

Package ‘MazamaLocationUtils’

October 12, 2022

Type Package

Version 0.3.8

Title Manage Spatial Metadata for Known Locations

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Description Utility functions for discovering and managing metadata associated with spatially unique “known locations”. Applications include all fields of environmental monitoring (e.g. air and water quality) where data are collected at stationary sites.

License GPL-3

URL <https://github.com/MazamaScience/MazamaLocationUtils>

BugReports <https://github.com/MazamaScience/MazamaLocationUtils/issues>

Depends R (>= 3.5)

Imports dplyr, geodist (>= 0.0.7), httr, jsonlite, leaflet, lubridate, magrittr, methods, MazamaCoreUtils (>= 0.4.10), MazamaSpatialUtils (>= 0.7), readr, rlang, stringr, tidygeocoder

Suggests knitr, markdown, testthat (>= 2.1.0), rmarkdown, roxygen2

Encoding UTF-8

VignetteBuilder knitr

LazyData true

RoxygenNote 7.1.2

NeedsCompilation no

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Repository CRAN

Date/Publication 2022-08-24 23:42:34 UTC

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coreMetadataNames	<i>Names of standard spatial metadata columns</i>
-------------------	---------------------------------------------------

Description

Character string identifiers of the minimum set of fields required for a table to be considered a valid "known locations" table.

Usage

```
coreMetadataNames
```

Format

A vector with 3 elements

Details

```
coreMetadataNames
```

getAPIKey	<i>Get API key</i>
-----------	--------------------

Description

Returns the API key associated with a web service.

getLocationDataDir	<i>Get location data directory</i>
--------------------	------------------------------------

Description

Returns the directory path where known location data tables are located.

Usage

```
getLocationDataDir()
```

Value

Absolute path string.

See Also

[LocationDataDir](#)

[setLocationDataDir](#)

id_monitors_500 *Idaho monitor locations dataset*

Description

The `id_monitor_500` dataset provides a set of known locations associated with Idaho state air quality monitors. This dataset was generated on 2021-10-19 by running:

```
library(PWFSLSmoke)
library(MazamaLocationUtils)

mazama_initialize()
setLocationDataDir("./data")

monitor <- monitor_loadLatest()
lons <- monitor$meta$longitude
lats <- monitor$meta$latitude

table_initialize() %>%
  table_addLocation(
    lons, lats,
    distanceThreshold = 500,
    elevationService = "usgs",
    addressService = "photon"
  ) %>%
  table_save("id_monitors_500")
```

Usage

```
id_monitors_500
```

Format

A tibble with 30 rows and 13 columns of data.

See Also

[or_monitors_500](#)

[wa_monitors_500](#)

LocationDataDir	<i>Directory for location data</i>
-----------------	------------------------------------

Description

This package maintains an internal directory path which users can set using `setLocationDataDir()`. All package functions use this directory whenever known location tables are accessed.

The default setting when the package is loaded is `getwd()`.

Format

Absolute path string.

See Also

[getLocationDataDir](#)

[setLocationDataDir](#)

location_createID	<i>Create one or more unique locationIDs</i>
-------------------	----------------------------------------------

Description

A unique locationID is created for each incoming longitude and latitude.

See `MazamaCoreUtils::createLocationID` for details.

Usage

```
location_createID(longitude = NULL, latitude = NULL)
```

Arguments

longitude Vector of longitudes in decimal degrees E.

latitude Vector of latitudes in decimal degrees N.

Value

Vector of character locationIDs.

References

https://en.wikipedia.org/wiki/Decimal_degrees

<https://www.johndcook.com/blog/2017/01/10/probability-of-secure-hash-collisions/>

Examples

```
library(MazamaLocationUtils)

# Wenatchee
lon <- -120.325278
lat <- 47.423333
locationID <- location_createID(lon, lat)
print(locationID)
```

location_getCensusBlock

Get census block data from the FCC API

Description

The FCC Block API is used get census block, county, and state FIPS associated with the longitude and latitude. The following list of data is returned:

- stateCode
- countyName
- censusBlock

The data from this function should be considered to be the gold standard for state and county. i.e. this information could and should be used to override information we get elsewhere.

Usage

```
location_getCensusBlock(
  longitude = NULL,
  latitude = NULL,
  censusYear = 2010,
  verbose = TRUE
)
```

Arguments

longitude	Single longitude in decimal degrees E.
latitude	Single latitude in decimal degrees N.
censusYear	Year the census was taken.
verbose	Logical controlling the generation of progress messages.

Value

List of census block/county/state data.

References

<https://anypoint.mulesoft.com/exchange/portals/fccdomain/>

Examples

```
library(MazamaLocationUtils)

# Fail gracefully if any resources are not available
try({

  # Wenatchee
  lon <- -120.325278
  lat <- 47.423333

  censusList <- location_getCensusBlock(lon, lat)
  str(censusList)

}, silent = FALSE)
```

location_getOpenCageInfo

Get location information from OpenCage

Description

The OpenCage reverse geocoding service is used to obtain all available information for a specific location.

The data from OpenCage should be considered to be the gold standard for address information could and should be used to override information we get elsewhere.

Usage

```
location_getOpenCageInfo(longitude = NULL, latitude = NULL, verbose = FALSE)
```

Arguments

longitude	Single longitude in decimal degrees E.
latitude	Single latitude in decimal degrees N.
verbose	Logical controlling the generation of progress messages.

Value

Single-row tibble with OpenCage information.

Note

The OpenCage service requires an API key which can be obtained from their web site. This API key must be set as an environment variable with:

```
Sys.setenv("OPENCAGE_KEY" = "<your api key>")
```

The OpenCage "free trial" level allows for 1 request/sec and a maximum of 2500 requests per day.

References

<https://opencagedata.com>

Examples

```
library(MazamaLocationUtils)

# Fail gracefully if any resources are not available
try({

  Sys.setenv("OPENCAGE_KEY" = "<YOUR_KEY>")

  # Wenatchee
  lon <- -120.325278
  lat <- 47.423333

  openCageTbl <- location_getOpenCageInfo(lon, lat)
  dplyr::glimpse(openCageTbl)

}, silent = FALSE)
```

location_getSingleAddress_Photon

Get address data from the Photon API to OpenStreetMap

Description

The Photon API is used get address data associated with the longitude and latitude. The following list of data is returned:

- houseNumber
- street
- city
- stateCode
- stateName
- zip
- countryCode
- countryName

The function makes an effort to convert both state and country Name into Code with codes defaulting to NA. Both Name and Code are returned so that improvements can be made in the conversion algorithm.

Usage

```
location_getSingleAddress_Photon(  
  longitude = NULL,  
  latitude = NULL,  
  baseUrl = "https://photon.komoot.io/reverse",  
  verbose = TRUE  
)
```

Arguments

longitude	Single longitude in decimal degrees E.
latitude	Single latitude in decimal degrees N.
baseUrl	Base URL for data queries.
verbose	Logical controlling the generation of progress messages.

Value

List of address components.

References

<https://photon.komoot.io>

Examples

```
library(MazamaLocationUtils)  
  
# Fail gracefully if any resources are not available  
try({  
  
  # Set up standard directories and spatial data  
  spatialDataDir <- tempdir() # typically "~/Data/Spatial"  
  mazama_initialize(spatialDataDir)  
  
  # Wenatchee  
  lon <- -120.325278  
  lat <- 47.423333  
  
  addressList <- location_getSingleAddress_Photon(lon, lat)  
  str(addressList)  
  
}, silent = FALSE)
```

`location_getSingleAddress_TexasAM`*Get an address from the Texas A&M reverse geocoding service*

Description

Texas A&M APIs are used to determine the address associated with the longitude and latitude.

Usage

```
location_getSingleAddress_TexasAM(  
  longitude = NULL,  
  latitude = NULL,  
  apiKey = NULL,  
  verbose = TRUE  
)
```

Arguments

longitude	Single longitude in decimal degrees E.
latitude	Single latitude in decimal degrees N.
apiKey	Texas A&M Geocoding requires an API key. The first 2500 requests are free. Default: NULL
verbose	Logical controlling the generation of progress messages.

Value

Numeric elevation value.

References

https://geoservices.tamu.edu/Services/ReverseGeocoding/WebService/v04_01/HTTP.aspx

Examples

```
## Not run:  
library(MazamaLocationUtils)  
  
# Fail gracefully if any resources are not available  
try({  
  
  # Wenatchee  
  longitude <- -122.47  
  latitude <- 47.47  
  apiKey <- YOUR_PERSONAL_API_KEY  
  
  location_getSingleAddress_TexasAM(longitude, latitude, apiKey)
```

```
    }, silent = FALSE)
## End(Not run)
```

```
location_getSingleElevation_USGS
```

Get elevation data from a USGS web service

Description

USGS APIs are used to determine the elevation in meters associated with the longitude and latitude.

Note: The conversion factor for meters to feet is 3.28084.

Usage

```
location_getSingleElevation_USGS(
  longitude = NULL,
  latitude = NULL,
  verbose = TRUE
)
```

Arguments

longitude	Single longitude in decimal degrees E.
latitude	Single latitude in decimal degrees N.
verbose	Logical controlling the generation of progress messages.

Value

Numeric elevation value.

References

<https://nationalmap.gov/epqs/>

Examples

```
library(MazamaLocationUtils)

# Fail gracefully if any resources are not available
try({

  # Wenatchee
  lon <- -120.325278
  lat <- 47.423333
```

```
location_getSingleElevation_USGS(lon, lat)
}, silent = FALSE)
```

location_initialize *Create known location record with core metadata*

Description

Creates a known location record with the following columns of core metadata:

- locationID
- locationName
- longitude
- latitude
- elevation
- countryCode
- stateCode
- countyName
- timezone
- houseNumber
- street
- city
- zip

Usage

```
location_initialize(
  longitude = NULL,
  latitude = NULL,
  stateDataset = "NaturalEarthAdm1",
  elevationService = NULL,
  addressService = NULL,
  verbose = TRUE
)
```

Arguments

longitude	Single longitude in decimal degrees E.
latitude	Single latitude in decimal degrees N.
stateDataset	Name of spatial dataset to use for determining state
elevationService	Name of the elevation service to use for determining the elevation. Default: NULL skips this step. Accepted values: "usgs".
addressService	Name of the address service to use for determining the street address. Default: NULL skips this step. Accepted values: "photon".
verbose	Logical controlling the generation of progress messages.

Value

Tibble with a single new known location.

Examples

```
library(MazamaLocationUtils)

# Fail gracefully if any resources are not available
try({

  # Set up standard directories and spatial data
  spatialDataDir <- tempdir() # typically "~/Data/Spatial"
  mazama_initialize(spatialDataDir)

  # Wenatchee
  lon <- -120.325278
  lat <- 47.423333

  locationRecord <- location_initialize(lon, lat)
  str(locationRecord)

}, silent = FALSE)
```

MazamaLocationUtils *Manage Spatial Metadata for Known Locations*

Description

A suite of utility functions for discovering and managing metadata associated with sets of spatially unique "known locations".

This package is intended to be used in support of data management activities associated with fixed locations in space. The motivating fields include both air and water quality monitoring where fixed sensors report at regular time intervals.

Details

When working with environmental monitoring time series, one of the first things you have to do is create unique identifiers for each individual time series. In an ideal world, each environmental time series would have both a `locationID` and a `deviceID` that uniquely identify the specific instrument making measurements and the physical location where measurements are made. A unique `timeseriesID` could be produced as `locationID_deviceID`. Metadata associated with each `timeseriesID` would contain basic information needed for downstream analysis including at least:

`timeseriesID`, `locationID`, `deviceID`, `longitude`, `latitude`, ...

- Multiple sensors placed at a location could be grouped by `locationID`.
- An extended `timeseries` for a mobile sensor would group by `deviceID`.
- Maps would be created using `longitude`, `latitude`.
- Time series would be accessed from a secondary data table with `timeseriesID`.

Unfortunately, we are rarely supplied with a truly unique and truly spatial `locationID`. Instead we often use `deviceID` or an associated non-spatial identifier as a standin for `locationID`.

Complications we have seen include:

- GPS-reported longitude and latitude can have *jitter* in the fourth or fifth decimal place making it challenging to use them to create a unique `locationID`.
- Sensors are sometimes *repositioned* in what the scientist considers the "same location".
- Data for a single sensor goes through different processing pipelines using different identifiers and is later brought together as two separate `timeseries`.
- The spatial scale of what constitutes a "single location" depends on the instrumentation and scientific question being asked.
- Deriving location-based metadata from spatial datasets is computationally intensive unless saved and identified with a unique `locationID`.
- Automated searches for spatial metadata occasionally produce incorrect results because of the non-infinite resolution of spatial datasets.

This package attempts to address all of these issues by maintaining a table of known locations for which CPU intensive spatial data calculations have already been performed. While requests to add new locations to the table may take some time, searches for spatial metadata associated with existing locations are simple lookups.

Working in this manner will solve the problems initially mentioned but also provides further useful functionality.

- Administrators can correct entries in the `collectionName` table. (*e.g.* locations in river bends that even high resolution spatial datasets mis-assign)
- Additional, non-automatable metadata can be added to `collectionName`. (*e.g.* commonly used location names within a community of practice)
- Different field campaigns can have separate `collectionName` tables.
- `.csv` or `.rda` versions of well populated tables can be downloaded from a URL and used locally, giving scientists working with known locations instant access to spatial data that otherwise requires special skills, large datasets and lots of compute cycles.

mazama_initialize	<i>Initialize with MazamaScience standard directories</i>
-------------------	-----------------------------------------------------------

Description

Convenience function to initialize spatial data. Wraps the following setup lines:

```
MazamaSpatialUtils::setSpatialDataDir(spatialDataDir)

MazamaSpatialUtils::loadSpatialData("EEZCountries.rda")
MazamaSpatialUtils::loadSpatialData("OSMTimezones.rda")
MazamaSpatialUtils::loadSpatialData("NaturalEarthAdm1.rda")
MazamaSpatialUtils::loadSpatialData("USCensusCounties.rda")
```

Usage

```
mazama_initialize(spatialDataDir = "~/Data/Spatial")
```

Arguments

`spatialDataDir` Directory where spatial datasets are found, Default: "~/Data/Spatial"

Value

No return value.

Examples

```
library(MazamaLocationUtils)

# Fail gracefully if any resources are not available
try({

  # Set up directory for spatial data
  spatialDataDir <- tempdir() # typically "~/Data/Spatial"
  MazamaSpatialUtils::setSpatialDataDir(spatialDataDir)

  exists("NaturalEarthAdm1")
  mazama_initialize(spatialDataDir)
  exists("NaturalEarthAdm1")
  class(NaturalEarthAdm1)

}, silent = FALSE)
```

or_monitors_500	<i>Oregon monitor locations dataset</i>
-----------------	-----------------------------------------

Description

The `or_monitor_500` dataset provides a set of known locations associated with Oregon state air quality monitors. This dataset was generated on 2021-10-19 by running:

```
library(PWFSLSmoke)
library(MazamaLocationUtils)

mazama_initialize()
setLocationDataDir("../data")

monitor <- monitor_loadLatest()
lons <- monitor$meta$longitude
lats <- monitor$meta$latitude

table_initialize() %>%
  table_addLocation(
    lons, lats,
    distanceThreshold = 500,
    elevationService = "usgs",
    addressService = "photon"
  ) %>%
  table_save("or_monitors_500")
```

Usage

```
or_monitors_500
```

Format

A tibble with 69 rows and 13 columns of data.

See Also

[id_monitors_500](#)
[wa_monitors_500](#)

setAPIKey	<i>Set API key</i>
-----------	--------------------

Description

Sets the API key associated with a web service.

setLocationDataDir	<i>Set location data directory</i>
--------------------	------------------------------------

Description

Sets the data directory where known location data tables are located. If the directory does not exist, it will be created.

Usage

```
setLocationDataDir(dataDir)
```

Arguments

dataDir	Directory where location tables are stored.
---------	---------------------------------------------

Value

Silently returns previous value of the data directory.

See Also

[LocationDataDir](#)

[getLocationDataDir](#)

showAPIKeys	<i>Show API keys</i>
-------------	----------------------

Description

Prints a list of all currently set API keys.

table_addColumn	<i>Add a new column of metadata to a table</i>
-----------------	------------------------------------------------

Description

A new metadata column is added to the locationTbl. For matching locationID records, the associated locatioData is inserted. Otherwise, the new column will be initialized with NA.

Usage

```
table_addColumn(  
  locationTbl = NULL,  
  columnName = NULL,  
  locationID = NULL,  
  locationData = NULL,  
  verbose = TRUE  
)
```

Arguments

locationTbl	Tibble of known locations.
columnName	Name to use for the new column.
locationID	Vector of locationID strings.
locationData	Vector of data to used at matching records.
verbose	Logical controlling the generation of progress messages.

Value

Updated tibble of known locations.

See Also

[table_removeColumn](#)

[table_updateColumn](#)

Examples

```
library(MazamaLocationUtils)  
  
# Starting table  
locationTbl <- get(data("wa_monitors_500"))  
names(locationTbl)  
  
# Add an empty column  
locationTbl <-  
  locationTbl %>%  
  table_addColumn("siteName")
```

```
names(locationTbl)
```

table_addCoreMetadata *Add missing core metadata columns to a known location table*

Description

An existing table will be amended to guarantee that it includes the following core metadata columns.

- locationID
- locationName
- longitude
- latitude
- elevation
- countryCode
- stateCode
- countyName
- timezone
- houseNumber
- street
- city
- zip

The longitude and latitude columns are required to exist in the incoming tibble but all others are optional.

If any of these core metadata columns are found, they will be retained.

The locationID will be generated (anew if already found) from existing longitude and latitude data.

Other core metadata columns will be filled with NA values of the proper type.

The result is a tibble with all of the core metadata columns. These columns must then be filled in to create a usable "known locations" table.

Usage

```
table_addCoreMetadata(locationTbl = NULL)
```

Arguments

locationTbl Tibble of known locations. This input tibble need not be a standardized "known location" with all required columns. They will be added.

Value

Tibble with the metadata columns required in a "known locations" table.

Note

No check is performed for overlapping locations. The returned tibble has the structure of a "known locations" table and is a good starting place for investigation. But further work is required to produce a valid table of "known locations" associated with a specific spatial scale.

table_addLocation	<i>Add new known location records to a table</i>
-------------------	--------------------------------------------------

Description

Incoming longitude and latitude values are compared against the incoming locationTbl to see if they are already within distanceThreshold meters of an existing entry. A new record is created for each location that is not already found in locationTbl.

Usage

```
table_addLocation(
  locationTbl = NULL,
  longitude = NULL,
  latitude = NULL,
  distanceThreshold = NULL,
  stateDataset = "NaturalEarthAdm1",
  elevationService = NULL,
  addressService = NULL,
  verbose = TRUE
)
```

Arguments

locationTbl	Tibble of known locations.
longitude	Vector of longitudes in decimal degrees E.
latitude	Vector of latitudes in decimal degrees N.
distanceThreshold	Distance in meters.
stateDataset	Name of spatial dataset to use for determining state codes, Default: 'NaturalEarthAdm1'
elevationService	Name of the elevation service to use for determining the elevation. Default: NULL skips this step. Accepted values: "usgs".
addressService	Name of the address service to use for determining the street address. Default: NULL skips this step. Accepted values: "photon".
verbose	Logical controlling the generation of progress messages.

Value

Updated tibble of known locations.

Note

This function is a vectorized version of `table_addSingleLocation()`.

See Also

[table_addSingleLocation](#)

[table_removeRecord](#)

[table_updateSingleRecord](#)

Examples

```
library(MazamaLocationUtils)

# Fail gracefully if any resources are not available
try({

  # Set up standard directories and spatial data
  spatialDataDir <- tempdir() # typically "~/Data/Spatial"
  mazama_initialize(spatialDataDir)

  locationTbl <- get(data("wa_monitors_500"))

  # Coulee City, WA
  lon <- -119.290904
  lat <- 47.611942

  locationTbl <-
    locationTbl %>%
    table_addLocation(lon, lat, distanceThreshold = 500)

  dplyr::glimpse(locationTbl)

}, silent = FALSE)
```

`table_addOpenCageInfo` *Add address fields to a known location table*

Description

The OpenCage reverse geocoding service is used to update an existing table. Updated columns include:

- `countryCode`

- stateCode
- countyName
- timezone
- houseNumber
- street
- city
- zip
- address

When `replaceExisting = TRUE`, all existing address fields are discarded in favor of the OpenCage versions. To only fill in missing values in `locationTbl`, use `replaceExisting = FALSE`.

The OpenCage service returns a large number of fields, some of which may be useful. To add all OpenCage fields to a location table, use `retainOpenCage = TRUE`. This will append 78+ fields of information, each each named with a prefix of "opencage_".

Usage

```
table_addOpenCageInfo(
  locationTbl = NULL,
  replaceExisting = FALSE,
  retainOpenCage = FALSE,
  verbose = FALSE
)
```

Arguments

<code>locationTbl</code>	Tibble of known locations.
<code>replaceExisting</code>	Logical specifying whether to replace existing data with data obtained from OpenCage.
<code>retainOpenCage</code>	Logical specifying whether to retain all fields obtained from OpenCage, each named with a prefix of <code>opencage_</code> .
<code>verbose</code>	Logical controlling the generation of progress messages.

Value

Tibble of "known locations" enhanced with information from the OpenCage reverse geocoding service.

Note

The OpenCage service requires an API key which can be obtained from their web site. This API key must be set as an environment variable with:

```
Sys.setenv("OPENCAGE_KEY" = "<your api key>")
```

Parameters are set for use at the OpenCage "free trial" level which allows for 1 request/sec and a maximum of 2500 requests per day.

Because of the 1 request/sec default, it is recommended that table_addOpenCageInfo() only be used in an interactive session when updating a table with a large number of records.

References

<https://opencagedata.com>

Examples

```
library(MazamaLocationUtils)

# Fail gracefully if any resources are not available
try({

  myTbl <- id_monitors_500[1:3,]
  myTbl$countryCode[1] <- NA
  myTbl$countryCode[2] <- "WRONG"
  myTbl$countyName[3] <- "WRONG"
  myTbl$timezone <- NA

  dplyr::glimpse(myTbl)

  Sys.setenv("OPENCAGE_KEY" = "<YOUR_KEY>")

  table_addOpenCageInfo(myTbl) %>%
    dplyr::glimpse()

  table_addOpenCageInfo(myTbl, replaceExisting = TRUE) %>%
    dplyr::glimpse()

  table_addOpenCageInfo(myTbl, replaceExisting = TRUE, retainOpenCage = TRUE) %>%
    dplyr::glimpse()

}, silent = FALSE)
```

table_addSingleLocation

Add a single new known location record to a table

Description

Incoming longitude and latitude values are compared against the incoming locationTbl to see if they are already within distanceThreshold meters of an existing entry. A new record is created for if the location is not already found in locationTbl.

Usage

```
table_addSingleLocation(  
  locationTbl = NULL,  
  longitude = NULL,  
  latitude = NULL,  
  distanceThreshold = NULL,  
  stateDataset = "NaturalEarthAdm1",  
  elevationService = NULL,  
  addressService = NULL,  
  verbose = TRUE  
)
```

Arguments

locationTbl	Tibble of known locations.
longitude	Single longitude in decimal degrees E.
latitude	Single latitude in decimal degrees N.
distanceThreshold	Distance in meters.
stateDataset	Name of spatial dataset to use for determining state codes, Default: "NaturalEarthAdm1".
elevationService	Name of the elevation service to use for determining the elevation. Default: NULL. Accepted values: "usgs".
addressService	Name of the address service to use for determining the street address. Default: NULL. Accepted values: "photon".
verbose	Logical controlling the generation of progress messages.

Value

Updated tibble of known locations.

See Also

[table_addLocation](#)
[table_removeRecord](#)
[table_updateSingleRecord](#)

Examples

```
library(MazamaLocationUtils)  
  
# Fail gracefully if any resources are not available  
try({  
  
  # Set up standard directories and spatial data
```



```
spatialDataDir <- tempdir() # typically "~/Data/Spatial"
mazama_initialize(spatialDataDir)

locationTbl <- get(data("wa_monitors_500"))

# Coulee City, WA
lon <- -119.290904
lat <- 47.611942

locationTbl <-
  locationTbl %>%
  table_addSingleLocation(lon, lat, distanceThreshold = 500)

}, silent = FALSE)
```

table_filterByDistance

Return known locations near a target location

Description

Returns a tibble of the known locations from locationTbl that are within distanceThreshold meters of the target location specified by longitude and latitude.

Usage

```
table_filterByDistance(
  locationTbl = NULL,
  longitude = NULL,
  latitude = NULL,
  distanceThreshold = NULL,
  measure = c("geodesic", "haversine", "vincenty", "cheap")
)
```

Arguments

locationTbl	Tibble of known locations.
longitude	Target longitude in decimal degrees E.
latitude	Target latitude in decimal degrees N.
distanceThreshold	Distance in meters.
measure	One of "haversine", "vincenty", "geodesic", or "cheap" specifying desired method of geodesic distance calculation.

Value

Tibble of known locations.

Note

Only a single target location is allowed.

Examples

```
library(MazamaLocationUtils)

locationTbl <- get(data("wa_monitors_500"))

# Too small a distanceThreshold will not find a match
locationTbl %>%
  table_filterByDistance(
    longitude = -117.3647,
    latitude = 47.6725,
    distanceThreshold = 10
  ) %>%
  dplyr::glimpse()

# Expanding the distanceThreshold will find several
locationTbl %>%
  table_filterByDistance(
    longitude = -117.3647,
    latitude = 47.6725,
    distanceThreshold = 10000
  ) %>%
  dplyr::glimpse()
```

table_findAdjacentDistances

Find distances between adjacent locations in a known locations table

Description

Calculate distances between all locations within a known locations table and return a tibble with the row indices and separation distances of those records separated by less than distanceThreshold meters. Records are returned in order of distance.

It is useful when working with new metadata tables to identify adjacent locations early on so that decisions can be made about the appropriateness of the specified distanceThreshold.

Usage

```
table_findAdjacentDistances(
  locationTbl = NULL,
  distanceThreshold = NULL,
  measure = c("geodesic", "haversine", "vincenty", "cheap")
)
```

Arguments

locationTbl	Tibble of known locations.
distanceThreshold	Distance in meters.
measure	One of "haversine" "vincenty", "geodesic", or "cheap" specifying desired method of geodesic distance calculation. See <code>geodist::geodist</code> for details.

Value

Tibble of row indices and distances for those locations separated by less than `distanceThreshold` meters.

Note

The measure "cheap" may be used to speed things up depending on the spatial scale being considered. Distances calculated with `measure = "cheap"` will vary by a few meters compared with those calculated using `measure = "geodesic"`.

Examples

```
library(MazamaLocationUtils)

meta <- wa_airfire_meta

# Any locations closer than 2 km?
table_findAdjacentDistances(meta, distanceThreshold = 2000)

# How about 4 km?
table_findAdjacentDistances(meta, distanceThreshold = 4000)
```

`table_findAdjacentLocations`

Finds adjacent locations in a known locations table.

Description

Calculate distances between all locations within a known locations table and return a tibble containing all records that have an adjacent location separated by less than `distanceThreshold` meters. The return tibble is ordered by separation distance.

It is useful when working with new metadata tables to identify adjacent locations early on so that decisions can be made about the appropriateness of the specified `distanceThreshold`.

Usage

```
table_findAdjacentLocations(
  locationTbl = NULL,
  distanceThreshold = NULL,
  measure = c("geodesic", "haversine", "vincenty", "cheap")
)
```

Arguments

locationTbl	Tibble of known locations.
distanceThreshold	Distance in meters.
measure	One of "haversine" "vincenty", "geodesic", or "cheap" specifying desired method of geodesic distance calculation. See <code>geodist::geodist</code> for details.

Value

Tibble of known locations separated by less than distanceThreshold meters.

Note

The measure "cheap" may be used to speed things up depending on the spatial scale being considered. Distances calculated with measure = "cheap" will vary by a few meters compared with those calculated using measure = "geodesic".

Examples

```
library(MazamaLocationUtils)

meta <- wa_airfire_meta

# Any locations closer than 2 km?
meta %>%
  table_findAdjacentLocations(distanceThreshold = 2000) %>%
  dplyr::select(siteName, timezone)

# How about 4 km?
meta %>%
  table_findAdjacentLocations(distanceThreshold = 4000) %>%
  dplyr::select(siteName, timezone)
```

`table_getDistanceFromTarget`

Return distances and directions from a target location to known locations

Description

Returns a tibble with the same number of rows as `locationTbl` containing the distance and direction from the target location specified by longitude and latitude to each known location found in `locationTbl`.

Usage

```
table_getDistanceFromTarget(  
  locationTbl = NULL,  
  longitude = NULL,  
  latitude = NULL,  
  measure = c("geodesic", "haversine", "vincenty", "cheap")  
)
```

Arguments

<code>locationTbl</code>	Tibble of known locations.
<code>longitude</code>	Target longitude in decimal degrees E.
<code>latitude</code>	Target latitude in decimal degrees N.
<code>measure</code>	One of "haversine" "vincenty", "geodesic", or "cheap" specifying desired method of geodesic distance calculation.

Value

Tibble of distances in meters and cardinal directions from a target location.

Note

Only a single target location is allowed.

Examples

```
library(MazamaLocationUtils)  
  
locationTbl <- get(data("wa_monitors_500"))  
  
locationTbl %>%  
  table_getDistanceFromTarget(  
    longitude = -117.3647,  
    latitude = 47.6725  
  ) %>%  
  dplyr::glimpse()
```

table_getLocationID	<i>Return IDs of known locations</i>
---------------------	--------------------------------------

Description

Returns a vector of locationIDs for the known locations that each incoming location will be assigned to within the given. If more than one known location exists within the given distanceThreshold, the closest will be assigned. NA will be returned for each incoming that cannot be assigned to a known location in locationTbl.

Usage

```
table_getLocationID(
  locationTbl = NULL,
  longitude = NULL,
  latitude = NULL,
  distanceThreshold = NULL,
  measure = c("geodesic", "haversine", "vincenty", "cheap")
)
```

Arguments

locationTbl	Tibble of known locations.
longitude	Vector of longitudes in decimal degrees E.
latitude	Vector of latitudes in decimal degrees N.
distanceThreshold	Distance in meters.
measure	One of "haversine" "vincenty", "geodesic", or "cheap" specifying desired method of geodesic distance calculation. See ?geodist::geodist.

Value

Vector of known locationIDs.

Note

The measure "cheap" may be used to speed things up depending on the spatial scale being considered. Distances calculated with measure = "cheap" will vary by a few meters compared with those calculated using measure = "geodesic".

Examples

```
locationTbl <- get(data("wa_monitors_500"))

# Wenatchee
lon <- -120.325278
lat <- 47.423333
```

```
# Too small a distanceThreshold will not find a match
table_getLocationID(locationTbl, lon, lat, distanceThreshold = 50)

# Expanding the distanceThreshold will find one
table_getLocationID(locationTbl, lon, lat, distanceThreshold = 5000)
```

table_getNearestDistance

Return distances to nearest known locations

Description

Returns distances between target locations and the closest location found in `locationTbl` (if any). Target locations are specified with longitude and latitude.

For each target location, only a single distance to the closest known location is returned. If no known location is found within `distanceThreshold`, the distance associated with that target location will be NA. The length and order of resulting distances will match the order of the incoming target locations.

Usage

```
table_getNearestDistance(
  locationTbl = NULL,
  longitude = NULL,
  latitude = NULL,
  distanceThreshold = NULL,
  measure = c("geodesic", "haversine", "vincenty", "cheap")
)
```

Arguments

<code>locationTbl</code>	Tibble of known locations.
<code>longitude</code>	Vector of target longitudes in decimal degrees E.
<code>latitude</code>	Vector of target latitudes in decimal degrees N.
<code>distanceThreshold</code>	Distance in meters.
<code>measure</code>	One of "haversine", "vincenty", "geodesic", or "cheap" specifying desired method of geodesic distance calculation.

Value

Vector of closest distances between target locations and known locations.

Use Case

You may have a set of locations of interest for which you want to assess whether any monitoring locations are nearby. In this case, the locations of interest will provide longitude and latitude while `locationTbl` will be the known location table associated with the monitoring locations.

The resulting vector of distances will tell you the distance, for each target location, to the nearest monitoring location.

Note

The measure "cheap" may be used to speed things up depending on the spatial scale being considered. Distances calculated with `measure = "cheap"` will vary by a few meters compared with those calculated using `measure = "geodesic"`.

See `geodist::geodist` for details.

Examples

```
library(MazamaLocationUtils)

locationTbl <- get(data("wa_monitors_500"))

# Wenatchee
lon <- -120.325278
lat <- 47.423333

# Too small a distanceThreshold will not find a match
table_getNearestDistance(locationTbl, lon, lat, distanceThreshold = 50)

# Expanding the distanceThreshold will find one
table_getNearestDistance(locationTbl, lon, lat, distanceThreshold = 5000)
```

`table_getNearestLocation`

Return known locations

Description

Returns a tibble of the known locations from `locationTbl` that are closest to the vector of target locations specified by longitude and latitude. Only a single known location is returned for each incoming target location. If no known location is found for a particular incoming location, that record in the tibble will contain all NA.

Usage

```
table_getNearestLocation(
  locationTbl = NULL,
  longitude = NULL,
```



```

    latitude = NULL,
    distanceThreshold = NULL
  )

```

Arguments

```

locationTbl    Tibble of known locations.
longitude      Vector of longitudes in decimal degrees E.
latitude       Vector of latitudes in decimal degrees N.
distanceThreshold
                Distance in meters.

```

Value

Tibble of known locations.

Examples

```

library(MazamaLocationUtils)

locationTbl <- get(data("wa_monitors_500"))

# Wenatchee
lon <- -120.325278
lat <- 47.423333

# Too small a distanceThreshold will not find a match
table_getNearestLocation(locationTbl, lon, lat, distanceThreshold = 50) %>% str()

# Expanding the distanceThreshold will find one
table_getNearestLocation(locationTbl, lon, lat, distanceThreshold = 5000) %>% str()

```

table_getRecordIndex *Return indexes of known location records*

Description

Returns a vector of locationTbl row indexes for the locations associated with each locationID.

Usage

```
table_getRecordIndex(locationTbl = NULL, locationID = NULL, verbose = TRUE)
```

Arguments

```

locationTbl    Tibble of known locations.
locationID     Vector of locationID strings.
verbose        Logical controlling the generation of progress messages.

```

Value

Vector of locationTbl row indexes.

Examples

```
library(MazamaLocationUtils)

locationTbl <- get(data("wa_monitors_500"))

# Wenatchee
lon <- -120.325278
lat <- 47.423333

# Get the locationID first
locationID <- table_getLocationID(locationTbl, lon, lat, distanceThreshold = 5000)

# Now find the row associated with this ID
recordIndex <- table_getRecordIndex(locationTbl, locationID)

str(locationTbl[recordIndex,])
```

table_initialize

Create an empty known location table

Description

Creates an empty known location tibble with the following columns of core metadata:

- locationID
- locationName
- longitude
- latitude
- elevation
- countryCode
- stateCode
- countyName
- timezone
- houseNumber
- street
- city
- zip

Usage

```
table_initialize()
```

Value

Empty known location tibble with the specified metadata columns.

Examples

```
library(MazamaLocationUtils)

# Create an empty Tbl
emptyTbl <- table_initialize()
dplyr::glimpse(emptyTbl)
```

table_initializeExisting

Converts an existing table into a known location table

Description

An existing table may have much of the data that is needed for a known location table. This function accepts an incoming table and searches for required columns:

- locationID
- locationName
- longitude
- latitude
- elevation
- countryCode
- stateCode
- countyName
- timezone
- houseNumber
- street
- city
- zip

The longitude and latitude columns are required but all others are optional.

If any of these optional columns are found, they will be used and the often slow and sometimes slightly inaccurate steps to generate that information will be skipped for locations that have non-missing data. Any additional columns of information that are not part of the required core metadata will be retained.

This method skips the assignment of columns like `elevation` and all address related fields that require web service requests.

Compared to initializing a brand new table and populating it one record at a time, this is a much faster way of creating a known location table from a pre-existing table of metadata.

Usage

```
table_initializeExisting(
  locationTbl = NULL,
  stateDataset = "NaturalEarthAdm1",
  countryCodes = NULL,
  distanceThreshold = NULL,
  measure = c("geodesic", "haversine", "vincenty", "cheap"),
  verbose = TRUE
)
```

Arguments

<code>locationTbl</code>	Tibble of known locations. This input tibble need not be a standardized "known location" table with all required columns. Missing columns will be added.
<code>stateDataset</code>	Name of spatial dataset to use for determining state codes, Default: 'NaturalEarthAdm1'
<code>countryCodes</code>	Vector of country codes used to optimize spatial searching. (See <code>?MazamaSpatialUtils::getStateCode()</code>)
<code>distanceThreshold</code>	Distance in meters.
<code>measure</code>	One of "haversine" "vincenty", "geodesic", or "cheap" specifying desired method of geodesic distance calculation. See <code>?geodist::geodist</code> .
<code>verbose</code>	Logical controlling the generation of progress messages.

Value

Known location tibble with the specified metadata columns. Any locations whose circles (as defined by `distanceThreshold`) overlap will generate warning messages.

It is incumbent upon the user to address overlapping locations by one of:

1. reduce the `distanceThreshold` until no overlaps occur
2. assign one of the overlapping locations to the other location

Note

The measure "cheap" may be used to speed things up depending on the spatial scale being considered. Distances calculated with `measure = "cheap"` will vary by a few meters compared with those calculated using `measure = "geodesic"`.

table_leaflet	<i>Leaflet interactive map for known locations</i>
---------------	----------------------------------------------------

Description

This function creates interactive maps that will be displayed in RStudio's 'Viewer' tab. The default setting of `jitter` will move locations randomly within an ~50 meter radius so that overlapping locations can be identified. Set `jitter = 0` to see precise locations.

Usage

```
table_leaflet(  
  locationTbl = NULL,  
  maptype = c("terrain", "roadmap", "satellite", "toner"),  
  extraVars = NULL,  
  jitter = 5e-04,  
  ...  
)
```

Arguments

<code>locationTbl</code>	Tibble of known locations.
<code>maptype</code>	Optional name of leaflet ProviderTiles to use, e.g. terrain.
<code>extraVars</code>	Character vector of addition <code>locationTbl</code> column names to be shown in leaflet popups.
<code>jitter</code>	Amount to use to slightly adjust locations so that multiple monitors at the same location can be seen. Use zero or NA to see precise locations.
<code>...</code>	Additional arguments passed to <code>leaflet::addCircleMarker()</code> .

Details

The `maptype` argument is mapped onto leaflet "ProviderTile" names. Current mappings include:

1. "roadmap" – "OpenStreetMap"
2. "satellite" – "Esri.WorldImagery"
3. "terrain" – "Esri.WorldTopoMap"
4. "toner" – "Stamen.Toner"

If a character string not listed above is provided, it will be used as the underlying map tile if available. See <https://leaflet-extras.github.io/leaflet-providers/> for a list of "provider tiles" to use as the background map.

Value

A leaflet "plot" object which, if not assigned, is rendered in Rstudio's 'Viewer' tab.

Examples

```
## Not run:
library(MazamaLocationUtils)

# A table with all core metadata
table_leaflet(wa_monitors_500)

# A table missing some core metadata
table_leaflet(
  wa_airfire_meta,
  extraVars = c("stateCode", "countyName", "msaName")
)

# Customizing the map
table_leaflet(
  wa_airfire_meta,
  extraVars = c("stateCode", "countyName", "msaName"),
  radius = 6,
  color = "black",
  weight = 2,
  fillColor = "red",
  fillOpacity = 0.3
)

## End(Not run)
```

table_leafletAdd	<i>Add to a leaflet interactive map for known locations</i>
------------------	-------------------------------------------------------------

Description

This function adds a layer to an interactive map displayed in RStudio's 'Viewer' tab. The default setting of `jitter` will move locations randomly within an ~50 meter radius so that overlapping locations can be identified. Set `jitter = 0` to see precise locations.

Usage

```
table_leafletAdd(
  map = NULL,
  locationTbl = NULL,
  extraVars = NULL,
  jitter = 5e-04,
  ...
)
```

Arguments

`map` Leaflet map.

locationTbl	Tibble of known locations.
extraVars	Character vector of additional locationTbl column names to be shown in leaflet popups.
jitter	Amount to use to slightly adjust locations so that multiple monitors at the same location can be seen. Use zero or NA to see precise locations.
...	Additional arguments passed to leaflet::addCircleMarkers().

Value

A leaflet "plot" object which, if not assigned, is rendered in Rstudio's 'Viewer' tab.

table_load	<i>Load a known location table</i>
------------	------------------------------------

Description

Load a tibble of known locations from the preferred directory.

The known location table must be named either <collectionName>.rda or <collectionName>.csv. If both are found, only <collectionName>.rda will be loaded to ensure that columns will have the proper type assigned.

Usage

```
table_load(collectionName = NULL)
```

Arguments

collectionName Character identifier for this table.

Value

Tibble of known locations.

See Also

[setLocationDataDir](#)

Examples

```
library(MazamaLocationUtils)

# Set the directory for saving location tables
setLocationDataDir(tempdir())

# Load an example table and check the dimensions
locationTbl <- get(data("wa_monitors_500"))
dim(locationTbl)
```

```
# Save it as "table_load_example"
table_save(locationTbl, "table_load_example")

# Load it and check the dimensions
my_table <- table_load("table_load_example")
dim(my_table)

# Check the locationDataDir
list.files(getLocationDataDir(), pattern = "table_load_example")
```

table_removeColumn *Remove a column of metadata in a table*

Description

Remove the column matching columnName. This function can be used in pipelines.

Usage

```
table_removeColumn(locationTbl = NULL, columnName = NULL, verbose = TRUE)
```

Arguments

locationTbl	Tibble of known locations.
columnName	Name of the column to be removed.
verbose	Logical controlling the generation of progress messages.

Value

Updated tibble of known locations.

See Also

[table_addColumn](#)
[table_removeColumn](#)

Examples

```
library(MazamaLocationUtils)

# Starting table
locationTbl <- get(data("wa_monitors_500"))
names(locationTbl)

# Add a new column
locationTbl <-
  locationTbl %>%
  table_addColumn("siteName")
```



```
names(locationTbl)

# Now remove it
locationTbl <-
  locationTbl %>%
  table_removeColumn("siteName")

names(locationTbl)

try({
  # Cannot remove "core" metadata
  locationTbl <-
    locationTbl %>%
    table_removeColumn("zip")
}, silent = FALSE)
```

table_removeRecord	<i>Remove location records from a table</i>
--------------------	---------------------------------------------

Description

Incoming locationID values are compared against the incoming locationTbl and any matches are removed.

Usage

```
table_removeRecord(locationTbl = NULL, locationID = NULL, verbose = TRUE)
```

Arguments

locationTbl	Tibble of known locations.
locationID	Vector of locationID strings.
verbose	Logical controlling the generation of progress messages.

Value

Updated tibble of known locations.

See Also

[table_addLocation](#)

[table_addSingleLocation](#)

[table_updateSingleRecord](#)

Examples

```
library(MazamaLocationUtils)

locationTbl <- get(data("wa_monitors_500"))
dim(locationTbl)

# Wenatchee
lon <- -120.325278
lat <- 47.423333

# Get the locationID first
locationID <- table_getLocationID(locationTbl, lon, lat, distanceThreshold = 500)

# Remove it
locationTbl <- table_removeRecord(locationTbl, locationID)
dim(locationTbl)

# Test
table_getLocationID(locationTbl, lon, lat, distanceThreshold = 500)
```

table_save

Save a known location table

Description

Save a tibble of known locations to the preferred directory.

Usage

```
table_save(
  locationTbl = NULL,
  collectionName = NULL,
  backup = TRUE,
  outputType = c("rda", "csv")
)
```

Arguments

locationTbl	Tibble of known locations.
collectionName	Character identifier for this table.
backup	Logical specifying whether to save a backup version of any existing tables sharing collectionName.
outputType	Output format. One of "rda" or "csv".

Details

Backup files are saved with "YYYY-mm-ddTHH:MM:SS"

Value

File path of saved file.

Examples

```
library(MazamaLocationUtils)

# Set the directory for saving location tables
setLocationDataDir(tempdir())

# Load an example table and check the dimensions
locationTbl <- get(data("wa_monitors_500"))
dim(locationTbl)

# Save it as "table_save_example"
table_save(locationTbl, "table_save_example")

# Add a column and save again
locationTbl %>%
  table_addColumn("my_column") %>%
  table_save("table_save_example")

# Check the locationDataDir
list.files(getLocationDataDir(), pattern = "table_save_example")
```

table_updateColumn	<i>Update a column of metadata in a table</i>
--------------------	-----------------------------------------------

Description

Updates records in a location table. Records are identified by locationID and the data found in locationData is used to replace any existing value in the columnName column. locationID and locationData must be of the same length. Any NA values in locationID will be ignored.

If columnName is not a named column within locationTbl, a new column will be created.

Usage

```
table_updateColumn(  
  locationTbl = NULL,  
  columnName = NULL,  
  locationID = NULL,  
  locationData = NULL,  
  verbose = TRUE  
)
```

Arguments

locationTbl	Tibble of known locations.
columnName	Name of an existing/new column in locationTbl whose data will be updated/created.
locationID	Vector of locationID strings.
locationData	Vector of data to be inserted at records identified by locationID.
verbose	Logical controlling the generation of progress messages.

Value

Updated tibble of known locations.

See Also

[table_addColumn](#)

[table_removeColumn](#)

Examples

```
library(MazamaLocationUtils)

locationTbl <- get(data("wa_monitors_500"))
wa <- get(data("wa_airfire_meta"))

# We will merge some metadata from wa into locationTbl

# Record indices for wa
wa_indices <- seq(5,65,5)
wa_sub <- wa[wa_indices,]

locationID <-
  table_getLocationID(
    locationTbl,
    wa_sub$longitude,
    wa_sub$latitude,
    distanceThreshold = 500
  )

locationData <- wa_sub$siteName

locationTbl <-
  table_updateColumn(locationTbl, "siteName", locationID, locationData)

# Look at the data we attempted to merge
wa$siteName[wa_indices]

# And two columns from the updated locationTbl
locationTbl_indices <- table_getRecordIndex(locationTbl, locationID)
locationTbl[locationTbl_indices, c("city", "siteName")]
```

`table_updateSingleRecord`*Update a single known location record in a table*

Description

Information in the `locationList` is used to replace existing information found in `locationTbl`. This function can be used for small tweaks to an existing `locationTbl`. Wholesale replacement of records should be performed with `table_removeRecord()` followed by `table_addLocation()`.

Usage

```
table_updateSingleRecord(  
  locationTbl = NULL,  
  locationList = NULL,  
  verbose = TRUE  
)
```

Arguments

<code>locationTbl</code>	Tibble of known locations.
<code>locationList</code>	List containing <code>locationID</code> and one or more named columns whose values are to be replaced.
<code>verbose</code>	Logical controlling the generation of progress messages.

Value

Updated tibble of known locations.

See Also

[table_addLocation](#)
[table_addSingleLocation](#)
[table_removeRecord](#)

Examples

```
library(MazamaLocationUtils)  
  
locationTbl <- get(data("wa_monitors_500"))  
  
# Wenatchee  
wenatcheeRecord <-  
  locationTbl %>%  
  dplyr::filter(city == "Wenatchee")  
  
str(wenatcheeRecord)
```

```

wenatcheeID <- wenatcheeRecord$locationID

locationTbl <- table_updateSingleRecord(
  locationTbl,
  locationList = list(
    locationID = wenatcheeID,
    locationName = "Wenatchee-Fifth St"
  )
)

# Look at the new record
locationTbl %>%
  dplyr::filter(city == "Wenatchee") %>%
  str()

```

validateLocationTbl *Validate a location table*

Description

Ensures that the incoming table has numeric longitude and latitude columns.

Usage

```
validateLocationTbl(locationTbl = NULL, locationOnly = TRUE)
```

Arguments

locationTbl Tibble of known locations.
locationOnly Logical specifying whether to check for all standard columns.

Value

Invisibly returns TRUE if no error message has been generated.

validateMazamaSpatialUtils
Validate proper setup of MazamaSpatialUtils

Description

The **MazamaSpatialUtils** package must be properly installed and initialized before using functions from the **MazamaLocationUtils** package. This function tests for this.

Usage

```
validateMazamaSpatialUtils()
```

Value

Invisibly returns TRUE if no error message has been generated.

wa_airfire_meta	<i>Washington monitor metadata dataset</i>
-----------------	--------------------------------------------

Description

The wa_pwfs1_meta dataset provides a set of Washington state air quality monitor metadata used by the USFS AirFire group. This dataset was generated on 2021-10-19 by running:

```
library(PWFSLSmoke)

wa_airfire_meta <-
  monitor_loadLatest()
  monitor_subset(stateCodes = "WA") %>%
  monitor_extractMeta()

save(wa_airfire_meta, file = "data/wa_airfire_meta.rda")
```

Usage

```
wa_airfire_meta
```

Format

A tibble with 73 rows and 19 columns of data.

wa_monitors_500	<i>Washington monitor locations dataset</i>
-----------------	---------------------------------------------

Description

The wa_monitor_500 dataset provides a set of known locations associated with Washington state air quality monitors. This dataset was generated on 2021-10-19 by running:

```
library(PWFSLSmoke)
library(MazamaLocationUtils)

mazama_initialize()
setLocationDataDir("./data")
```

```
monitor <- monitor_loadLatest()
lons <- monitor$meta$longitude
lats <- monitor$meta$latitude

table_initialize() %>%
  table_addLocation(
    lons, lats,
    distanceThreshold = 500,
    elevationService = "usgs",
    addressService = "photon"
  ) %>%
  table_save("wa_monitors_500")
```

Usage

```
wa_monitors_500
```

Format

A tibble with 72 rows and 13 columns of data.

See Also

[id_monitors_500](#)

[or_monitors_500](#)

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