Package 'wrv'

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Title Wood River Valley Groundwater Flow Model

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Depends R (>= 3.1.0), sp, rgdal, rgeos, raster

Imports igraph

Suggests RCurl, knitr, xtable

SystemRequirements MODFLOW-USG (>= 1.2)

Description Pre- and post-processing program for the groundwater-flow model of the Wood River Valley aquifer system, south-central Idaho.

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URL https://github.com/jfisher-usgs/wrv

BugReports https://github.com/jfisher-usgs/wrv/issues

ByteCompile yes

LazyData yes

LazyDataCompression xz

VignetteBuilder knitr

R topics documented:

`alluvium.bottom` *Pre-Quaternary Bedrock Surface and Top of Quaternary Basalt*

Description

Estimated elevation of the pre-Quaternary bedrock surface and top of Quaternary basalt in the Wood River Valley aquifer system, South-Central Idaho.

Usage

```
alluvium.bottom
```

Format

An object of class `RasterLayer`. Each cell on the surface grid represents an elevation in meters above the North American Vertical Datum of 1988 (NAVD 88). Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM). The spatial grid is composed of 565 rows and 429 columns, and has cell sizes that are constant at 100 meters by 100 meters.

Source

This dataset is a revised version of Plate 1 in Bartolino and Adkins (2012).

References

Bartolino, J.R., and Adkins, C.B., 2012, Hydrogeologic framework of the Wood River Valley aquifer system, south-central Idaho: U.S. Geological Survey Scientific Investigations Report 2012-5053, 46 p., available at http://pubs.usgs.gov/sir/2012/5053/.

Examples

```
plot(alluvium.bottom)
summary(alluvium.bottom)
```

aquifer.extent *Extent of Aquifer System*

Description

Estimated extent of the Wood River Valley aquifer system, south-central Idaho.

Usage

```
aquifer.extent
```

Format

An object of SpatialPolygonsDataFrame-class containing 1 Polygons. Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM).

Source

Extent defined by Bartollino and Adkins (2012, Plate 1).

References

Bartolino, J.R., and Adkins, C.B., 2012, Hydrogeologic framework of the Wood River Valley aquifer system, south-central Idaho: U.S. Geological Survey Scientific Investigations Report 2012-5053, 46 p., available at http://pubs.usgs.gov/sir/2012/5053/.

Examples

```
plot(aquifer.extent)
str(aquifer.extent)
```

aquitard.extent *Extent of Aquitard*

Description

The estimated extent of the confining unit (aquitard) separating the unconfined aquifer from the underlying confined aquifer in the Wood River Valley.

Usage

```
aquitard.extent
```

Format

An object of SpatialPolygonsDataFrame-class containing 2 Polygons. Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM).

Source

Extent defined by Moreland (1977, fig. 3 in USGS Open-File report). Moreland shows an outlier by Picabo that is assumed to indicate confined conditions in the basalt and not the lake sediments.

References

Moreland, J.A., 1977, Ground water-surface water relations in the Silver Creek area, Blaine County, Idaho: Boise, Idaho Department of Water Resources, Water Information Bulletin 44, 42 p., 5 plates in pocket, accessed January 31, 2012. Also published as U.S. Geological Survey Open-File report 77-456, 66 p., available at http://pubs.er.usgs.gov/pubs/ofr/ofr77456.

Examples

```
plot(aquitard.extent)
str(aquitard.extent)
```

---

basalt.extent *Extent of Basalt*

Description

The estimated extent of the basalt underlying the alluvial Wood River Valley aquifer system.

Usage

```
basalt.extent
```

Format

An object of SpatialPolygonsDataFrame-class containing 1 Polygons. Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM).

Source

Extent defined by Bartollino and Adkins (2012, Plate 1).

References

Bartolino, J.R., and Adkins, C.B., 2012, Hydrogeologic framework of the Wood River Valley aquifer system, south-central Idaho: U.S. Geological Survey Scientific Investigations Report 2012-5053, 46 p., available at http://pubs.usgs.gov/sir/2012/5053/.

Examples

```
plot(basalt.extent)
str(basalt.extent)
```

`BumpDisconnectedCells` *Adjustment for Vertically Disconnected Cells*

Description

Decrease model cell values in the lower raster layer if they violate a minimum vertical overlap between adjacent cells.

Usage

```
BumpDisconnectedCells(rs, min.overlap = 2, bump.by = 0.1, max.itr = 1e+04)
```

Arguments

`rs`	`RasterStack`; a raster stack with two layers, the first and second layers represent the top and bottom of a model layer.
`min.overlap`	`numeric`; the minimum vertical overlap between adjacent cells.
`bump.by`	`numeric`; the amount to decrease a cell value by during each iteration of the algorithm.
`max.itr`	`numeric`; the maximum number of iterations.

Details

During each iteration of the algorithm: (1) Cells are identified that violate the minimum vertical overlap between adjacent cells; that is, the bottom of cell `i` is greater than or equal to the top of an adjacent cell `j` minus the minimum overlap specified by the `min.overlap` argument. (2) For cells violating the minimum vertical overlap, lower raster layer (`rs[[2]]`) values are decreased by the value specified in the `bump.by` argument.

Value

Returns a `RasterLayer` that can be added to `rs[[2]]` to ensure connectivity between cells. Cell values in the returned raster grid represent vertical adjustments in meters

Author(s)

J.C. Fisher

Examples

```
set.seed(0)
r.top <- raster(ncols = 10, nrows = 10)
r.bot <- raster(ncols = 10, nrows = 10)
r.top[] <- rnorm(ncell(r.top), mean = 12)
r.bot[] <- rnorm(ncell(r.bot), mean = 10)
summary(r.top - r.bot)

r <- BumpDisconnectedCells(stack(r.top, r.bot), min.overlap = 0.1)
plot(r.bot + r)
```

bwr.sc *Reaches of the Big Wood River and Silver Creek*

Description

Reaches of the Big Wood River and Silver Creek, Wood River Valley, Idaho.

Usage

```
bwr.sc
```

Format

An object of SpatialLinesDataFrame-class containing 21 Lines and a data.frame with the following variables:

Reach is the name of the subreaches measured in U.S. Geological Survey (USGS) seepage survey.

BigReach is the name of the reaches for which time series targets are available for part or all of the calibration period.

GainLoss is the flow type, specified as "Gaining", "Losing", or "Seasonal".

DrainRiver is the model boundary assignment, either "drain" or "river".

RchAvg is the estimated average reach gain in cubic meters per day for 1995-2010 based on a combination of gage data and the USGS seepage survey.

BigRAv is the estimated average reach gain in cubic meters per day for 1995-2010 based on gage data.

ReachNo is the reach number identifier.

Depth is the estimated average depth in meters of water in reach, measured from the air-water interface to the top of the riverbed sediments.

BedThk is the estimated thickness in meters of the saturated riverbed sediments.

Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM).

Source

Idaho Department of Water Resources

Examples

```
plot(bwr.sc)
str(bwr.sc@data)
```

canal.seep *Canal Seepage*

Description

Canal seepage as a fraction of diversions for irrigation entities in the Wood River Valley.

Usage

```
canal.seep
```

Format

A `data.frame` object with 13 records and the following variables:

EntityName is the name of the irrigation entity served by the canal system.

SeepFrac is the estimated canal seepage as a fraction of diversions.

Source

Idaho Department of Water Resources

See Also

`canals`

Examples

```
str(canal.seep)
```

canals *Canals*

Description

Canal systems in the Wood River Valley and surrounding areas.

Usage

```
canals
```

Format

An object of `SpatialLinesDataFrame-class` containing 114 `Lines` and a `data.frame` with the following variable:

EntityName is the name of the irrigation entity served by the canal system.

Source

Idaho Department of Water Resources (IDWR)

See Also

canal.seep

Examples

```
plot(canals)
str(canals@data)
```

---

cities *Cities and Towns*

Description

Cities and towns in the Wood River Valley and surrounding areas.

Usage

```
cities
```

Format

An object of SpatialPointsDataFrame-class containing 9 points. Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM).

Source

Idaho Department of Water Resources (IDWR)

Examples

```
spplot(cities)
str(cities)
```

---

comb.sw.irr *Combined Surface Water Irrigation Diversions*

Description

Supplemental groundwater rights and associated surface water rights.

Usage

```
comb.sw.irr
```

Format

A `data.frame` object with 1,213 records and the following variables:

WaterRight is the name of the supplemental groundwater right.

CombWaterRight is the name of the surface water right that shares a combined limit with the groundwater right.

Source is the river or stream source name for the surface water right.

WaterUse is the authorized beneficial use for the surface water right.

MaxDivRate is the authorized maximum diversion rate for the surface water right, in cubic meters per day.

Pdate is the priority date of the surface water right.

Source

Idaho Department of Water Resources (IDWR); derived from combined limit comments in IDWR water rights database.

Examples

```
str(comb.sw.irr)
```

`CreateModflowInputFiles`

Create MODFLOW Input Files

Description

Generate and write input files for a MODFLOW simulation of groundwater flow in the Wood River Valley (WRV) aquifer system.

Usage

```
CreateModflowInputFiles(rs.model, rech, well, id, dir.run, perlen)
```

Arguments

`rs.model`	`RasterStack`; a collection of `RasterLayer` objects with the same extent and resolution, see 'Details' for required raster layers.
`rech`	`RasterStack`; something...
`well`	`data.frame`; something...
`id`	`character`; a short identifier for the model run.
`dir.run`	`character`; the path name of the directory to write model input files.
`perlen`	`integer`; the period length for the simulation, in days.

Details

Steady-state flow in the WRV aquifer is simulated using the MODFLOW-USG groundwater flow model. This numerical model was chosen for its ability to solve complex unconfined groundwater flow simulations. The solver implemented in MODFLOW-USG incorporates the Newton-Raphson formulation for improving solution convergence and avoiding problems with the drying and rewetting of cells (Niswonger and others, 2011). A structured finite-difference grid was implemented in the model to (1) simplify discretization, (2) keep formats and structures for the MODFLOW-USG packages identical to those of MODFLOW-2005, and (3) allow any MODFLOW post-processor to be used to analyze the results of the MODFLOW-USG simulation (such as Model Viewer).

Model input files are written to `dir.run` and include the Name (‘`.nam`’), Basic (‘`.ba6`’), Discretization (‘`.dis`’), Zone (‘`.zon`’), Layer-Property Flow (‘`.lpf`’), Flow and Head Boundary (‘`.fhb`’), Drain (‘`.drn`’), River (‘`.riv`’), Connected Linear Network (‘`.cln`’), Well (‘`.wel`’), Sparse Matrix Solver (‘`.sms`’), and Output Control (‘`.oc`’) files. See the users guide (*Description of Model Input and Output*) included with the MODFLOW-USG software for details on input file formats and structures. The Layer-Property Flow file includes options for the calculation of vertical flow in partially dewatered cells. For the WRV model, where there is no indication that perched conditions exist, `CONSTANTCV` and `NOVFC` options are used to create the most stable solution (Panday and others, 2013, p. 15-16). Options for the Sparse Matrix Solver were set for unconfined simulations by implementing an upstream-weighting scheme with Newton-Raphson linearization, Delta-Bar-Delta under-relaxation, and the χMD solver of Ibaraki (2005).

The required raster layers in the raster stack `rs.model` include the following:

lay1.ibound is the boundary variable in model layer 1 where values `< 0` is a constant hydraulic head, `= 0` is inactive, and `> 0` is active.

lay2.ibound is the boundary variable in model layer 2.

lay3.ibound is the boundary variable in model layer 3.

lay1.strt is the initial (starting) hydraulic head in model layer 1, in meters above the North American Vertical Datum of 1988 (NAVD 88).

lay2.strt is the initial hydraulic head in model layer 2.

lay3.strt is the initial hydraulic head in model layer 3.

lay1.top is the elevation at the top of model layer 1 (land surface), in meters above the NAVD 88.

lay1.bot is the elevation at the bottom of model layer 1, in meters above the NAVD 88.

lay2.bot is the elevation at the bottom of model layer 2.

lay3.bot is the elevation at the bottom of model layer 3.

lay1.zones is the hydrogeologic zones in model layer 1 where values `= 1` is unconfined alluvium, `= 2` is basalt, `= 3` is clay (aquitard), and `= 4` is confined alluvium.

lay2.zones is the hydrogeologic zones in model layer 2.

lay3.zones is the hydrogeologic zones in model layer 3.

riv.reach is the stream reach number identifier.

riv.bottom is the elevation of the bottom of the riverbed sediments.

riv.stage is the stage elevation of the stream.

Value

Returns an object of class `NULL`.

Author(s)

J.C. Fisher

References

Ibaraki, M., 2005, χMD User's guide-An efficient sparse matrix solver library, version 1.30: Columbus, Ohio State University School of Earth Sciences.

Niswonger, R.G., Panday, Sorab, and Ibaraki, Motomu, 2011, MODFLOW-NWT, A Newton formulation for MODFLOW-2005: U.S. Geological Survey Techniques and Methods 6-A37, 44 p., available at http://pubs.usgs.gov/tm/tm6a37/.

Panday, Sorab, Langevin, C.D., Niswonger, R.G., Ibaraki, Motomu, and Hughes, J.D., 2013, MODFLOW-USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p., available at http://pubs.usgs.gov/tm/06/a45/.

Examples

```
## Not run: # see wrv-process vignette
```

---

div.gw *Groundwater Diversions*

Description

Groundwater diversions recorded by Water District 37 or municipal water providers.

Usage

```
div.gw
```

Format

A `data.frame` object with 7,095 records and the following variables:

YearMonth is the year and month during which diversions were recorded, with a required date format of `YYYYMM`.

Diversion is the name of the well.

Reach is the name of the river subreach into which the well water is discharged; only applicable to exchange wells.

BigReach is the name of the river reach into which the well water is discharged; only applicable to exchange wells.

EntityName is the name of the irrigation entity which the well supplies water.

WMISNumber is the well number in the Idaho Department of Water Resources (IDWR) Water Measurement Information System.

GWDiv is the volume of water diverted during the month, in cubic meters.

Source

IDWR; compiled data records from Water District 37 and 37M, City of Ketchum, Sun Valley Water and Sewer District, City of Hailey, and City of Bellevue.

Examples

```
str(div.gw)
```

---

div.sw *Surface Water Diversions*

Description

Surface water diversions recorded by Water District 37 or municipal water providers.

Usage

```
div.sw
```

Format

A `data.frame` object with 14,941 records and the following variables:

YearMonth is the year and month during which diversions were recorded, with a required date format of `YYYYMM`.

Diversion is the name of the surface-water diversion.

Reach is the river subreach from which the water is diverted.

BigReach is the river reach from which the water is diverted.

EntityName is the name of the irrigation entity which the diversion supplies water.

SWDiv is the volume of water diverted during the month, in cubic meters.

Source

Idaho Department of Water Resources; compiled data records from Water District 37 and 37M, City of Hailey, and City of Bellevue.

Examples

```
str(div.sw)
```

div.ww *Wastewater Treatment Plant Diversions*

Description

Recorded discharge from wastewater treatment plants.

Usage

```
div.ww
```

Format

A `data.frame` object with 1,080 records and the following variables:

YearMonth is the year and month during which diversions were recorded, with a required date format of `YYYYMM`.

Return is the name of the wastewater treatment plant.

Reach is the name of the river subreach to which treated effluent is discharged; only applicable to wastewater treatment plants that discharge to the river.

BigReach is the name of the river reach to which treated effluent is discharged; only applicable to wastewater treatment plants that discharge to the river.

EntityName is the name of the irrigation entity served by the wastewater treatment plant.

WWDiv is the volume of wastewater discharged during the month, in cubic meters.

Source

Idaho Department of Water Resources and U.S. Geological Survey; compiled data records from the U.S. Environmental Protection Agency for plants that discharge to the river, and from records of the Idaho Department of Environmental Quality for plants that discharge to land application.

Examples

```
str(div.ww)
```

DownloadFile *Download File from the Internet*

Description

This function downloads a file from the Internet.

Usage

```
DownloadFile(url, dest.dir = tempdir(), mode = NULL, extract = TRUE,
             max.attempts = 10L, wait.time = 30)
```

Arguments

url	character; the URL of a resource to be downloaded.
dest.dir	character; the directory where the downloaded file is saved.
mode	character; The mode with which to write the file, such as "w", "wb" (binary), "a" (append) and "ab".
extract	logical; if TRUE, an attempt is made to extract files from the file archive.
max.attempts	integer; the maximum number of attempts to download a file.
wait.time	numeric; the time in seconds to wait between download attempts.

Details

This function requires the suggested package **RCurl**.

Value

Returns the file path(s) to the downloaded file (or uncompressed files).

Author(s)

J.C. Fisher

See Also

CFILE, curlPerform

Examples

```
url <- "https://github.com/jfisher-usgs/wrv/raw/master/inst/extdata/aquifer.extent.zip"
files <- DownloadFile(url)
unlink(files)
```

---

drains *Drain Locations*

Description

Polygons used to define the loctions of drain boundaries in the model domain. The polygons clip the line segments along the aquifer boundary (see aquifer.extent), and model cells intersecting these clipped-line segments are defined as boundary cells.

Usage

```
drains
```

Format

An object of SpatialPolygonsDataFrame-class containing a set of 2 Polygons and a data.frame with the following variable:

Name is an identifier for the polygon.

Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM).

Source

A Keyhole Markup Language (KML) file created in Google Earth with polygons drawn by hand in areas of known drains.

Examples

```
plot(drains)
str(drains)
```

---

efficiency *Irrigation Efficiency*

Description

Irrigation efficiency for each irrigation entity.

Usage

```
efficiency
```

Format

A `data.frame` object with 89 records and the following variables:

EntityName is the name of the irrigation entity which the irrigation efficiency is applied.

Eff is the estimated irrigation efficiency, the ratio of the amount of water consumed by the crop to the amount of water supplied through irrigation.

Source

Idaho Department of Water Resources

Examples

```
str(efficiency)
```

---

entity.components *Irrigation Entity Components*

Description

Something...

Usage

```
entity.components
```

Format

A `list` object with components of `SpatialPolygonsDataFrame-class`. There are a total of 192 components, one `SpatialPolygonsDataFrame` for each month in the 1995-2010 time period. Linked `data.frame` objects have the following variables:

EntitySrce is a concatenation of the `EntityName` and `Source` character strings.

mean.et something...

area something...

PrecipZone is the name of the precipitation zone. See `precip.zones` dataset for details.

et.vol something...

precip.vol something...

cir.vol something...

EntityName is the name of the irrigation entity served by a group of diversions.

Source is the water source: "Mixed" for a mixture of surface water and groundwater, "SW Only" for surface water only, and "GW Only" for groundwater only.

Source

Something...

Examples

```
names(entity.components)
print(entity.components[["199506"]])
```

---

et *Evapotranspiration*

Description

Evapotranspiration (ET) in the Wood River Valley and surrounding areas. Defined as the amount of water lost to the atmosphere via direct evaporation, transpiration by vegetation, or sublimation from snow covered areas.

Usage

```
et
```

Format

An object of class `RasterStack`, a collection of `raster` layers. There are a total of 192 layers, one layer for each month in the 1995-2010 time period. Each cell on a layers surface grid represents the monthly depth of ET in meters. Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM).

Source

Idaho Department of Water Resources

See Also

et.method

Examples

```
rasterOptions(standardnames = FALSE)
print(et)
plot(et[["199505"]])
```

`et.method` *Method Used to Calculate Evapotranspiration*

Description

The methods used to estimate evapotranspiration (ET) values.

Usage

```
et.method
```

Format

A `data.frame` object with 122 records with the following variables:

YearMonth The year and month during which the method was applied, with a required date format of `YYYYMM`.

ETMethod An identifier that indicates the method used to estimate ET values. Identifiers include: "MET", the Mapping Evapotranspiration at high Resolution and with Internalized Calibration (METRIC) evapotranspiration model. "NET", the correlation between Normalized Difference Vegetation Index (NDVI) and historic ET values. "INT", interpolating form historic ET values. "ADJ", interpolating form historic ET values and adjusted to remove outliers. "WNT", the Allen and Robison method.

Source

Idaho Department of Water Resources

References

Allen, R., Robison, C.W., 2007, Evapotranspiration and consumptive water requirements for Idaho, University of Idaho, Kimberly, Idaho.

Allen, R., Robison, C.W., Garcia, M., Trezza, R., Tasumi, M., and Kjaersgaard, J., 2010, ETrF vs NDVI relationships for southern Idaho for rapid estimation of evapotranspiration, University of Idaho, Kimberly, ID.

Allen, R., Tasumi, M., Trezza, R., and Kjaersgaard, J., 2010, METRIC mapping evapotranspiration at high resolution applications manual for Landsat satellite imagery version 2.07, University of Idaho, Kimberly, ID.

ET Idaho: http://data.kimberly.uidaho.edu/ETIdaho/

Examples

```
str(et.method)
```

ExcludeSmallCellChunks *Exclude Small Cell Chunks*

Description

A cell chunk is defined as a group of connected cells with non-missing values. This function identifies cell chunks in a single raster grid layer. The chunk with the largest surface area is preserved and all others removed.

Usage

```
ExcludeSmallCellChunks(r)
```

Arguments

r	RasterLayer; a raster grid layer with cell values.

Value

The raster grid layer r with cell values in the smaller cell chunks set to NA.

Author(s)

J.C. Fisher

See Also

clump

Examples

```
set.seed(0)
r <- raster(ncols = 10, nrows = 10)
r[] <- round(runif(ncell(r)) * 0.7)
r <- clump(r)
plot(r)

r.new <- ExcludeSmallCellChunks(r)
plot(r.new, zlim = range(r[], na.rm = TRUE))
```

ExportRasterStack *Export Raster Stack*

Description

Write raster-stack layers to a local directory in multiple formats (such as Text, PNG, and GeoTIFF).

Usage

```
ExportRasterStack(p, rs, NAflag = -999)
```

Arguments

p	character; path name to write raster stack.
rs	RasterStack; a collection of RasterLayer objects with the same extent and resolution.
NAflag	numeric; to overwrite the default value used to represent NA in a file.

Details

Three directories ('Text', 'PNG', and 'GeoTIFF') are created in the path p and named after the intended data format for files it will contain. A file is written for each raster layer in the raster stack rs and for each format type. Base names for files are a concatenation of layer order in the raster stack, layer name, and an extension consistent with its data format ('.txt', '.png', and '.tif'). An external representation of the RasterStack object is also written to path p and given the name 'raster.stack.rda'.

Value

Returns an object of class NULL.

Author(s)

J.C. Fisher

Examples

```
## Not run:
load(file = file.path(getwd(), "20130926130613", "Data", "raster.stack.rda"))
ExportRasterStack(tempdir(), rs)
## End(Not run)
```

ExtractAlongTransect *Extract Raster Values Along Transect*

Description

Extract values from raster layer(s) along a user defined transect line.

Usage

```
ExtractAlongTransect(r, v, rtn.polygon = FALSE)
```

Arguments

r	RasterLayer or RasterStack; the raster layer(s).
v	SpatialPoints; the transect line vertices.
rtn.polygon	logical; if TRUE, a polygon is returned. See 'Value' for additional information.

Details

The transect line is described using a simple polygonal chain. Transect line vertices and raster layer(s) must be specified in a coordinate reference system.

Value

If r is a RasterLayer or rtn.polygon is FALSE, a list is returned with components of class SpatialPointsDataFrame. These components represent continuous line segments along the transect line. The following variables are specified for each coordinate point in the line segment:

d	numeric; the distance along the transect line.
z1	numeric; the value of raster layer r1.
z2	numeric; the value of raster layer r2.

Alternatively, if r is a RasterStack and rtn.polygon is TRUE, a polygon of class gpc.poly is returned. Georeferencing is absent from the polygon with *x* representing the distance along the transect line and *y* representing the raster layer value.

Author(s)

J.C. Fisher

Examples

```
coords <- rbind(c(-100, -90), c(80, 90), c(80, 0), c(40, -40))
crs <- CRS("+proj=longlat +datum=WGS84")
v <- SpatialPoints(coords, proj4string = crs)
r1 <- raster(nrows = 10, ncols = 10, ymn = -80, ymx = 80)
set.seed(0)
r1[] <- runif(ncell(r1))
r1[4, 6] <- NA
plot(r1, xlab = "x", ylab = "y")
lines(SpatialLines(list(Lines(list(Line(coords)), ID = "Transect")), proj4string = crs))
points(v, pch = 21, bg = "grey")
segs <- ExtractAlongTransect(r1, v = v)
for (i in 1:length(segs))
  points(segs[[i]], col = "blue")

xlab <- "Distance along transect"
ylab <- "Value"
xlim <- range(vapply(segs, function(seg) range(seg@data[, "d"]), c(0, 0)))
ylim <- range(vapply(segs, function(seg) range(seg@data[, "z1"]), c(0, 0)))
dev.new()
plot(NA, type = "n", xlab = xlab, ylab = ylab, xlim = xlim, ylim = ylim)
for (i in 1:length(segs))
  lines(segs[[i]]@data[, c("d", "z1")], col = rainbow(length(segs))[i])
n <- length(v)
d <- cumsum(c(0, as.matrix(dist((coordinates(v))))[cbind(1:(n - 1), 2:n)]))
abline(v = d, col = "grey", lty = 2)
mtext(paste0("(", paste(head(coordinates(v), 1), collapse = ", "), ")"), adj = 0)
mtext(paste0("(", paste(tail(coordinates(v), 1), collapse = ", "), ")"), adj = 1)

r2 <- sum(r1, 2.0, na.rm = TRUE)
ply <- ExtractAlongTransect(stack(r1, r2), v = v, rtn.polygon = TRUE)
dev.new()
plot(ply, asp = 100, xlab = xlab, ylab = ylab, poly.args = list(col = "lightblue"))
abline(v = d, col = "grey", lty = 2)
mtext(paste("Cross sectional area =", format(area.poly(ply))))
```

GetSeasonalMultiplier *Get Seasonal Multiplier*

Description

This function determines the seasonal fraction of the mean.

Usage

```
GetSeasonalMultiplier(x, reduction, d.in.mv.ave, dlim)
```

Arguments

x	data.frame; a time series with Date and numeric components.
reduction	numeric; a factor in the signal amplitude reduction algorithm. Its magnitude should be greater than or equal to 1, where a value of 1 indicates no reduction in the signal amplitude.
d.in.mv.ave	numeric; the number of days in the moving average subset.
dlim	Date; a vector of length 2 giving the start and end dates for the time period of interest.

Details

A simple moving average is first calculated for each month using the previous data. The seasonal average of the monthly moving average is then passed through a signal amplitude reduction algorithm. The reduced values are then divided by the mean of the seasonal reduced data to give the seasonal fraction of the mean (seasonal multiplier).

Value

An object of class data.frame with Date and numeric components; that is, the starting date and multiplier for each season.

Author(s)

J.C. Fisher, A. Wylie, J.R. Bartolino, and J. Sukow

Examples

```
m <- GetSeasonalMultiplier(hailey.discharge, 2, 273.932,
                           as.Date(c("1995-01-01", "2010-12-31")))
f <- vapply(tributaries$Flow, function(i) m$multiplier * i, rep(0, nrow(m)))
colnames(f) <- tributaries$ID
d <- cbind(m, f)
str(d)
```

GetWellConfig *Get Well Configuration in Model Space*

Description

Something...

Usage

```
GetWellConfig(pod.rech, rs.model, lay2.hk.tol = 1e-02)
```

Arguments

pod.rech	data.frame; somehting...
rs.model	RasterStack; see CreateModflowInputFiles for details.
lay2.hk.tol	numeric; something...

Details

Something...

Value

An object of class data.frame with the following components:

WMISNUmber	numeric; a unique number assigned to a water right point of diversion.
lay	integer; layer number in model grid.
row	integer; row number in model grid.
col	integer; column number in model grid.
hk	numeric; something...
thk	numeric; something...
frac	numeric; something...
199501, ..., 201012	numeric; something...
ss	numeric; something...

Author(s)

J.C. Fisher, and A. Wylie

Examples

```
print("something")
```

hailey.discharge *Mean Daily Discharge at Hailey Gaging Station*

Description

Mean daily discharge in the Big Wood River recorded at the USGS 13139510 stream gage, Big Wood River at Hailey Idaho. Daily values bracket the 1995-2010 modeling period to accommodate calculation of a moving average.

Usage

```
hailey.discharge
```

Format

A `data.frame` object with 7,671 records and the following variables:

Date is the date during which discharge was recorded.

Disch is the daily mean discharge in cubic meters per day.

Code is a qualification code: 'A' is processed and reviewed data, 'P' is provisional data subject to revision, and 'e' is estimated data.

Source

National Water Information System (NWIS), accessed on August 8, 2014.

Examples

```
str(hailey.discharge)
```

hill.shading *Land Surface Hill Shading*

Description

Something...

Usage

```
hill.shading
```

Format

Something...

Source

Something...

Examples

```
plot(hill.shading)
```

infil.basins *Infiltration Basins*

Description

Something...

Usage

```
infil.basins
```

Format

An object of SpatialPolygonsDataFrame-class containing 1 Polygons and a data.frame with the following variable:

RechSite is the name of the recharge site.

Source

Something...

Examples

```
plot(infil.basins)
print(infil.basins)
```

infiltration *Recharge from Infiltration Basins*

Description

Recharge from infiltration basins in the Wood River Valley.

Usage

```
infiltration
```

Format

A data.frame object with 216 records and the following variables:

YearMonth is the year and month during which recharge was recorded, with a required date format of YYYYMM.

RechSite is the name of the recharge site, see infil.basins dataset for details.

Rech is the monthly volume of recharge in cubic meters.

Source

Something...

References

Something...

Examples

```
str(infiltration)
```

`irr.entities` *Irrigation Entities*

Description

Delineation of areas served by a group of surface water and (or) groundwater diversions.

Usage

```
irr.entities
```

Format

An object of `SpatialPolygonsDataFrame-class` containing 210 `Polygons` and a `data.frame` with the following variables:

EntityName is the name of the irrigation entity served by a group of diversions.

Source is the water source: "Mixed" for a mixture of surface water and groundwater, "SW Only" for surface water only, and "GW Only" for groundwater only.

EntitySrce is a concatenation of the `EntityName` and `Source` character strings.

PrecipZone is the name of the precipitation zone. See `precip.zones` dataset for details.

Source

Idaho Department of Water Resources (IDWR); derived from IDWR water rights database, Blaine County tax lot data, and IDWR irrigated land classification files.

Examples

```
plot(irr.entities)
print(irr.entities)
```

irr.lands *Irrigated Lands*

Description

Irrigation classification of land area; available for years 1996, 2000, 2002, 2006, 2008, 2009, and 2010.

Usage

```
irr.lands
```

Format

A `list object` of length 7 with components of `SpatialPolygonsDataFrame-class`. The `data.frame` associated with each of the `SpatialPolygons` objects has the following variable:

Status is the status of land during the year reviewed, may be "irrigated", "semi-irrigated", or "non-irrigated".

Source

Idaho Department of Water Resources; polygons derived from U.S. Department of Agriculture Common Land Unit polygons with some refinement of polygons. Irrigation status interpreted using satellite imagery and aerial photography.

See Also

`irr.lands.year`

Examples

```
spplot(irr.lands[["2010"]], "Status")
print(irr.lands)
```

irr.lands.year *Irrigation Lands for Year*

Description

Land classification specifying irrigation practices is not available for all years. For missing years, this dataset provides substitute years when land-classification was available (see `irr.lands`).

Usage

```
irr.lands.year
```

Format

A `data.frame` object with 16 records and the following variables:

Year is the year with a required date format of `YYYY`.

IL_Year is the substitute year with a required date format of `YYYY`.

Source

Idaho Department of Water Resources

Examples

```
str(irr.lands.year)
```

`lakes` *Lakes and Reservoirs*

Description

Lakes and reservoirs of the Wood River Valley and surrounding areas.

Usage

```
lakes
```

Format

An object of `SpatialPolygonsDataFrame-class` containing 55 `Polygons`. Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM).

Source

Idaho Department of Water Resources (IDWR)

Examples

```
plot(lakes)
str(lakes)
```

land.surface *Topography of Land Surface*

Description

The Wood River Valley (WRV) is a geologic feature located in south-central Idaho. This dataset gives the topography of the land surface in the WRV and vicinity.

Usage

```
land.surface
```

Format

An object of class SpatialGridDataFrame-class. Each cell on the surface grid represents an elevation in meters above the North American Vertical Datum of 1988 (NAVD 88). Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM). The spatial grid is composed of 565 rows and 429 columns, and has cell sizes that are constant at 100 meters by 100 meters.

Source

The National Elevation Dataset (NED) 1/3-arc-second raster (Gesch, 2007; Gesch and others, 2002). This dataset was downloaded on September 22, 2013 in a Esri ArcGRID format using the National Map Viewer. NED data are distributed in geographic coordinates in units of decimal degrees, and in conformance with the NAD 83. Elevation values are in meters above the NAVD 88. The west, east, south, and north bounding coordinates for this dataset are -115, -114, 43, and 44 decimal degrees, respectively. Post-processing includes: (1) project the values of the NED dataset into the alluvium.bottom spatial grid using bilinear interpolation, and (2) set values in cells where the elevation of the alluvium bottom is missing to NA.

References

Gesch, D.B., 2007, The National Elevation Dataset, in Maune, D., ed., Digital Elevation Model Technologies and Applications: The DEM Users Manual, 2nd Edition: Bethesda, Maryland, American Society for Photogrammetry and Remote Sensing, p. 99-118.

Gesch, D., Oimoen, M., Greenlee, S., Nelson, C., Steuck, M., and Tyler, D., 2002, The National Elevation Dataset: Photogrammetric Engineering and Remote Sensing, v. 68, no. 1, p. 5-11.

Examples

```
image(land.surface)
summary(land.surface)
```

map.labels *Map Labels*

Description

Map labels in the Wood River Valley and surrounding areas.

Usage

```
map.labels
```

Format

An object of SpatialPointsDataFrame-class containing 6 points. Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM).

Source

Best estimates of label locations.

Examples

```
plot(map.labels, col = "red")
lab <- cbind(map.labels@coords, map.labels@data)
for (i in seq_len(nrow(lab))) {
  text(lab$x[i], lab$y[i], labels = lab$label[i], cex = lab$cex[i],
       col = lab$col[i], font = lab$font[i], srt = lab$srt[i])
}
```

PlotMap *Plot Map*

Description

Map values of a raster layer. A key showing how the colors map to raster values is shown below the map.

Usage

```
PlotMap(r, layer = 1, att = NULL, n, breaks, xlim = NULL, ylim = NULL,
        zlim = NULL, asp = 1, extend.xy = FALSE, extend.z = FALSE,
        reg.axs = TRUE, trim.r = TRUE, dms.tick = FALSE, bg.lines = FALSE,
        bg.image = NULL, bg.image.alpha = 1, pal = rainbow, col = NULL,
        max.dev.dim = c(43, 56), bw = NULL, scale.loc = "bottomleft",
        arrow.loc = NULL, explanation = NULL, credit = proj4string(r),
        shade = NULL, contour.lines = NULL, rivers = NULL, lakes = NULL,
        useRaster = TRUE, dev.type = c("cur", "new", "pdf", "png"),
        file = "Rplot")
```

Arguments

r	RasterLayer, SpatialGridDataFrame, or CRS; a raster layer with values to be plotted or a coordinate reference system (CRS).
layer	integer; the column to use in the SpatialGridDataFrame.
att	numeric or character; the variable identifying the levels attribute to use in the Raster Attribute Table (RAT). This argument requires r values that are of class factor.
n	integer; the desired number of intervals to partition the range of raster values (or zlim if specified) (optional).
breaks	numeric; a vector of break points used to partition the colors representing numeric raster values (optional).
xlim	numeric; a vector of length 2 giving the minimum and maximum values for the *x*-axis.
ylim	numeric; a vector of length 2 giving the minimum and maximum values for the *y*-axis.
zlim	numeric; a vector of length 2 giving the minimum and maximum raster values for which colors should be plotted.
asp	numeric; the *y/x* aspect ratio for spatial axes.
extend.xy	logical; if TRUE, the spatial limits will be extended to the next tick mark on the axes beyond the grid extent.
extend.z	logical; if TRUE, the raster value limits will be extended to the next tick mark on the color key beyond the measured range.
reg.axs	logical; if TRUE, the spatial data range is extended.
trim.r	logical; if TRUE, the outer rows and columns that consist of all NA values will be removed.
dms.tick	logical; if TRUE, the axes tickmarks are specified in degrees, minutes, and decimal seconds.
bg.lines	logical; if TRUE, the graticule is drawn in back of the raster layer using white lines and a grey background.
bg.image	RasterLayer; an image to drawn in back of the main raster layer r.
bg.image.alpha	numeric; the opacity of the background image from 0 to 1.
pal	function; a color palette to be used to assign colors in the plot.
col	character; a vector of colors to be used in the plot. This argument requires breaks specification for numeric values of r and overrides any palette function specification. For numeric values there should be one less color than breaks. Factors require a color for each level.
max.dev.dim	numeric; a vector of length 2 giving the maximum width and height for the graphics device in picas, respectively. Suggested dimensions for single-column, double-column, and sidetitle figures are c(21, 56), c(43, 56), and c(56, 43), respectively.
bw	numeric; the width of the color key box in picas. This argument requires r values that are of class factor.
scale.loc	character; the position of the scale bar: "bottomleft", "topleft", "topright", or "bottomright" to denote scale location.
arrow.loc	character; the position of the north arrow: "bottomleft", "topleft", "topright", or "bottomright" to denote arrow location.

explanation	character; a label explaining the raster value.
credit	character; a label crediting the base map.
shade	list; if specified, a semi-transparent shade layer is drawn on top of the raster layer. This layer is described using a list of arguments supplied to hillShade. Passed arguments include "angle" and "direction". Additional arguments may also be passed that control the vertical aspect ratio ("z.factor") and color opacity ("alpha").
contour.lines	list; if specified, contour lines are drawn. The contours are described using a list of arguments supplied to contour. Passed arguments include "drawlables", "method", and "col".
rivers	list; if specified, lines are drawn. The lines are described using a list of arguments supplied to the plot method for SpatialLines. Passed arguments include "x", "col", and "lwd".
lakes	list; if specified, polygons are drawn. The polygons are described using a list of arguments supplied to the plot method for SpatialPolygons. Passed arguments include "x", "col", "border", and "lwd".
useRaster	logical; if TRUE, a bitmap raster is used to plot the image instead of polygons. Bitmap images require a regular grid.
dev.type	character; the graphics device type. Defaults to the 'active' device ("cur") and if it is unavailable a new device ("new") is opened based on getOption("device"). Specification of a file argument is required to open a new graphic device for a PDF formatted file ("pdf") or PNG formatted bitmap file ("png").
file	character; the name of the output file. Requires a dev.type of "pdf" or "png".

Details

The dimensions of a new graphics device is dependent on the argument values of max.dev.dim and asp.

Value

Returns a list object with graphical parameters "din" and "usr". See par for details.

Author(s)

J.C. Fisher

Examples

```
r <- raster(system.file("external/test.grd", package="raster"))
PlotMap(r, scale.loc = "topleft", dms.tick = TRUE, trim.r = TRUE)

graphics.off()
r <- raster(nrow = 10, ncol = 10)
r[] <- 1L
r[51:100] <- 2L
r[3:6, 1:5] <- 8L
r <- ratify(r)
rat <- levels(r)[[1]]
rat$land.cover <- c("Pine", "Oak", "Meadow")
rat$code <- c(12, 25, 30)
```

```
levels(r) <- rat
PlotMap(r, att = "land.cover", col = c("grey", "orange", "purple"))
PlotMap(r, att = "code")

graphics.off()
r <- alluvium.bottom
PlotMap(r@crs, bg.image = hill.shading, reg.axs = FALSE)
plot(aquifer.extent, border = "red", add = TRUE)
PlotMap(r, bg.image = hill.shading, bg.image.alpha = 0.6, dev.type = "new")
PlotMap(r, n = 10, extend.xy = TRUE, dev.type = "new")

graphics.off()
PlotMap(r, ylim = c(NA, 1360000), max.dev.dim = c(56, 43), n = 10, extend.z = TRUE,
        contour.lines = list(col = "#A9A9A9"))
plot(aquifer.extent, add = TRUE)
shade <- list(z.factor = 15, alpha = 0.4)
txt <- "Land surface elevation in meters above National Geodetic Vertical Datum of 1929."
ans <- PlotMap(r, ylim = c(NA, 1360000), max.dev.dim = c(56, 43), bg.lines = TRUE,
               shade = shade, arrow.loc = "topright", explanation = txt)

## Not run:
pdf("Rplot.pdf", width = ans$din[1], height = ans$din[2], version = "1.6",
    colormodel = "cmyk")
PlotMap(r, ylim = c(NA, 1360000), max.dev.dim = c(56, 43), bg.lines = TRUE,
        shade = shade, arrow.loc = "topright", explanation = txt,
        useRaster = FALSE)
dev.off()
PlotMap(r, ylim = c(NA, 1360000), max.dev.dim = c(56, 43), bg.lines = TRUE,
        shade = shade, arrow.loc = "topright", explanation = txt,
        dev.type = "png")
## End(Not run)

graphics.off()
```

---

pod.gw *Points of Diversion for Groundwater*

Description

Points of diversion for groundwater within the Wood River Valley model study area.

Usage

```
pod.gw
```

Format

A `data.frame` object with 1,081 records and the following variables:

WMISNumber is a unique number assigned to a water right point of diversion.

WaterRight is a number identifying a specific authorization to use water in a prescribed manner.

EntityName is the name of the irrigation entity the point of diversion is assigned to.

EntitySrce is the source of water for an irrigation entity. Possible sources of water include surface water, groundwater and mixed. Mixed source entities derive water from both groundwater and surface water.

Pdate is the priority date, the date the water right was established.

IrrRate is the irrigation rate in cubic meters per day, the maximum permitted water use rate associated with a water right.

Source

Idaho Department of Water Resources water rights database.

See Also

`pod.wells`

Examples

```
summary(pod.gw)
```

`pod.wells` *Groundwater Points of Diversion, Wells*

Description

Groundwater points of diversion, wells, within the Wood River Valley model study area.

Usage

```
pod.wells
```

Format

An object of `SpatialPointsDataFrame-class` containing 563 points with the following variables:

WMISNumber is a unique number assigned to a water right point of diversion.

WellUse is the permitted use(s) for a groundwater well.

TopOpen1 is the depth to the top of the first open interval in a groundwater well, in meters below land surface.

BotOpen1 is the depth to the bottom of the first open interval in a groundwater well, in meters below land surface.

TopOpen2 is the depth to the top of the second open interval in a groundwater well, in meters below land surface.

BotOpen2 is the depth to the bottom of the second open interval in a groundwater well, in meters below land surface.

Pred is a logical value indicating a completion report is not available for the well and values of `TopOpen1` and `BotOpen1` were predicted using opening information from the nearest irrigation well.

Source

Idaho Department of Water Resources water rights database.

See Also

pod.gw

Examples

```
plot(pod.wells)
str(pod.wells@data)
```

---

precip.zones *Precipitation Zones*

Description

Precipitation zones specified for the Wood River Valley and surrounding areas. There are three precipitation zones, each containing a single weather station. Precipitation zones were distributed to maintain the geographic similarity between weather stations and zones.

Usage

```
precip.zones
```

Format

An object of SpatialPolygonsDataFrame-class containing 3 Polygons and a data.frame with the following variables:

ID a numeric identifier assigned to the polygon.

PrecipZone the name of the precipitation zone: "Ketchum", the northernmost zone with data from the Ketchum National Weather Service coop weather station. "Hailey", the central zone with data from the Hailey 3NNW National Weather Service coop weather station. "Picabo", the southernmost zone with data from the Picabo AgriMet weather station.

Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM).

Source

Idaho Department of Water Resources

See Also

precipitation

Examples

```
spplot(precip.zones, "PrecipZone")
print(precip.zones)
```

precipitation *Precipitation*

Description

Precipitation data recorded at three weather stations in the Wood River Valley and surrounding areas.

Usage

```
precipitation
```

Format

A `data.frame` object with 576 records and the following variables:

YearMonth is the year and month during which precipitation were recorded, with a required date format of `YYYYMM`.

PrecipZone the name of the precipitation zone, see `precip.zones` dataset for details.

Precip is the monthly precipitation in meters.

Source

Idaho Department of Water Resources

References

National Oceanic and Atmospheric Administration's National Weather Service (NWS) Cooperative Observer Program

U.S. Bureau of Reclamation's Cooperative Agricultural Weather Network (AgriMet)

Examples

```
str(precipitation)
```

priority.cuts *Priority Cuts*

Description

Priority cut dates applied to Big Wood River above Magic Reservoir and Silver Creek by Water District 37 and 37M on the 16th of each month.

Usage

```
priority.cuts
```

Format

A `data.frame` object with 112 records and the following variables:

YearMonth is the year and month during of the priority cut date, with a required date format of `YYYYMM`.

Pdate_BWR is the date of the priority cut applied to Big Wood River above Magic Reservoir by Water District 37.

Pdate_SC is the date of the priority cut applied to Silver Creek by Water District 37M.

Source

Idaho Department of Water Resources compiled priority cut dates in effect on the 16th of each month from Water District 37 and 37M records.

Examples

```
str(priority.cuts)
```

`ProcessRecharge` *Process Recharge*

Description

Something...

Usage

```
ProcessRecharge(tr.stress.periods, rs.model, write.summary = FALSE)
```

Arguments

`tr.stress.periods`	`Date`; somehting...
`rs.model`	`RasterStack`; something...
`write.summary`	`logical`; if `TRUE`, tables summarizing water diversions are written to the working directory.

Details

Something...

Value

Returns a `list` object with `RasterBrick` and `data.frame` components.

Author(s)

J.C. Fisher, J. Sukow, and M. McVay

Examples

```
## Not run: # see wrv-process vignette
```

public.parcels *Public Land Parcels*

Description

Public land parcels in the Wood River Valley and surrounding areas.

Usage

```
public.parcels
```

Format

An object of SpatialPolygons-class containing 638 Polygons.

Source

Idaho Department of Water Resources; derived from Blaine County tax lots.

Examples

```
plot(public.parcels)
print(public.parcels)
```

r.canals *Rasterized Canals*

Description

Something...

Usage

```
r.canals
```

Format

An object of class RasterLayer.

Source

Something...

Examples

```
plot(r.canals)
summary(r.canals)
```

ReadModflowBinaryFile *Read MODFLOW Binary File*

Description

Read binary output data from a MODFLOW run.

Usage

```
ReadModflowBinaryFile(f, data.type = c("array", "flow"))
```

Arguments

f	character; the name of the binary file.
data.type	character; a description of how the data is saved.

Details

This function reads binary head ('.hds'), drawdown ('.ddn'), and budget ('.bud') files generated from a MODFLOW run.

Value

Returns a list object of length equal to the number of times the data type is written to the binary file. List components are list objects with the following components:

d	matrix or data.frame; the data values.
kstp	integer; the time step.
kper	integer; the stress period.
desc	character; the variable name.
ilay	integer; the model-grid layer.
pertim	numeric; the time in the stress period.
totim	numeric; the total elapsed time.

Author(s)

J.C. Fisher

See Also

readBin

Examples

```
## Not run:
obj <- ReadModflowBinaryFile(file.path(getwd(), "Run", "wrv_ss_mfusg.hds"), "array")
str(obj)
## End(Not run)
```

`ReadModflowListFile` *Read Volumetric Budget from MODFLOW Listing File*

Description

Reads and parses the volumetric budget for the entire model at the end of time step and stress period.

Usage

```
ReadModflowListFile(f)
```

Arguments

`f`	`character`; the name of the MODFLOW listing file.

Value

Returns a `list` object of length equal to the number of times the volumetric budget was written to the listing file. Each component is a list and represents a single volumetric budget with components:

`caption`	`character`; a title for the volumetric budget information.
`time.step`	`integer`; the time step in the model run.
`stess.period`	`integer`; the stress period in the model run.
`inputs`	`matrix`; the volume and rate for input components.
`outputs`	`matrix`; the volume and rate for output components.
`discrepancy`	`matrix`; the volume and rate for the discrepancy between inputs and outputs.

Author(s)

J.C. Fisher

See Also

`readLines`

Examples

```
## Not run:
budgets <- ReadModflowListFile(file.path(getwd(), "tr.lst"))
## End(Not run)
```

rivers *Rivers and Streams*

Description

Rivers and streams of the Wood River Valley and surrounding areas.

Usage

```
rivers
```

Format

An object of SpatialLinesDataFrame-class containing 581 Lines. Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM).

Source

Idaho Department of Water Resources (IDWR)

Examples

```
spplot(rivers)
str(rivers)
```

rs.entities *Monthly Irrigation Entities*

Description

Something...

Usage

```
rs.entities
```

Format

An object of class RasterStack.

Source

Something...

Examples

```
names(rs.entities)
plot(rs.entities[["199507"]])
```

rs.rech.non.irr *Rasterized Monthly Recharge on Non-Irrigated Lands*

Description

Something...

Usage

```
rs.rech.non.irr
```

Format

An object of class RasterStack.

Source

Something...

Examples

```
names(rs.rech.non.irr)
plot(rs.rech.non.irr[["199507"]])
```

SetPolygons *Analysis of Multi-Polygon Objects*

Description

Determines the intersection or difference between two multi-polygon objects.

Usage

```
SetPolygons(x, y, cmd = c("gIntersection", "gDifference"), buffer.width = NA)
```

Arguments

x	SpatialPolygons*; a multi-polygon object.
y	SpatialPolygons*; a multi-polygon object.
cmd	character; specifying "gIntersection", the default, cuts out portions of the x polygons that overlay the y polygons. If "gDifference" is specified, only those portions of the x polygons falling outside the y polygons are copied to the output polygons.
buffer.width	numeric; expands or contracts the geometry of y to include the area within the specified width, see gBuffer. Specifying NA, the default, indicates no buffer.

Details

This function tests if the resulting geometry is valid, see gIsValid.

Value

Returns an object of class `SpatialPolygons*`.

Author(s)

J.C. Fisher

See Also

`gIntersection`, `gDifference`

Examples

```
print("something...")
```

`soils` *Soils*

Description

Representation of mapped soil units created by the Idaho Office of the National Resource Conservation Service (NRCS). Soils have been assigned an infiltration rate based on the average, saturated hydraulic conductivity of the soils as classified using the Unified Soil Classification System (USCS).

Usage

```
soils
```

Format

An object of `SpatialPolygonsDataFrame-class` containing 288 `Polygons` and a `data.frame` with the following variables:

SoilLayer is an identifier used to differentiate the soil data source used to create the soils map. Data sources are either NRCS USCS or NRCS State Soil Geographic Data Base (STATSGO).

InfRate is the infiltration rate in meters per day.

Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM).

Source

Idaho Department of Water Resources

Examples

```
spplot(soils, "InfRate")
str(soils@data)
```

specified.flows *Specified Flow Locations*

Description

Polygons used to define the location of specified flow boundaries in the model domain. Model cells intersecting a polygon line segment are defined as specified flow cells. Cells within the body of the polygon but not a specified source cell are made inactive.

Usage

```
specified.flows
```

Format

An object of SpatialPolygonsDataFrame-class containing a set of 21 Polygons and a data.frame with the following variable:

Name is an identifier for the polygon, typically the abbreviated name of the gulch where the specified flow boundary is located.

Geographic coordinates are in units of meters, in conformance with the North American Datum of 1983 (NAD 83), and placed in a Idaho Transverse Mercator projection (IDTM).

Source

A Keyhole Markup Language (KML) file created in Google Earth with polygons drawn by hand in areas of known specified flow boundaries.

Examples

```
plot(specified.flows)
str(specified.flows)
```

tributaries *Estimated Annual Flows in the Tributaries*

Description

The estimated groundwater flow from tributary canyons into the Wood River Valley aquifer system, south-central Idaho.

Usage

```
tributaries
```

Format

A `data.frame` object with 22 records and the following variables:

Name is the tributary name.

ID is a unique tributary identifier.

BasinArea is the basin area in square meters.

Flow is the estimated volumetric flux in cubic meters per day.

Source

This dataset was derived by Darcian analysis of flux using an estimate of cross-sectional area of the saturated thickness in tributary canyons from well and geophysical data. Adjustments to these estimates were made for tributary canyons less than 2.6e+07 square meters (10 square miles) in area.

Examples

```
str(tributaries)
```

`wetlands` *Wetlands*

Description

Wetlands in the Wood River Valley and surrounding areas.

Usage

```
wetlands
```

Format

An object of `SpatialPolygons-class` containing 3,024 `Polygons`.

Source

U.S. Fish and Wildlife Service National Wetlands Inventory

Examples

```
plot(wetlands)
print(wetlands)
```

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