_dendritic = FALSE,
                             warn = FALSE),
             by = "COMID") %>%
  sf::st_sf() %>%
  select(ID = COMID, toID = toCOMID, area = AreaSqKM)

fl$nameID = ""
fl$totda <- calculate_total_drainage_area(sf::st_set_geometry(fl, NULL))
```

```
fl <- left_join(fl, get_levelpaths(rename(sf::st_set_geometry(fl, NULL),
                                    weight = totda)), by = "ID")

pfaf <- get_pfaf(fl, max_level = 3)

fl <- left_join(fl, pfaf, by = "ID")

plot(fl["pf_level_3"], lwd = 2)

pfaf <- get_pfaf(fl, max_level = 4)

hr_catchment <- left_join(hr_data$NHDPlusCatchment, pfaf, by = c("FEATUREID" = "ID"))

colors <- data.frame(pf_level_4 = unique(hr_catchment$pf_level_4),
                color = sample(terrain.colors(length(unique(hr_catchment$pf_level_4)))),
                    stringsAsFactors = FALSE)
hr_catchment <- left_join(hr_catchment, colors, by = "pf_level_4")
plot(hr_catchment["color"], border = NA, reset = FALSE)
plot(sf::st_geometry(hr_flowline), col = "blue", add = TRUE)

source(system.file("extdata", "walker_data.R", package = "nhdplusTools"))

fl <- select(walker_flowline, COMID, AreaSqKM) %>%
  right_join(prepare_nhdplus(walker_flowline, 0, 0,
                             purge_non_dendritic = FALSE, warn = FALSE),
            by = "COMID") %>%
  sf::st_sf() %>%
  select(ID = COMID, toID = toCOMID, area = AreaSqKM)

fl$nameID = ""
fl$totda <- calculate_total_drainage_area(sf::st_set_geometry(fl, NULL))
fl <- left_join(fl, get_levelpaths(rename(sf::st_set_geometry(fl, NULL),
                                    weight = totda)), by = "ID")

pfaf <- get_pfaf(fl, max_level = 2)

fl <- left_join(fl, pfaf, by = "ID")

plot(fl["pf_level_2"], lwd = 2)
```

`get_raindrop_trace` *Get Raindrop Trace*

Description

Uses a raindrop trace web service to trace the nhdplus digital elevation model to the nearest downslop flowline.

Usage

```
get_raindrop_trace(point, direction = "down")
```

Arguments

point	sfc POINT including crs as created by: sf::st_sfc(sf::st_point(.. ,..), crs)
direction	character "up", "down", or "none". Controls the portion of the split flowline that is returned along with the raindrop trace line.

Value

sf data.frame containing raindrop trace and requested portion of flowline.

Examples

```
point <- sf::st_sfc(sf::st_point(x = c(-89.2158, 42.9561)), crs = 4326)

(trace <- get_raindrop_trace(point))

bbox <- sf::st_bbox(trace) + c(-0.005, -0.005, 0.005, 0.005)

nhdplusTools::plot_nhdplus(bbox = bbox, cache_data = FALSE)

plot(sf::st_transform(sf::st_sfc(point, crs = 4326), 3857), add = TRUE)
plot(sf::st_transform(sf::st_geometry(trace)[1], 3857), add = TRUE, col = "red")
plot(sf::st_transform(sf::st_geometry(trace)[2], 3857), add = TRUE, col = "black")
```

---

get_sorted *Get Sorted Network*

Description

given a tree with an id and and toid in the first and second columns, returns a sorted and potentially split set of output.

Can also be used as a very fast implementation of upstream with tributaries navigation. The full network from each outlet is returned in sorted order.

Usage

```
get_sorted(x, split = FALSE, outlets = NULL)
```

Arguments

x	data.frame with an identifier and to identifier in the first and second columns.
split	logical if TRUE, the result will be split into independent networks identified by the id of their outlet. The outlet id of each independent network is added as a "terminalID" attribute.
outlets	same as id in x; if specified only the network emanating from these outlets will be considered and returned.

Value

data.frame containing a topologically sorted version of the requested network and optionally a terminal id.

Examples

```
source(system.file("extdata/new_hope_data.R", package = "nhdplusTools"))

fpath <- get_tocomid(
  dplyr::select(new_hope_flowline, COMID, FromNode, ToNode, Divergence, FTYPE,
                AreaSqKM, LENGTHKM, GNIS_ID)
)

head(fpath <- get_sorted(fpath, split = TRUE))

fpath['sort_order'] <- 1:nrow(fpath)

plot(fpath['sort_order'])
```

---

get_split_catchment *Get split catchment*

Description

Uses catchment splitting web service to retrieve the portion of a catchment upstream of the point provided.

Usage

```
get_split_catchment(point, upstream = TRUE)
```

Arguments

point	scf POINT including crs as created by: `sf::st_sfc(sf::st_point(.. ,..), crs)`
upstream	logical If TRUE, the entire drainage basin upstream of the point provided is returned in addition to the local catchment.

Value

sf data.frame containing the local catchment, the split portion and optionally the total dranage basin.

Examples

```
point <- sf::st_sfc(sf::st_point(x = c(-89.2158, 42.9561)), crs = 4326)

trace <- get_raindrop_trace(point)

(snap_point <- sf::st_sfc(sf::st_point(trace$intersection_point[[1]]),
                          crs = 4326))

(catchment <- get_split_catchment(snap_point))

bbox <- sf::st_bbox(catchment) + c(-0.005, -0.005, 0.005, 0.005)

nhdplusTools::plot_nhdplus(bbox = bbox, cache_data = FALSE)

plot(sf::st_transform(sf::st_geometry(catchment)[2], 3857), add = TRUE, col = "black")
plot(sf::st_transform(sf::st_geometry(catchment)[1], 3857), add = TRUE, col = "red")
plot(sf::st_transform(sf::st_sfc(point, crs = 4326), 3857), add = TRUE, col = "white")

(catchment <- get_split_catchment(snap_point, upstream = FALSE))

bbox <- sf::st_bbox(catchment) + c(-0.005, -0.005, 0.005, 0.005)

nhdplusTools::plot_nhdplus(bbox = bbox, cache_data = FALSE)

plot(sf::st_transform(sf::st_geometry(catchment)[1], 3857), add = TRUE, col = "red")
plot(sf::st_transform(sf::st_geometry(catchment)[2], 3857), add = TRUE, col = "black")
plot(sf::st_transform(sf::st_sfc(point, crs = 4326), 3857), add = TRUE, col = "white")

pour_point <- sf::st_sfc(sf::st_point(x = c(-89.25619, 42.98646)), crs = 4326)

(catchment <- get_split_catchment(pour_point, upstream = FALSE))

bbox <- sf::st_bbox(catchment) + c(-0.005, -0.005, 0.005, 0.005)

nhdplusTools::plot_nhdplus(bbox = bbox, cache_data = FALSE)

plot(sf::st_transform(sf::st_geometry(catchment)[1], 3857), add = TRUE, col = "red")
plot(sf::st_transform(sf::st_geometry(catchment)[2], 3857), add = TRUE, col = "black")
plot(sf::st_transform(sf::st_sfc(pour_point, crs = 4326), 3857), add = TRUE, col = "white")
```

`get_streamlevel` *Get Streamlevel*

Description

Applies a topological sort and calculates stream level. Algorithm: Terminal level paths are assigned level 1 (see note 1). Paths that terminate at a level 1 are assigned level 2. This pattern is repeated until no paths remain.

If a TRUE/FALSE coastal attribute is included, coastal terminal paths begin at 1 and internal terminal paths begin at 4 as is implemented by the NHD stream leveling rules.

Usage

```
get_streamlevel(x)
```

Arguments

x	data.frame with levelpathi, dnlevelpat, and optionally a coastal flag. If no coastal flag is included, all terminal paths are assumed to be coastal.

Value

numeric stream order in same order as input

Examples

```
source(system.file("extdata", "walker_data.R", package = "nhdplusTools"))

test_flowline <- data.frame(
 levelpathi = walker_flowline$LevelPathI,
 dnlevelpat = walker_flowline$DnLevelPat)

 test_flowline$dnlevelpat[1] <- 0

(level <- get_streamlevel(test_flowline))

walker_flowline$level <- level

plot(sf::st_geometry(walker_flowline), lwd = walker_flowline$level, col = "blue")

test_flowline$coastal <- rep(FALSE, nrow(test_flowline))
(level <- get_streamlevel(test_flowline))

test_flowline$coastal[!test_flowline$dnlevelpat %in% test_flowline$levelpathi] <- TRUE
(level <- get_streamlevel(test_flowline))
```

get_streamorder *Get Streamorder*

Description

Applies a topological sort and calculates strahler stream order. Algorithm: If more than one upstream flowpath has an order equal to the maximum upstream order then the downstream flowpath is assigned the maximum upstream order plus one. Otherwise it is assigned the max upstream order.

Usage

```
get_streamorder(x, status = TRUE)
```

Arguments

x	data.frame with dendritic ID and toID columns.
status	logical show progress update messages?

Value

numeric stream order in same order as input

Examples

```
source(system.file("extdata", "walker_data.R", package = "nhdplusTools"))

test_flowline <- prepare_nhdplus(walker_flowline, 0, 0, FALSE)

test_flowline <- data.frame(
  ID = test_flowline$COMID,
  toID = test_flowline$toCOMID)

(order <- get_streamorder(test_flowline))

walker_flowline$order <- order

plot(sf::st_geometry(walker_flowline), lwd = walker_flowline$order, col = "blue")
```

get_terminal *Get Terminal ID (DEPRECATED)*

Description

Get the ID of the basin outlet for each flowline. This function has been deprecated in favor of get_sorted.

Usage

```
get_terminal(x, outlets)
```

Arguments

x	two column data.frame with IDs and toIDs. Names are ignored.
outlets	IDs of outlet flowlines

Value

data.frame containing the terminal ID for each outlet

Examples

```
source(system.file("extdata", "walker_data.R", package = "nhdplusTools"))

fl <- dplyr::select(prepare_nhdplus(walker_flowline, 0, 0),
                    ID = COMID, toID = toCOMID)

outlet <- fl$ID[which(!fl$toID %in% fl$ID)]

get_terminal(fl, outlet)
```

get_tocomid *Get tocomid*

Description

Given flowlines with fromnode and tonode attributes, will return a toid attribute that is the result of joining tonode and fromnode attributes. In the case that a terminalpa attribute is included, the join is executed by terminalpa group. This is done grouped by terminalpathID because duplicate node ids have been encountered accross basins in some datasets. If ‘remove_coastal‘ is ‘TRUE‘ (the default) either ftype or fcode are required.

Usage

```
get_tocomid(
  x,
  return_dendritic = TRUE,
  missing = 0,
  remove_coastal = TRUE,
  add = TRUE
)
```

Arguments

x	data.frame with comid, tonode, fromnode, and (optionally) divergence and terminalpa attributes.
return_dendritic	logical if TRUE, a divergence attribute is required (2 indicates diverted path, 1 is main) and diverted paths will be treated as headwaters. If this is FALSE, the return value is a data.frame including the comid and tocomid attributes.
missing	integer value to use for terminal nodes.
remove_coastal	logical remove coastal features prior to generating tocomid values? ftype or fcode are required if 'TRUE'. fcode == 56600 or fcode == "Coastline" will be fremoved.
add	logical if TRUE, a tocomid column will be added, otherwise a data.frame with two columns will be returned.

Value

data.frame containing comid and tocomid attributes or all attributes provided with comid and tocomid in the first and second columns..

Examples

```
source(system.file("extdata", "sample_flines.R", package = "nhdplusTools"))

tocomid <- get_tocomid(sample_flines)

tocomid <- get_tocomid(sample_flines, return_dendritic = FALSE)
```

---

get_UM *Navigate Upstream Mainstem*

Description

Traverse NHDPlus network upstream main stem

Usage

```
get_UM(network, comid, distance = NULL, sort = FALSE, include = TRUE)
```

Arguments

network	data.frame NHDPlus flowlines including at a minimum: COMID,Pathlength, LevelPathI, and Hydroseq.
comid	integer identifier to start navigating from.
distance	numeric distance in km to limit how many COMIDs are
sort	if TRUE, the returned COMID vector will be sorted in order of distance from the input COMID (nearest to farthest)
include	if TRUE, the input COMID will be included in the returned COMID vector returned. The COMID that exceeds the distance specified is returned.

Value

integer vector of all COMIDs upstream of the starting COMID along the mainstem

Examples

```
library(sf)

source(system.file("extdata", "sample_flines.R", package = "nhdplusTools"))

plot(sample_flines$geom)
start_COMID <- 11690196
UM_COMIDs <- get_UM(sample_flines, start_COMID)
plot(dplyr::filter(sample_flines, COMID %in% UM_COMIDs)$geom,
     col = "red", add = TRUE, lwd = 3)

UM_COMIDs <- get_UM(sample_flines, start_COMID, distance = 50)
plot(dplyr::filter(sample_flines, COMID %in% UM_COMIDs)$geom,
     col = "blue", add = TRUE, lwd = 2)
```

---

get_UT *Navigate Upstream with Tributaries*

Description

Traverse NHDPlus network upstream with tributaries

Usage

```
get_UT(network, comid, distance = NULL)
```

Arguments

network	data.frame NHDPlus flowlines including at a minimum: COMID, Pathlength, LENGTHKM, and Hydroseq.
comid	integer Identifier to start navigating from.
distance	numeric distance in km to limit how many COMIDs are returned. The COMID that exceeds the distance specified is returned.

Value

integer vector of all COMIDs upstream with tributaries of the starting COMID.

Examples

```
library(sf)
source(system.file("extdata", "sample_flines.R", package = "nhdplusTools"))
plot(sample_flines$geom)
start_COMID <- 11690196
UT_COMIDs <- get_UT(sample_flines, start_COMID)
plot(dplyr::filter(sample_flines, COMID %in% UT_COMIDs)$geom,
     col = "red", add = TRUE)

UT_COMIDs <- get_UT(sample_flines, start_COMID, distance = 50)
plot(dplyr::filter(sample_flines, COMID %in% UT_COMIDs)$geom,
     col = "blue", add = TRUE)
```

---

get_vaa *NHDPlusV2 Attribute Subset*

Description

Return requested NHDPlusv2 Attributes.

Usage

```
get_vaa(
  atts = NULL,
  path = get_vaa_path(),
  download = TRUE,
  updated_network = FALSE
)
```

Arguments

atts	character The variable names you would like, always includes comid
path	character path where the file should be saved. Default is a persistent system data as retrieved by nhdplusTools_data_dir. Also see: get_vaa_path

download logical if TRUE, the default, will download VAA table if not found at path.

updated_network
logical default FALSE. If TRUE, updated network attributes from E2NHD and National Water Model retrieved from here.

Details

The VAA data is a aggregate table of information from the NHDPlusV2 elevslope.dbf(s), PlusFlowlineVAA.dbf(s); and NHDFlowlines. All data originates from the EPA NHDPlus Homepage here. To see the location of cached data on your machine use `get_vaa_path`. To view aggregate data and documentation, see here

Value

data.frame containing requested VAA data

Examples

```
## Not run:
# This will download the vaa file to the path from get_vaa_path()

get_vaa("slope")
get_vaa(c("slope", "lengthkm"))

get_vaa(updated_network = TRUE)
get_vaa("reachcode", updated_network = TRUE)

#cleanup if desired
unlink(dirname(get_vaa_path()), recursive = TRUE)

## End(Not run)
```

---

get_vaa_names *Available NHDPlusV2 Attributes*

Description

Find variables available from the NHDPlusV2 attribute data.frame

Usage

```
get_vaa_names(updated_network = FALSE)
```

Arguments

updated_network
logical default FALSE. If TRUE, updated network attributes from E2NHD and National Water Model retrieved from here.

Details

The VAA data is a aggregate table of information from the NHDPlusV2 elevslope.dbf(s), PlusFlowlineVAA.dbf(s); and NHDFlowlines. All data originates from the EPA NHDPlus Homepage here. To see the location of cached data on your machine use get_vaa_path. To view aggregate data and documentation, see here

Value

character vector

Examples

```
## Not run:
# This will download the vaa file to the path from get_vaa_path()
get_vaa_names()

#cleanup if desired
unlink(dirname(get_vaa_path()), recursive = TRUE)

## End(Not run)
```

---

get_vaa_path *File path to value added attribute (vaa) Cache*

Description

nhdplusTools will download and cache an 'fst' file with NHDPlusV2 attribute data sans geometry. This function returns the file path to the cached file. Will use the user data dir indicated by nhdplusTools_data_dir.

Usage

```
get_vaa_path(updated_network = FALSE)
```

Arguments

updated_network	logical default FALSE. If TRUE, returns path to updated network parameters. See get_vaa for more.

Details

The VAA data is a aggregate table of information from the NHDPlusV2 elevslope.dbf(s), PlusFlowlineVAA.dbf(s); and NHDFlowlines. All data originates from the EPA NHDPlus Homepage here. To see the location of cached data on your machine use get_vaa_path. To view aggregate data and documentation, see here

Value

character file path

Examples

```
get_vaa_path()

get_vaa_path(updated_network = TRUE)
```

---

get_waterbodies *Find NHD Water Bodies*

Description

Subsets NHD waterbody features by location (POINT), area (POLYGON), or set of IDs.

Usage

```
get_waterbodies(AOI = NULL, id = NULL, t_srs = NULL, buffer = 0.5)
```

Arguments

AOI	sf (MULTI)POINT or (MULTI)POLYGON. An 'area of interest' can be provided as either a location (sf POINT) or area (sf POLYGON) in any Spatial Reference System.
id	NHD Waterbody COMID(s)
t_srs	character (PROJ string or EPSG code) or numeric (EPSG code). A user specified - target -Spatial Reference System (SRS/CRS) for returned objects. Will default to the CRS of the input AOI if provided, and to 4326 for ID requests.
buffer	numeric. The amount (in meters) to buffer a POINT AOI by for an extended search. Default = 0.5

Details

The returned object(s) will have the same Spatial Reference System (SRS) as the input AOI. If a individual or set of IDs are used to query, then the default geoserver CRS of EPSG:4326 is preserved. In all cases, a user-defined SRS can be passed to `t_srs` which will override all previous SRS's (either input or default). All buffer and distance operations are handled internally using in EPSG:5070 Albers Equal Area projection

Value

a simple features (sf) object

`get_waterbody_index` *Get Waterbody Index*

Description

given an sf point geometry column, return waterbody id, and COMID of dominant artificial path

Usage

```
get_waterbody_index(waterbodies, points, flines = NULL, search_radius = NULL)
```

Arguments

`waterbodies`	sf data.frame of type POLYGON or MULTIPOLYGON including COMID attributes.
`points`	sfc of type POINT
`flines`	sf data.frame of type LINESTRING or MULTILINESTRING including COMID, WBAREACOMI, and Hydroseq attributes
`search_radius`	units class with a numeric value indicating how far to search for a waterbody boundary in units of provided projection. Set units with set_units.

Value

data.frame with two columns, COMID, in_wb_COMID, near_wb_COMID, near_wb_dist, and outlet_fline_COMID. Distance is in units of provided projection.

Examples

```
source(system.file("extdata/sample_data.R", package = "nhdplusTools"))

waterbodies <- sf::st_transform(
  sf::read_sf(sample_data, "NHDWaterbody"), 5070)

points <- sf::st_transform(
  sf::st_sfc(sf::st_point(c(-89.356086, 43.079943)),
             crs = 4326), 5070)

get_waterbody_index(waterbodies, points,
                    search_radius = units::set_units(500, "m"))
```

get_wb_outlet *Get Waterbody Outlet*

Description

Get Waterbody Outlet

Usage

```
get_wb_outlet(lake_id, network)
```

Arguments

lake_id	integer COMID (or character permenent identifier for hi res) of lake.
network	data.frame of network features containing wbareacomi, and Hydroseq

Value

sf data.frame with single record of network COMID associated with most-downstream reach in the NHD Waterbody

Examples

```
source(system.file("extdata/sample_data.R", package = "nhdplusTools"))

fline <- sf::read_sf(sample_data, "NHDFlowline_Network")
wtbdy <- sf::read_sf(sample_data, "NHDWaterbody")

lake_COMID <- wtbdy$COMID[wtbdy$GNIS_NAME=='Lake Mendota 254']

get_wb_outlet(13293262, fline)
```

get_xs_point *Get Cross Section From Point (experimental)*

Description

Uses a cross section retrieval web services to retrieve a cross section given a point and specified width. Orientation is determined based on direction of a the flowline found near point. This function uses a 10m Natioinal Elevation Dataset request on the back end.

Usage

```
get_xs_point(point, width, num_pts)
```

Arguments

point	sfc POINT including crs as created by: sf::st_sfc(sf::st_point(.. ,..), crs)crs.
width	Cross section width in meters.
num_pts	numeric number of points to retrieve along the cross section.

Value

sf data.frame containing points retrieved.

Examples

```
point <- sf::st_sfc(sf::st_point(x = c(-105.97218, 36.17592)), crs = 4326)

(xs <- get_xs_point(point, 300, 100))

bbox <- sf::st_bbox(xs) + c(-0.005, -0.005, 0.005, 0.005)

nhdplusTools::plot_nhdplus(bbox = bbox, cache_data = FALSE)

plot(sf::st_transform(sf::st_geometry(xs), 3857), pch = ".", add = TRUE, col = "red")
plot(sf::st_transform(sf::st_sfc(point, crs = 4326), 3857), add = TRUE)

plot(xs$distance_m, xs$elevation_m)
```

---

get_xs_points *Get Cross Section Endpoints (experimental)*

Description

Uses a cross section retrieval web services to retrieve a cross section between two endpoints.

Usage

```
get_xs_points(point1, point2, num_pts, res = 1)
```

Arguments

point1	sfc POINT including crs as created by: sf::st_sfc(sf::st_point(.. ,..), crs)
point2	sfc POINT including crs.
num_pts	numeric number of points to retrieve along the cross section.
res	integer resolution of 3D Elevation Program data to request. Must be on of: 1, 3, 5, 10, 30, 60.

Value

sf data.frame containing points retrieved.

Examples

```
point1 <- sf::st_sfc(sf::st_point(x = c(-105.9667, 36.17602)), crs = 4326)
point2 <- sf::st_sfc(sf::st_point(x = c(-105.97768, 36.17526)), crs = 4326)

(xs <- get_xs_points(point1, point2, 100))

bbox <- sf::st_bbox(xs) + c(-0.005, -0.005, 0.005, 0.005)

nhdplusTools::plot_nhdplus(bbox = bbox, cache_data = FALSE)

plot(sf::st_transform(sf::st_geometry(xs), 3857), pch = ".", add = TRUE, col = "red")
plot(sf::st_transform(sf::st_sfc(point1, crs = 4326), 3857), add = TRUE)
plot(sf::st_transform(sf::st_sfc(point2, crs = 4326), 3857), add = TRUE)

plot(xs$distance_m, xs$elevation_m)
```

---

make_standalone *Make isolated NHDPlusHR region a standalone dataset*

Description

Cleans up and prepares NHDPlusHR regional data for use as complete NHDPlus data. The primary modification applied is to ensure that any flowpath that exits the domain is labeled as a terminal path and attributes are propagated upstream such that the domain is independently complete.

Usage

```
make_standalone(flowlines)
```

Arguments

flowlines	sf data.frame of NHDPlusHR flowlines.

Value

sf data.frame containing standalone network

Examples

```
library(dplyr)
library(sf)
source(system.file("extdata/nhdplushr_data.R", package = "nhdplusTools"))

(outlet <- filter(hr_data$NHDFlowline, Hydroseq == min(Hydroseq)))
nrow(filter(hr_data$NHDFlowline, TerminalPa == outlet$Hydroseq))

hr_data$NHDFlowline <- make_standalone(hr_data$NHDFlowline)

(outlet <- filter(hr_data$NHDFlowline, Hydroseq == min(Hydroseq)))
nrow(filter(hr_data$NHDFlowline, TerminalPa == outlet$Hydroseq))

source(system.file("extdata/nhdplushr_data.R", package = "nhdplusTools"))

# Remove mainstem and non-dendritic stuff.
subset <- filter(hr_data$NHDFlowline,
                         StreamLeve > min(hr_data$NHDFlowline$StreamLeve) &
                           StreamOrde == StreamCalc)

subset <- subset_nhdplus(subset$COMID, nhdplus_data = hr_gpkg)$NHDFlowline

plot(sf::st_geometry(hr_data$NHDFlowline))

flowline_mod <- make_standalone(subset)

terminals <- unique(flowline_mod$TerminalPa)

colors <- sample(hcl.colors(length(terminals), palette = "Zissou 1"))

for(i in 1:length(terminals)) {
  fl <- flowline_mod[flowline_mod$TerminalPa == terminals[i], ]
  plot(st_geometry(fl), col = colors[i], lwd = 2, add = TRUE)
}

ol <- filter(flowline_mod, TerminalFl == 1 & TerminalPa %in% terminals)

plot(st_geometry(ol), lwd = 2, add = TRUE)
```

map_nhdplus *Make Interactive Map of NHDPlus*

Description

Given a list of outlets, get their basin boundaries and network and return a leaflet map in EPSG:4326.

Usage

```
map_nhdplus(
  outlets = NULL,
  bbox = NULL,
  streamorder = NULL,
  nhdplus_data = NULL,
  gpkg = NULL,
  flowline_only = NULL,
  plot_config = NULL,
  overwrite = TRUE,
  cache_data = NULL,
  return_map = FALSE
)
```

Arguments

outlets	list of nldi outlets. Other inputs are coerced into nldi outlets, see details.
bbox	object of class bbox with a defined crs. See examples.
streamorder	integer only streams of order greater than or equal will be returned
nhdplus_data	geopackage containing source nhdplus data (omit to download)
gpkg	path and file with .gpkg ending. If omitted, no file is written.
flowline_only	boolean only subset and plot flowlines only, default=FALSE
plot_config	list containing plot configuration, see details.
overwrite	passed on the subset_nhdplus.
cache_data	character path to rds file where all plot data can be cached. If file doesn't exist, it will be created. If set to FALSE, all caching will be turned off – this includes basemap tiles.
return_map	if FALSE (default), a data.frame of plot data is returned invisibly in NAD83 Lat/Lon, if TRUE the leaflet object is returned

Details

map_nhdplus supports several input specifications. An unexported function "as_outlet" is used to convert the outlet formats as described below.

1. if outlets is omitted, the bbox input is required and all nhdplus data in the bounding box is plotted.

2. If outlets is a list of integers, it is assumed to be NHDPlus IDs (comids) and all upstream tributaries are plotted.
3. if outlets is an integer vector, it is assumed to be all NHDPlus IDs (comids) that should be plotted. Allows custom filtering.
4. If outlets is a character vector, it is assumed to be NWIS site ids.
5. if outlets is a list containing only characters, it is assumed to be a list of nldi features and all upstream tributaries are plotted.
6. if outlets is a data.frame with point geometry, a point in polygon match is performed and upstream with tributaries from the identified catchments is plotted.

See plot_nhdplus for details on plot configuration.

Value

data.frame or leaflet map (see return_map)

Examples

```
map_nhdplus("05428500")

map_nhdplus("05428500", streamorder = 2)

map_nhdplus(list(13293970, 13293750))

source(system.file("extdata/sample_data.R", package = "nhdplusTools"))

map_nhdplus(list(13293970, 13293750), streamorder = 3, nhdplus_data = sample_data)

#return leaflet object
map_nhdplus("05428500", return_map = TRUE)
```

---

navigate_network *Navigate Network*

Description

Provides a full feature network navigation function that will work with local or web service data. Parameter details provide context.

Usage

```
navigate_network(
  start,
  mode = "UM",
  network = NULL,
  output = "flowlines",
```

```
  distance_km = 10,
  trim_start = FALSE,
  trim_stop = FALSE,
  trim_tolerance = 5
)
```

Arguments

start	list, integer, sf, or sfc if list must be a valid NLDI feature if integer must be a valid comid. If sf, must contain a "comid" field.
mode	character chosen from c(UM, DM, UT, or DD)
network	sf should be compatible with network navigation functions If NULL, network will be derived from requests to the NLDI
output	character flowline or a valid NLDI data source
distance_km	numeric distance to navigate in km
trim_start	logical should start be trimmed or include entire catchment?
trim_stop	logical should stop(s) be trimmed or include entire catchment(s)? # Not supported
trim_tolerance	numeric from 0 to 100 percent of flowline length. If amount to trim is less than this tolerance, no trim will be applied.

Examples

```
navigate_network(list(featureSource = "nwissite", featureID = "USGS-06287800"),
                 "UM",
                 output = "flowlines",
                 trim_start = TRUE)


source(system.file("extdata", "walker_data.R", package = "nhdplusTools"))
hydro_location <- list(comid = 5329339,
                       reachcode = "18050005000078",
                        reach_meas = 30)

hydro_location <- sf::st_sf(
  hydro_location,
  geom = nhdplusTools::get_hydro_location(data.frame(hydro_location),
                                          walker_flowline))

net <- navigate_network(hydro_location,
                        mode = "DM", network = walker_flowline,
                        trim_start = TRUE, distance_km = 20)

plot(sf::st_geometry(walker_flowline))
plot(sf::st_geometry(hydro_location), add = TRUE)
plot(sf::st_geometry(net), add = TRUE, col = "blue", lwd = 2)
```

navigate_nldi *Navigate NLDI*

Description

Navigate the Network Linked Data Index network.

Usage

```
navigate_nldi(
  nldi_feature,
  mode = "upstreamMain",
  data_source = "flowlines",
  distance_km = 10
)
```

Arguments

nldi_feature	list with names ‘featureSource‘ and ‘featureID‘ where ‘featureSource‘ is derived from the "source" column of the response of dataRetrieval::get_nldi_sources() and the ‘featureID‘ is a known identifier from the specified ‘featureSource‘.
mode	character chosen from ("UM", "UT", DM", "DD"). See examples.
data_source	character chosen from "source" column of the response of dataRetrieval::get_nldi_sources() or empty string for flowline geometry.
distance_km	numeric distance in km to stop navigating.

Value

sf data.frame with result

Examples

```
library(sf)
library(dplyr)

nldi_nwis <- list(featureSource = "nwissite", featureID = "USGS-05428500")

navigate_nldi(nldi_feature = nldi_nwis,
              mode = "upstreamTributaries")$UT %>%
  st_geometry() %>%
  plot()

navigate_nldi(nldi_feature = nldi_nwis,
              mode = "UM")$UM %>%
  st_geometry() %>%
  plot(col = "blue", add = TRUE)
```

```
nwissite <- navigate_nldi(nldi_feature = nldi_nwis,
                          mode = "UT",
                          data_source = "nwissite")$UT_nwissite

st_geometry(nwissite) %>%
  plot(col = "green", add = TRUE)

nwissite
```

---

nhdplusTools_data_dir *Get or set nhdplusTools data directory*

Description

if left unset, will return the user data dir as returned by ‘tools::R_user_dir‘ for this package.

Usage

```
nhdplusTools_data_dir(dir = NULL)
```

Arguments

dir	path of desired data directory

Value

character path of data directory (silent when setting)

Examples

```
nhdplusTools_data_dir()

nhdplusTools_data_dir("demo")

nhdplusTools_data_dir(tools::R_user_dir("nhdplusTools"))
```

nhdplus_path *NHDPlus Data Path*

Description

Allows specification of a custom path to a source dataset. Typically this will be the national seamless dataset in geodatabase or geopackage format.

Usage

```
nhdplus_path(path = NULL, warn = FALSE)
```

Arguments

path	character path ending in .gdb or .gpkg
warn	boolean controls whether warning an status messages are printed

Value

0 (invisibly) if set successfully, character path if no input.

Examples

```
nhdplus_path("/data/NHDPlusV21_National_Seamless.gdb")

nhdplus_path("/data/NHDPlusV21_National_Seamless.gdb", warn=FALSE)

nhdplus_path()
```

plot_nhdplus *Plot NHDPlus*

Description

Given a list of outlets, get their basin boundaries and network and return a plot in EPSG:3857 Web Mercator Projection.

Usage

```
plot_nhdplus(
  outlets = NULL,
  bbox = NULL,
  streamorder = NULL,
  nhdplus_data = NULL,
  gpkg = NULL,
```

```
  plot_config = NULL,
  basemap = "cartolight",
  add = FALSE,
  actually_plot = TRUE,
  overwrite = TRUE,
  flowline_only = NULL,
  cache_data = NULL,
  ...
)
```

Arguments

outlets	list of nldi outlets. Other inputs are coerced into nldi outlets, see details.
bbox	object of class bbox with a defined crs. See examples.
streamorder	integer only streams of order greater than or equal will be returned
nhdplus_data	geopackage containing source nhdplus data (omit to download)
gpkg	path and file with .gpkg ending. If omitted, no file is written.
plot_config	list containing plot configuration, see details.
basemap	character indicating which basemap type to use. Chose from: osm.types.
add	boolean should this plot be added to an already built map.
actually_plot	boolean actually draw the plot? Use to get data subset only.
overwrite	passed on the subset_nhdplus.
flowline_only	boolean only subset and plot flowlines only, default=FALSE
cache_data	character path to rds file where all plot data can be cached. If file doesn't exist, it will be created. If set to FALSE, all caching will be turned off – this includes basemap tiles.
...	parameters passed on to rosm.

Details

plot_nhdplus supports several input specifications. An unexported function "as_outlet" is used to convert the outlet formats as described below.

1. if outlets is omitted, the bbox input is required and all nhdplus data in the bounding box is plotted.
2. If outlets is a list of integers, it is assumed to be NHDPlus IDs (comids) and all upstream tributaries are plotted.
3. if outlets is an integer vector, it is assumed to be all NHDPlus IDs (comids) that should be plotted. Allows custom filtering.
4. If outlets is a character vector, it is assumed to be NWIS site ids.
5. if outlets is a list containing only characters, it is assumed to be a list of nldi features and all upstream tributaries are plotted.
6. if outlets is a data.frame with point geometry, a point in polygon match is performed and upstream with tributaries from the identified catchments is plotted.

The plot_config parameter is a list with names "basin", "flowline", "outlets", "network_wtbd", and "off_network_wtbd". The following shows the defaults that can be altered.

1. basin

```
list(lwd = 1, col = NA, border = "black")
```

2. flowline

```
list(lwd = 1, col = "blue")
```

3. outlets

```
list(default = list(col = "black", border = NA, pch = 19, cex = 1),
     nwissite = list(col = "grey40", border = NA, pch = 17, cex = 1),
     huc12pp = list(col = "white", border = "black", pch = 22, cex = 1),
     wqp = list(col = "red", border = NA, pch = 20, cex = 1))
```

4. network_wtbd `list(lwd = 1, col = "lightblue", border = "black")`
5. off_network_wtbd `list(lwd = 1, col = "darkblue", border = "black")`

If adding additional layers to the plot, data must be projected to EPSG:3857 with 'sf::st_transform(x, 3857)' prior to adding to the plot.

Value

data.frame plot data is returned invisibly in NAD83 Lat/Lon.

Examples

```
options("rgdal_show_exportToProj4_warnings"="none")
# Beware plot_nhdplus caches data to the default location.
# If you do not want data in "user space" change the default.
old_dir <- nhdplusTools::nhdplusTools_data_dir()
nhdplusTools_data_dir(tempdir())

plot_nhdplus("05428500")

plot_nhdplus("05428500", streamorder = 2)

plot_nhdplus(list(13293970, 13293750))

source(system.file("extdata/sample_data.R", package = "nhdplusTools"))

plot_nhdplus(list(13293970, 13293750), streamorder = 3, nhdplus_data = sample_data)

plot_nhdplus(list(list("comid", "13293970"),
                  list("nwissite", "USGS-05428500"),
                  list("huc12pp", "070900020603"),
                  list("huc12pp", "070900020602")),
             streamorder = 2,
             nhdplus_data = sample_data)
```

```
plot_nhdplus(sf::st_as_sf(data.frame(x = -89.36083,
                                     y = 43.08944),
                          coords = c("x", "y"), crs = 4326),
             streamorder = 2,
             nhdplus_data = sample_data)

plot_nhdplus(list(list("comid", "13293970"),
                  list("nwissite", "USGS-05428500"),
                  list("huc12pp", "070900020603"),
                  list("huc12pp", "070900020602")),
             streamorder = 2,
             nhdplus_data = sample_data,
             plot_config = list(basin = list(lwd = 2),
                                outlets = list(huc12pp = list(cex = 1.5),
                                               comid = list(col = "green"))))

bbox <- sf::st_bbox(c(xmin = -89.43, ymin = 43, xmax = -89.28, ymax = 43.1),
                    crs = "+proj=longlat +datum=WGS84 +no_defs")

fline <- sf::read_sf(sample_data, "NHDFlowline_Network")
comids <- nhdplusTools::get_UT(fline, 13293970)

plot_nhdplus(comids)

#' # With Local Data
plot_nhdplus(bbox = bbox, nhdplus_data = sample_data)

# With downloaded data
plot_nhdplus(bbox = bbox, streamorder = 3)

# Can also plot on top of the previous!
plot_nhdplus(bbox = bbox, nhdplus_data = sample_data,
             plot_config = list(flowline = list(lwd = 0.5)))
plot_nhdplus(comids, nhdplus_data = sample_data, streamorder = 3, add = TRUE,
             plot_config = list(flowline = list(col = "darkblue")))

nhdplusTools::nhdplusTools_data_dir(old_dir)
```

`prepare_nhdplus` *Prep NHDPlus Data*

Description

Function to prep NHDPlus data for use by nhdplusTools functions

Usage

```
prepare_nhdplus(
  flines,
```

```
  min_network_size = 0,
  min_path_length = 0,
  min_path_size = 0,
  purge_non_dendritic = TRUE,
  warn = TRUE,
  error = TRUE,
  skip_toCOMID = FALSE,
  align_names = TRUE
)
```

Arguments

flines	data.frame NHDPlus flowlines including: COMID, LENGTHKM, FTYPE (or FCODE), TerminalFl, FromNode, ToNode, TotDASqKM, StartFlag, StreamOrde, StreamCalc, TerminalPa, Pathlength, and Divergence variables.
min_network_size	numeric Minimum size (sqkm) of drainage network to include in output.
min_path_length	numeric Minimum length (km) of terminal level path of a network.
min_path_size	numeric Minimum size (sqkm) of outlet level path of a drainage basin. Drainage basins with an outlet drainage area smaller than this will be removed.
purge_non_dendritic	logical Should non dendritic paths be removed or not.
warn	logical controls whether warning an status messages are printed
error	logical controls whether to return potentially invalid data with a warning rather than an error
skip_toCOMID	logical if TRUE, toCOMID will not be added to output.
align_names	logical

Value

data.frame ready to be used with the refactor_flowlines function.

Examples

```
source(system.file("extdata", "sample_flines.R", package = "nhdplusTools"))

prepare_nhdplus(sample_flines,
                min_network_size = 10,
                min_path_length = 1,
                warn = FALSE)
```

rename_geometry *rename_geometry*

Description

correctly renames the geometry column of a sf object.

Usage

```
rename_geometry(g, name)
```

Arguments

g	sf data.table
name	character name to be used for geometry

Examples

```
(g <- sf::st_sf(a=3, geo = sf::st_sfc(sf::st_point(1:2))))
rename_geometry(g, "geometry")
```

rescale_measures *Rescale reachcode measure to comid flowline measure*

Description

Given a reachcode measure and the from and to measure for a comid flowline, returns the measure along the comid flowline. This is a utility specific to the NHDPlus data model where many comid flowlines make up a single reachcode / reach. "Measures" are typically referenced to reaches. Flowlines have a stated from-measure / to-measure. In some cases it is useful to rescale the measure such that it is relative only to the flowline.

from is downstream – 0 is the outlet to is upstream – 100 is the inlet

Usage

```
rescale_measures(measure, from, to)
```

Arguments

measure	numeric reach measure between 0 and 100
from	numeric flowline from-measure relative to the reach
to	numeric flowline to-measure relative to the reach

Value

numeric rescaled measure

Examples

```
rescale_measures(40, 0, 50)
rescale_measures(60, 50, 100)
```

`rpu_boundaries` *RPU Boundaries Raster Processing Unit boundaries*

Description

RPU Boundaries Raster Processing Unit boundaries

Usage

```
rpu_boundaries
```

Format

An object of class `"sf"`

`stage_national_data` *Stage NHDPlus National Data (deprecated)*

Description

Breaks down the national geo database into a collection of quick to access R binary files.

Usage

```
stage_national_data(
  include = c("attribute", "flowline", "catchment"),
  output_path = NULL,
  nhdplus_data = NULL,
  simplified = TRUE
)
```

Arguments

`include`	character vector containing one or more of: "attributes", "flowline", "catchment".
`output_path`	character path to save the output to defaults to the directory of the nhdplus_data.
`nhdplus_data`	character path to the .gpkg or .gdb containing the national seamless dataset. Not required if `nhdplus_path` has been set.
`simplified`	boolean if TRUE (the default) the CatchmentSP layer will be included.

Details

"attributes" will save ‘NHDFlowline_Network‘ attributes as a separate data.frame without the geometry. The others will save the ‘NHDFlowline_Network‘ and ‘Catchment‘ or ‘CatchmentSP‘ (per the ‘simplified‘ parameter) as sf data.frames with superfluous Z information dropped.

The returned list of paths is also added to the nhdplusTools_env as "national_data".

Value

list containing paths to the .rds files.

Examples

```
source(system.file("extdata/sample_data.R", package = "nhdplusTools"))

stage_national_data(nhdplus_data = sample_data, output_path = tempdir())
```

---

st_compatibalize *make spatial inputs compatible*

Description

makes sf1 compatible with sf2 by projecting into the projection of 2 and ensuring that the geometry columns are the same name.

Usage

```
st_compatibalize(sf1, sf2)
```

Arguments

sf1	sf data.frame
sf2	sf data.frame

Examples

```
source(system.file("extdata", "sample_flines.R", package = "nhdplusTools"))

(one <- dplyr::select(sample_flines))
(two <- sf::st_transform(one, 5070))

attr(one, "sf_column") <- "geotest"
names(one)[names(one) == "geom"] <- "geotest"

st_compatibalize(one, two)
```

subset_nhdplus *Subset NHDPlus*

Description

Saves a subset of the National Seamless database or other nhdplusTools compatible data based on a specified collection of COMIDs. This function uses get_nhdplus for the "download" data source but returns data consistent with local data subsets in a subset file.

Usage

```
subset_nhdplus(
  comids = NULL,
  output_file = NULL,
  nhdplus_data = NULL,
  bbox = NULL,
  simplified = TRUE,
  overwrite = FALSE,
  return_data = TRUE,
  status = TRUE,
  flowline_only = NULL,
  streamorder = NULL,
  out_prj = 4269
)
```

Arguments

comids	integer vector of COMIDs to include.
output_file	character path to save the output to defaults to the directory of the nhdplus_data.
nhdplus_data	character path to the .gpkg or .gdb containing the national seamless database, a subset of NHDPlusHR, or "download" to use a web service to download NHDPlusV2.1 data. Not required if nhdplus_path has been set or the default has been adopted. See details for more.
bbox	object of class "bbox" as returned by sf::st_bbox in Latitude/Longitude. If no CRS is present, will be assumed to be in WGS84 Latitude Longitude.
simplified	boolean if TRUE (the default) the CatchmentSP layer will be included. Not relevant to the "download" option or NHDPlusHR data.
overwrite	boolean should the output file be overwritten
return_data	boolean if FALSE path to output file is returned silently otherwise data is returned in a list.
status	boolean should the function print status messages
flowline_only	boolean WARNING: experimental if TRUE only the flowline network and attributes will be returned
streamorder	integer only streams of order greater than or equal will be downloaded. Not implemented for local data.
out_prj	character override the default output CRS of NAD83 lat/lon (EPSG:4269)

Details

This function relies on the National Seamless Geodatabase or Geopackage. It can be downloaded here.

The "download" option of this function should be considered preliminary and subject to revision. It does not include as many layers and may not be available permenently.

Value

character path to the saved subset geopackage

Examples

```
source(system.file("extdata/sample_data.R", package = "nhdplusTools"))

nhdplus_path(sample_data)

staged_nhdplus <- stage_national_data(output_path = tempdir())

sample_flines <- readRDS(staged_nhdplus$flowline)

geom_col <- attr(sample_flines, "sf_column")

plot(sample_flines[[geom_col]],
     lwd = 3)

start_point <- sf::st_sfc(sf::st_point(c(-89.362239, 43.090266)),
                          crs = 4326)

plot(start_point, cex = 1.5, lwd = 2, col = "red", add = TRUE)

start_comid <- discover_nhdplus_id(start_point)

comids <- get_UT(sample_flines, start_comid)

plot(dplyr::filter(sample_flines, COMID %in% comids)[[geom_col]],
     add=TRUE, col = "red", lwd = 2)

output_file <- tempfile(fileext = ".gpkg")

subset_nhdplus(comids = comids,
               output_file = output_file,
               nhdplus_data = sample_data,
               overwrite = TRUE,
               status = TRUE)

sf::st_layers(output_file)

catchment <- sf::read_sf(output_file, "CatchmentSP")
```

```
plot(catchment[[attr(catchment, "sf_column")]], add = TRUE)

waterbody <- sf::read_sf(output_file, "NHDWaterbody")

plot(waterbody[[attr(waterbody, "sf_column")]],
     col = rgb(0, 0, 1, alpha = 0.5), add = TRUE)

# Cleanup temp
sapply(staged_nhdplus, unlink)
unlink(output_file)

# Download Option:
subset_nhdplus(comids = comids,
               output_file = output_file,
               nhdplus_data = "download",
               overwrite = TRUE,
               status = TRUE, flowline_only = FALSE)

sf::st_layers(output_file)

# NHDPlusHR
source(system.file("extdata/nhdplushr_data.R", package = "nhdplusTools"))

up_ids <- get_UT(hr_data$NHDFlowline, 15000500028335)

sub_gpkg <- file.path(work_dir, "sub.gpkg")
sub_nhdhr <- subset_nhdplus(up_ids, output_file = sub_gpkg,
                            nhdplus_data = hr_gpkg, overwrite = TRUE)

sf::st_layers(sub_gpkg)
names(sub_nhdhr)

plot(sf::st_geometry(hr_data$NHDFlowline), lwd = 0.5)
plot(sf::st_geometry(sub_nhdhr$NHDFlowline), lwd = 0.6, col = "red", add = TRUE)

unlink(output_file)
unlink(sub_gpkg)
```

---

subset_rpu *Subset by Raster Processing Unit*

Description

Given flowlines and an rpu_code, performs a network-safe subset such that the result can be used in downstream processing. Has been tested to work against the entire NHDPlusV2 domain and satisfies a number of edge cases.

Usage

```
subset_rpu(fline, rpu, run_make_standalone = TRUE, strict = FALSE)
```

Arguments

fline	sf data.frame NHD Flowlines with comid, pathlength, lengthkm, hydroseq, levelpathi, rpuid, and arbolatesu (dnhydroseq is required if tocomid is not provided).
rpu	character e.g. "01a"
run_make_standalone	logical default TRUE should the run_make_standalone function be run on result?
strict	logical if TRUE, paths that extend outside the RPU but have no tributaries in the upstream RPU will be included in the output.

Value

data.frame containing subset network

Examples

```
source(system.file("extdata/sample_data.R", package = "nhdplusTools"))

sample_flines <- sf::read_sf(sample_data, "NHDFlowline_Network")

subset_rpu(sample_flines, rpu = "07b")
```

---

subset_vpu *Subset by Vector Processing Unit*

Description

Calls subset_rpu for all raster processing units for the requested vector processing unit.

Usage

```
subset_vpu(fline, vpu, include_null_rpuid = TRUE, run_make_standalone = TRUE)
```

Arguments

fline	sf data.frame NHD Flowlines with comid, pathlength, lengthkm, hydroseq, levelpathi, rpuid, vpuid, and arbolatesu (dnhydroseq is required if tocomid is not provided).
vpu	character e.g. "01"

include_null_rpuid
: logical default TRUE. Note that there are some flowlines that may have a NULL rpuid but be included in the vector processing unit.

run_make_standalone
: logical default TRUE should the run_make_standalone function be run on result?

Value

data.frame containing subset network

Examples

```
source(system.file("extdata/sample_data.R", package = "nhdplusTools"))

sample_flines <- sf::read_sf(sample_data, "NHDFlowline_Network")

subset_vpu(sample_flines, "07")
```

---

vpu_boundaries *VPU Boundaries Vector Processing Unit boundaries*

Description

VPU Boundaries Vector Processing Unit boundaries

Usage

```
vpu_boundaries
```

Format

An object of class "sf"

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