Package: mrdownscale (via r-universe)

June 4, 2026

Type Package

Title Downscale and harmonize land use data

Version 0.51.1

Date 2026-05-22

Description Downscale and harmonize land use data (e.g. MAgPIE or WITCH) using high resolution reference data (e.g. LUH2v2h or LUH3).

License LGPL (>= 3)

URL https://github.com/pik-piam/mrdownscale, https://doi.org/10.5281/zenodo.11244475

BugReports https://github.com/pik-piam/mrdownscale/issues

Depends madrat (>= 3.27.0), magclass (>= 7.0.0), mstools (>= 0.8.0), R (>= 4.0.0)

Imports gdx2, luscale (>= 3.1.4), magpie4 (>= 2.34.1), mip, ncdf4, terra, utils, withr

Suggests covr, knitr, mrlandcore, rmarkdown, testthat, usethis

VignetteBuilder knitr

Encoding UTF-8

LazyData true

Config/Needs/website tidyverse/tidytemplate

Config/roxygen2/version 8.0.0

Config/pak/sysreqs cmake libgdal-dev gdal-bin libgeos-dev libglpk-dev make libicu-dev libuv1-dev libxml2-dev libnetcdf-dev libssl-dev libproj-dev libsqlite3-dev libx11-dev zlib1g-dev

Repository https://pik-piam.r-universe.dev

Date/Publication 2026-05-22 09:21:39 UTC

RemoteUrl https://github.com/pik-piam/mrdownscale

RemoteRef HEAD

RemoteSha e58967fedb421d7ecc140437432133d0c807464d

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`mrdownscale-package` *mrdownscale: Downscale and harmonize land use data*

Description

Downscale and harmonize land use data (e.g. MAgPIE or WITCH) using high resolution reference data (e.g. LUH2v2h or LUH3).

Author(s)

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See Also

Useful links:

- https://github.com/pik-piam/mrdownscale
- doi:10.5281/zenodo.11244475
- Report bugs at https://github.com/pik-piam/mrdownscale/issues

calcLandCategorizationWeight
calcLandCategorizationWeight

Description

Computes weights for a weighted category mapping and aggregates the weights to the spatial resolution described by the arguments `geometry` and `crs`.

Usage

```
calcLandCategorizationWeight(map, geometry, crs)
```

Arguments

`map`	a map in form of a data.frame containing a mapping between reference categories (column name "reference"), input categories (column name "dataInput") and merged categories (column name "merge") for the data dimension of a magpie object
`geometry`	the geometry of the magpie object for which the categories should be mapped as given in the geometry attribute of a magpie object with geometry information `attr(x, "geometry")`.
`crs`	the coordinate reference system as returned by `attr(x, "crs")` from a magpie object with coordinates information.

Note

This calc-function has a rather unusual shape in that sense that the arguments to be provided are not simple configuration settings but rather relative complex. For this kind of implementation it is typically advised to use tool functions. The reason that a calc function is used in this particular case instead is, that the inputs of this function usually do not change over a long period of time so that caching of results becomes key for the overall performance of the data processing, which is available for calc- but not tool-functions. If tool-functions might support caching in the future as well as a conversion to a tool function might become a sensible option.

Author(s)

Jan Philipp Dietrich

calcLandHarmonized *calcLandHarmonized*

Description

This function computes a version of the chosen land input data in the resolution of the land input data but harmonized to the land use information of the chosen land target data set (harmonized categories as well as harmonized transition from historic target data to simulated input data).

Usage

```
calcLandHarmonized(input, target, harmonizationPeriod, harmonization)
```

Arguments

`input`	name of an input dataset, options: "magpie", "witch"
`target`	name of the land target source to be used
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
`harmonization`	name of harmonization method, see `toolGetHarmonizer`

Author(s)

Pascal Sauer, Jan Philipp Dietrich

calcLandHighRes *calcLandHighRes*

Description

This function performs the downscaling: It calculates a high resolution dataset from the low resolution input dataset and the high resolution target dataset using the given downscaling method.

Usage

```
calcLandHighRes(
  input,
  target,
  harmonizationPeriod,
  yearsSubset,
  harmonization,
  downscaling
)
```

Arguments

`input`	name of an input dataset, options: "magpie", "witch"
`target`	name of a target dataset
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
`yearsSubset`	vector of years to keep in the output dataset
`harmonization`	name of harmonization method, see `toolGetHarmonizer`
`downscaling`	name of downscaling method, currently only "magpieClassic"

Value

downscaled land use data

Author(s)

Jan Philipp Dietrich, Pascal Sauer

`calcLandInput` *calcLandInput*

Description

Prepare the land input data for the category mapping, checking data for consistency before returning. All "Land" functions deal with area data, as opposed to "Nonland" functions which deal with non-area data such as the amount of applied fertilizer. These are treated differently, because for area data other constraints apply, e.g. the total area must be constant over time.

Usage

```
calcLandInput(input)
```

Arguments

`input`	name of an input dataset, options: "magpie", "witch"

Details

input = "magpie": includes the land use categories past (pasture, including rangeland), forestry (managed forest plantations), primforest, secdforest, urban, other (other land) and many specific crop types. Furthermore, 1st gen biofuel is added and filled with zeros. 1st gen biofuel is only modeled implicitly in magpie via demand, and because of trade it is unclear on what area 1st gen biofuel is grown, also 1st gen biofuel is quickly phased out in magpie, so we fill biofuel_1st_gen with zeros and rely on the harmonization to produce a plausible 1st gen biofuel time series. input = "witch": includes a subset of LUH land use categories: primf, primn, secdn, pastr, c4per, pltns, secdf, c3ann_irrigated, c3ann_rainfed These are given as shares. A "rest" category is added so shares sum up to 1.

Value

land input data

Author(s)

Jan Philipp Dietrich, Pascal Sauer

---

calcLandInputRecategorized *calcLandInputRecategorized*

Description

Computes the land input data in target land categories. Splitting of land categories is performed under use of internal land weights reflecting the prevalence of a certain land category in the given area.

Usage

```
calcLandInputRecategorized(input, target)
```

Arguments

`input`	name of an input dataset, options: "magpie", "witch"
`target`	name of the land target source to be used

Details

Mapping from input to target categories is achieved via a merge of a land input mapping to reference categories and a mapping between land target categories and the same reference categories. Thereby a new source or new target can be supported by supplying a map of that new input and/or target to the reference categories.

input = "witch": The "rest" category added in calcLandInput is disaggregated into all missing land variables using the reference dataset included in mrdownscale. Thus the following variables are added, but were not at all part of the input scenario data: range, urban, c4ann_*, c3per_*, c3nfx_* This allows the harmonization and downscaling pipeline to continue with a complete dataset, but these variables should not be used or reported (at the very least they have to be checked extensively).

Author(s)

Jan Philipp Dietrich, Pascal Sauer

calcLandReport *calcLandReport*

Description

Convert the downscaled land use data to the format required by the given project.

Usage

```
calcLandReport(
  outputFormat,
  input,
  harmonizationPeriod,
  yearsSubset,
  harmonization,
  downscaling
)
```

Arguments

outputFormat	format in which the outputs should be prepared. Options: ESM, ScenarioMIP, downscaledmagpie
input	name of an input dataset, options: "magpie", "witch"
harmonizationPeriod	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
yearsSubset	vector of years to keep in the output dataset
harmonization	name of harmonization method, see toolGetHarmonizer
downscaling	name of downscaling method, currently only "magpieClassic"

Value

land use data

Author(s)

Pascal Sauer

calcLandReportScenarioMIP

calcLandReportScenarioMIP

Description

Convert the downscaled land use data to the format required by ScenarioMIP.

Usage

```
calcLandReportScenarioMIP(
  input,
  harmonizationPeriod,
  yearsSubset,
  harmonization,
  downscaling
)
```

Arguments

`input`	name of an input dataset, options: "magpie", "witch"
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
`yearsSubset`	vector of years to keep in the output dataset
`harmonization`	name of harmonization method, see `toolGetHarmonizer`
`downscaling`	name of downscaling method, currently only "magpieClassic"

Value

land use data

Author(s)

Pascal Sauer

calcLandTarget *calcLandTarget*

Description

Prepare the high resolution target land use dataset for harmonization and downscaling, checking data for consistency before returning.

Usage

```
calcLandTarget(target, endOfHistory)
```

Arguments

target	name of the target dataset, one of luh2, luh2mod, luh3 luh2mod/luh3 will split secdf into pltns and secdf
endOfHistory	years later than this are not returned

Value

land target data

Author(s)

Pascal Sauer

calcLandTargetExtrapolated *calcLandTargetExtrapolated*

Description

Aggregated low resolution target data is extrapolated to the given years using toolExtrapolate and normalized afterwards, so that the total sum over all land types is unchanged. To account for the relationship between wood harvest area and primary land (which is no longer primary once it has been harvested) wood harvest area is calculated here even though it is a nonland variable. The share of woody land that was harvested in the historical period is calculated and then multiplied by land (already extrapolated). Primary land is then converted to secondary land, so that total reduction equals harvested area.

Usage

```
calcLandTargetExtrapolated(input, target, harmonizationPeriod)
```

Arguments

`input`	name of an input dataset, options: "magpie", "witch"
`target`	character, name of the target data set
`harmonizationPeriod`	Two integer values, will extrapolate to all years present in input data between harmonization start and end year

Value

extrapolated land target data, if calcOutput is called with supplementary = TRUE and target is luh2mod wood harvest area is also returned

Author(s)

Pascal Sauer

`calcLandTargetLowRes` *calcLandTargetLowRes*

Description

Aggregate target land data to the spatial resolution of the input data in preparation for harmonization.

Usage

```
calcLandTargetLowRes(input, target, endOfHistory)
```

Arguments

`input`	name of an input dataset, options: "magpie", "witch"
`target`	name of a target dataset, see `calcLandTarget` for available target datasets
`endOfHistory`	years later than this are not returned

Value

low resolution target land data

Author(s)

Pascal Sauer

calcLandTransitions *calcLandTransitions*

Description

Ex-Post estimation of land use transitions based on land use state information

Usage

```
calcLandTransitions(
  outputFormat,
  input,
  harmonizationPeriod,
  yearsSubset,
  harmonization,
  downscaling,
  gross
)
```

Arguments

`outputFormat`	format in which the outputs should be prepared. Currently, only "ESM" for earth system model compatible input data is available.
`input`	name of an input dataset, currently only "magpie"
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
`yearsSubset`	vector of years to keep in the output dataset
`harmonization`	name of harmonization method, see `toolGetHarmonizer`
`downscaling`	name of downscaling method, currently only "magpieClassic"
`gross`	either boolean or a magpie object containing bidirectional transition shares relative to the area of the involved land pools (transition divided by the area of the land pool in the "from" sub dimension). If set to FALSE only net transitions will be returned. If set to TRUE an internal gross transition estimate based on average gross transitions in LUH2 in the period from 1995 to 2015 will be used.

Value

land use transition data

Author(s)

Jan Philipp Dietrich, Pascal Sauer

calcManagementNC *calcManagementNC*

Description

Prepare data to be written as a LUH-style management.nc file. Call this via calcOutput in a full function, and set calcOutput's file argument to a .nc file path.

Usage

```
calcManagementNC(
  outputFormat,
  input,
  harmonizationPeriod,
  yearsSubset,
  harmonization,
  downscaling
)
```

Arguments

`outputFormat`	options: ESM, ScenarioMIP
`input`	name of an input dataset, options: "magpie", "witch"
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
`yearsSubset`	remove years from the returned data which are not in yearsSubset
`harmonization`	name of harmonization method, see `toolGetHarmonizer`
`downscaling`	name of downscaling method, currently only "magpieClassic"

Value

data prepared to be written as a LUH-style management.nc file

Author(s)

Pascal Sauer, Jan Philipp Dietrich

calcNonlandHarmonized *calcNonlandHarmonized*

Description

Harmonize nonland input data to target data using the specified method, checking data for consistency before returning.

Usage

```
calcNonlandHarmonized(input, target, harmonizationPeriod, harmonization)
```

Arguments

`input`	name of an input dataset, currently only "magpie"
`target`	name of the target dataset
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
`harmonization`	harmonization method, see `toolGetHarmonizer` for available methods

Details

Wood harvest biomass (bioh) is adapted to the harmonized wood harvest area by calculating kg C per mega hectare for input and target data and harmonizing it. This is then multiplied by the harmonized wood harvest area and scaled so the total harmonized bioh is reached. Harmonize absolute fertilizer in Tg yr-1, then convert to fertilizer rate in kg ha-1 yr-1.

Value

harmonized nonland data

Author(s)

Pascal Sauer

calcNonlandHighRes *calcNonlandHighRes*

Description

Calculate a high resolution dataset from the low resolution input dataset and high resolution data.

Usage

```
calcNonlandHighRes(
  input,
  target,
  harmonizationPeriod,
  yearsSubset,
  harmonization,
  downscaling
)
```

Arguments

`input`	name of an input dataset, currently only "magpie"
`target`	name of a target dataset, see `calcLandTarget` for available target datasets
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
`yearsSubset`	vector of years to keep in the output dataset
`harmonization`	name of harmonization method, see `toolGetHarmonizer`
`downscaling`	name of downscaling method, currently only "magpieClassic"

Details

Wood harvest area is disaggregated using the maximum possible harvest per year which is based on the downscaled land data. Bioh is disaggregated using the just disaggregated wood harvest area as weight. Fertilizer is in kg ha-1 yr-1, so we simply use the low res/region value for each cell corresponding to that region. Harvest weight type is disaggregated using the nonland target data in the first year of the harmonization period as weight.

Value

downscaled nonland data

Author(s)

Pascal Sauer

Examples

```
## Not run:
  calcOutput("NonlandHighRes", input = "magpie", target = "luh2mod",
             harmonizationPeriod = c(2015, 2050), yearsSubset = 2015:2100,
             harmonization = "fade", downscaling = "magpieClassic")

## End(Not run)
```

---

calcNonlandInput *calcNonlandInput*

Description

Prepare the nonland input data for category mapping, checking data for consistency before returning.

Usage

```
calcNonlandInput(input)
```

Arguments

input	name of an input dataset, currently only "magpie"

Details

All "Land" functions deal with area data, as opposed to "Nonland" functions which deal with non-area data such as the amount of applied fertilizer. These are treated differently, because for area data other constraints apply, e.g. the total area must be constant over time. Fertilizer on regional level is disaggregated to cluster level using cropland as weight.

Value

nonland input data

Author(s)

Pascal Sauer

calcNonlandInputRecategorized

calcNonlandInputRecategorized

Description

Harmonize categories by mapping nonland input data categories to the categories of the nonland target dataset. See `calcLandInputRecategorized` for an explanation of the mapping procedure.

Usage

```
calcNonlandInputRecategorized(
  input,
  target,
  youngShareWoodHarvestArea = 0.95,
  youngShareWoodHarvestWeight = 0.5
)
```

Arguments

`input` name of an input dataset, currently only "magpie"

`target` name of a target dataset, see `calcLandTarget` for available target datasets

`youngShareWoodHarvestArea` share of wood harvest area taken from young (instead of mature) secondary forest; default value is based on LUH value from 2014; used to disaggregate wood harvest area from secondary forest to secondary young and mature forest

`youngShareWoodHarvestWeight` analogue to youngShareWoodHarvestArea for wood harvest weight instead of area

Details

Report and discard wood harvest area if there is zero wood harvest (bioh) or vice versa.

Value

nonland data with target categories

Author(s)

Pascal Sauer

calcNonlandReport *calcNonlandReport*

Description

Convert the downscaled nonland data to the format required by the given project.

Usage

```
calcNonlandReport(
  outputFormat,
  harmonizationPeriod,
  yearsSubset,
  harmonization,
  downscaling
)
```

Arguments

`outputFormat`	options: ESM, ScenarioMIP
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
`yearsSubset`	vector of years to keep in the output dataset
`harmonization`	name of harmonization method, see `toolGetHarmonizer`
`downscaling`	name of downscaling method, currently only "magpieClassic"

Value

nonland data

Author(s)

Pascal Sauer

Examples

```
## Not run:
  calcOutput("NonlandReport", outputFormat = "ESM",
             harmonizationPeriod = c(2015, 2050), yearsSubset = 2015:2100,
             harmonization = "fade", downscaling = "magpieClassic")

## End(Not run)
```

calcNonlandTarget *calcNonlandTarget*

Description

Prepare the high resolution nonland target dataset for harmonization and downscaling, checking data for consistency before returning.

Usage

```
calcNonlandTarget(target, endOfHistory)
```

Arguments

`target`	name of a target dataset, see `calcLandTarget` for available target datasets
`endOfHistory`	years later than this are not returned

Value

nonland target data

Author(s)

Pascal Sauer

calcNonlandTargetExtrapolated *calcNonlandTargetExtrapolated*

Description

Aggregated low resolution target data is extrapolated to the given years using toolExtrapolate. To extrapolate wood harvest weight (bioh) multiply wood harvest area already extrapolated by calcLandTargetExtrapolated with the historical wood harvest rate in kg C per Mha. Fertilizer is extrapolated and returned in kg ha-1 yr-1.

Usage

```
calcNonlandTargetExtrapolated(input, target, harmonizationPeriod)
```

Arguments

`input`	name of an input dataset, currently only "magpie"
`target`	name of a target dataset, see `calcLandTarget` for available target datasets
`harmonizationPeriod`	Two integer values, will extrapolate to all years present in input data between harmonization start and end year

Value

extrapolated nonland target data

Author(s)

Pascal Sauer

Examples

```
## Not run:
  calcOutput("NonlandTargetExtrapolated", input = "magpie",
             target = "luh3", harmonizationPeriod = c(2025, 2050))

## End(Not run)
```

---

calcNonlandTargetLowRes

calcNonlandTargetLowRes

Description

Aggregate target nonland data to the spatial resolution of the input data in preparation for harmonization. Fertilizer is converted to Tg yr-1, then aggregated and converted back to kg ha-1 yr-1.

Usage

```
calcNonlandTargetLowRes(input, target, endOfHistory)
```

Arguments

`input`	name of an input dataset, currently only "magpie"
`target`	name of a target dataset
`endOfHistory`	years later than this are not returned

Value

low resolution target nonland data

Author(s)

Pascal Sauer

calcResolutionMapping *calcResolutionMapping*

Description

Calculate a complete mapping from low (input dataset, clusters/countries/regions) to high resolution (target dataset, grid). As a basis the mapping from the low resolution clusters/countries/regions to grid cells is used. Cells which are present in that mapping, but not in the target dataset are discarded. Cells which are present in the target dataset, but not in the mapping are added using a nearest-neighbor approach: These cells are mapped to the same low resolution cluster/country/region as the closest cell which is already present in the mapping.

Usage

```
calcResolutionMapping(input, target)
```

Arguments

`input`	name of an input dataset, options: "magpie", "witch"
`target`	character, the target dataset

Value

a list including a data.frame with columns x, y, lowRes, country

Author(s)

Pascal Sauer

calcStatesNC *calcStatesNC*

Description

Prepare data to be written as LUH-style states.nc file. Call this via calcOutput in a full function, and set calcOutput's file argument to a .nc file path.

Usage

```
calcStatesNC(
  outputFormat,
  input,
  harmonizationPeriod,
  yearsSubset,
  harmonization,
  downscaling
)
```

Arguments

`outputFormat`	options: ESM, ScenarioMIP
`input`	name of an input dataset, options: "magpie", "witch"
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
`yearsSubset`	remove years from the returned data which are not in yearsSubset
`harmonization`	name of harmonization method, see `toolGetHarmonizer`
`downscaling`	name of downscaling method, currently only "magpieClassic"

Value

data prepared to be written as a LUH-style states.nc file

Author(s)

Pascal Sauer, Jan Philipp Dietrich

`calcTransitionsNC` *calcTransitionsNC*

Description

Prepared data to be written as a LUH-style transitions.nc file

Usage

```
calcTransitionsNC(
  outputFormat,
  input,
  harmonizationPeriod,
  yearsSubset,
  harmonization,
  downscaling
)
```

Arguments

`outputFormat`	options: ESM, ScenarioMIP
`input`	name of an input dataset, options: "magpie", "witch"
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets

yearsSubset	remove years from the returned data which are not in yearsSubset
harmonization	name of harmonization method, see toolGetHarmonizer
downscaling	name of downscaling method, currently only "magpieClassic"

Value

data prepared to be written as a LUH-style transitions.nc file

Author(s)

Pascal Sauer, Jan Philipp Dietrich

---

calcWoodHarvestAreaHarmonized

calcWoodHarvestAreaHarmonized

Description

Harmonize wood harvest area based on harmonized land data. First, wood harvest area is harmonized just like land data. Then, to ensure consistency, primary harvest is converted to seondary harvest (or vice versa) to match the primary land reduction from the harmonized land data. If secondary harvest exceeds the available secondary land, the excess is shifted to the other secondary land (secdf to secdn and vice versa). Remaining excess harvest area is reported.

Usage

```
calcWoodHarvestAreaHarmonized(
  input,
  target,
  harmonizationPeriod,
  harmonization
)
```

Arguments

input	name of an input dataset, currently only "magpie"
target	name of a target dataset, see calcLandTarget for available target datasets
harmonizationPeriod	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
harmonization	harmonization method, see toolGetHarmonizer for available methods

Value

harmonized wood harvest area data

Author(s)

Pascal Sauer

Examples

```
## Not run:
  calcOutput("WoodHarvestAreaHarmonized", input = "magpie",
             target = "luh2mod", harmonizationPeriod = c(2015, 2050),
             harmonization = "fade")

## End(Not run)
```

---

convertLUH2v2h *convertLUH2v2h*

Description

Convert LUH2 cell area shares to absolute areas by multiplying with cell area, convert to Mha.

Usage

```
convertLUH2v2h(x, subtype)
```

Arguments

x	SpatRaster with LUH2 cell area shares
subtype	Only "states" is converted

---

convertLUH3 *convertLUH3*

Description

Convert LUH3 cell area shares to absolute areas by multiplying with cell area, convert to Mha.

Usage

```
convertLUH3(x, subtype)
```

Arguments

x	SpatRaster with LUH3 cell area shares
subtype	Only "states" is converted

downloadLUH2v2h *downloadLUH2v2h*

Description

Download the LUH2v2h dataset (states.nc, transitions.nc, management.nc, staticData_quarterdeg.nc).

Usage

```
downloadLUH2v2h(subtype = NULL)
```

Arguments

subtype	one of states, management, transitions, cellArea

Value

metadata list with URL, DOI, title, description, author, unit, version, release date

Author(s)

Pascal Sauer

downloadLUH3 *downloadLUH3*

Description

Download the LUH3 dataset (states, management, transitions, static).

Usage

```
downloadLUH3(subtype)
```

Arguments

subtype	one of states, management, transitions, cellArea

Value

metadata list with URL, title, description, author, unit, version, release date

Author(s)

Pascal Sauer

downscaleRun *downscaleRun*

Description

Downscale MAgPIE results from the given folder. The resulting tgz file will be generated in the given folder.

Usage

```
downscaleRun(outputfolder, ...)
```

Arguments

outputfolder	path to a folder containing fulldata.gdx and clustermap_*.rds, resulting tgz will be written here
...	arguments passed on to retrieveData, e.g. model ("DOWNSCALEDMAGPIE" or "ESM"), rev, harmonizationPeriod

Value

Invisibly, the path to the newly created tgz archive.

Author(s)

Pascal Sauer

downscaleRunESM *downscaleRunESM*

Description

Downscale MAgPIE results from the given folder to 0.25 degree resolution in LUH2 format for ESMs. The resulting tgz file will be generated in the given folder.

Usage

```
downscaleRunESM(outputdir, revision = NULL, scenario = NULL, ...)
```

Arguments

outputdir	path to a folder containing fulldata.gdx and clustermap_*.rds, resulting tgz will be written here
revision	passed on to retrieveData, default: current date
scenario	passed on to retrieveData, default: slightly modified folder name
...	additional arguments passed on to retrieveData

Value

Invisibly, the path to the newly created tgz archive.

Author(s)

Pascal Sauer

---

fullDOWNSCALEDMAGPIE *fullDOWNSCALEDMAGPIE*

Description

Run the pipeline to generate harmonized and downscaled MAgPIE data using landuseinit as a reference dataset. Write output in the format of avl_land_t_0.5.mz, full report on consistency checks is printed and written to report.log.

Usage

```
fullDOWNSCALEDMAGPIE(
  rev = numeric_version("0"),
  harmonizationPeriod = c(2015, 2050),
  target = "landuseinit",
  downscaling = "magpieClassic",
  harmonization = "fade"
)
```

Arguments

`rev`	revision number of the data. If not provided the current date will be used instead. When called via madrat::retrieveData rev will be converted to numeric_version.
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
`target`	Name of dataset to be used as harmonization target and downscaling reference
`downscaling`	name of downscaling method, currently only "magpieClassic"
`harmonization`	name of harmonization method, see `toolGetHarmonizer`

Author(s)

Pascal Sauer

fullESM *fullESM*

Description

Run the pipeline to generate harmonized and downscaled data to report for RESCUE and other projects where ESM compatible land use inputs are required. Write .nc files, print full report on consistency checks and write it to report.log.

Usage

```
fullESM(
  rev = numeric_version("0"),
  input = "magpie",
  fileNamePart = "",
  harmonizationPeriod = c(2015, 2050),
  yearsSubset = 2015:2100,
  harmonization = "fade",
  downscaling = "magpieClassic",
  compression = 2,
  progress = TRUE
)
```

Arguments

rev	revision number of the data. If not provided the current date will be used instead. When called via madrat::retrieveData rev will be converted to numeric_version.
input	name of an input dataset, options: "magpie", "witch"
fileNamePart	scenario nc files will be called multiple-[type]_[fileNamePart]-[revision]_gn_[min(yearsSubset)]-[max(yearsSubset)].nc where type is one of states/management/transitions
harmonizationPeriod	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
yearsSubset	remove years from the returned data which are not in yearsSubset
harmonization	name of harmonization method, see toolGetHarmonizer
downscaling	name of downscaling method, currently only "magpieClassic"
compression	compression level of the resulting .nc files, possible values are integers from 1-9, 1 = fastest, 9 = best compression
progress	boolean defining whether progress should be printed

Author(s)

Pascal Sauer, Jan Philipp Dietrich

fullSCENARIOMIP *fullSCENARIOMIP*

Description

Run the pipeline to generate harmonized and downscaled data to report for ScenarioMIP. LUH3 is used as historical reference dataset for harmonization and downscaling. Write .nc files, print full report on consistency checks and write it to report.log.

Usage

```
fullSCENARIOMIP(
  rev = numeric_version("0"),
  input = "magpie",
  scenario = "",
  harmonizationPeriod = c(2025, 2050),
  yearsSubset = 1995:2100,
  harmonization = "fadeForest",
  downscaling = "magpieClassic",
  compression = 2,
  progress = TRUE
)
```

Arguments

`rev`	revision number of the data. If not provided the current date will be used instead. When called via madrat::retrieveData rev will be converted to numeric_version.
`input`	name of an input dataset, options: "magpie", "witch"
`scenario`	scenario name to be included in filenames
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
`yearsSubset`	remove years from the returned data which are not in yearsSubset
`harmonization`	name of harmonization method, see `toolGetHarmonizer`
`downscaling`	name of downscaling method, currently only "magpieClassic"
`compression`	compression level of the resulting .nc files, possible values are integers from 1-9, 1 = fastest, 9 = best compression
`progress`	boolean defining whether progress should be printed

Author(s)

Pascal Sauer

readLUH2v2h *readLUH2v2h*

Description

Read LUH2v2h data. For the states subtype, the secma and secmb categories are removed. For the management subtype, only the categories crpbf, rndwd, fulwd, fertl and irrig are read. For the transitions subtype, only the wood harvest categories bioh and harv are read. To match magpie semantics years are shifted by 1 when reading transitions.

Usage

```
readLUH2v2h(subtype)
```

Arguments

subtype	one of states, management, transitions, cellArea

readLUH3 *readLUH3*

Description

Read LUH3 data. For the states subtype, the secma and secmb categories are removed. For the management subtype, only the categories cpbf1, cpbf2, rndwd, fulwd, fertl and irrig are read. For the transitions subtype, only the wood harvest categories bioh and harv are read. To match magpie semantics years are shifted by 1 when reading transitions. The LUH3 nc files have day-based time, which is converted to years.

Usage

```
readLUH3(subtype, subset)
```

Arguments

subtype	one of states, management, transitions, cellArea
subset	which years to read

Value

data read from LUH3 historic nc files as SpatRaster

Author(s)

Pascal Sauer

readMagpieFulldataGdx *readMagpieFulldataGdx*

Description

Read function for data coming from the MAgPIE model.

Usage

```
readMagpieFulldataGdx(subtype)
```

Arguments

subtype	type of data to be read in. Available options are land, crop, woodHarvestWeight, woodHarvestArea, fertilizerRegional, clustermap

Author(s)

Pascal Sauer, Jan Philipp Dietrich

toolAddMetadataNC *toolAddMetadataNC*

Description

Add metdata nc output files

Usage

```
toolAddMetadataNC(
  ncFile,
  activityId,
  revision,
  harmonizationPeriod,
  missingValue,
  compression,
  resolution,
  references,
  targetMIP,
  ncTitle,
  referenceDataset,
  furtherInfoUrl
)
```

Arguments

ncFile	file name of the respective nc file
activityId	a string to store in the nc attribute activityId
revision	a string to store in the nc attribute revision
harmonizationPeriod	a string to store in the nc attribute harmonizationPeriod
missingValue	a string to store in the nc attribute missingValue
compression	a string to store in the nc attribute compression
resolution	a string to store in the nc attribute resolution
references	a string to store in the nc attribute references
targetMIP	a string to store in the nc attribute targetMIP
ncTitle	a string to store in the nc attribute ncTitle
referenceDataset	a string to store in the nc attribute referenceDataset
furtherInfoUrl	a string to store in the nc attribute furtherInfoUrl

Author(s)

Pascal Sauer, Jan Philipp Dietrich

---

toolAggregateCropland *toolAggregateCropland*

Description

Aggregate variables like c3ann_irrigated and c3ann_rainfed to just c3ann.

Usage

```
toolAggregateCropland(
  land,
  cropTypes = c("c3ann", "c4ann", "c3per", "c4per", "c3nfx"),
  ...,
  keepOthers = TRUE
)
```

Arguments

land	magpie object with variables starting with cropTypes in dim 3
cropTypes	character vector, the variables to aggregate to
...	reserved for future expansion
keepOthers	logical, if FALSE cropTypes will be the only variables in output

Value

land with crop data aggregated to cropTypes

Author(s)

Pascal Sauer

---

toolCheckWoodHarvestArea *toolCheckWoodHarvestArea*

Description

Check wood harvest area is not exceeding land area of the corresponding type divided by timestep length. Also, check that primf and primn are reduced by at least as much as they were harvested.

Usage

```
toolCheckWoodHarvestArea(harvest, land, endOfHistory)
```

Arguments

harvest	magpie object with exactly the following categories: paste0(c("primf", "secyf", "secmf", "pltns", "primn", "secnf"), "_wood_harvest_area")
land	magpie object with at least the following categories: c("primf", "secdf", "pltns", "primn", "secdn")
endOfHistory	The last year considered part of the historical period, will check and report consistency separately for history and after

Author(s)

Pascal Sauer

---

toolCropData *toolCropData*

Description

For each crop type (c3ann, c3nfx, c3per, c4ann, c4per) calculate irrigation share, 1st and 2nd generation biofuel shares and share of cell area (corresponding to LUH3 variables c3ann, irrig_c3ann, cpbf1_c3ann, cpbf2_c3ann and analogously for the other crop types).

Usage

```
toolCropData(landHighRes, cellArea)
```

Arguments

landHighRes	high resolution land use data as magclass object
cellArea	corresponding magclass object containing cell area in Mha

Value

crop data as magclass object with variables irrig_*, cpbf1_*, cpbf2_*, * for all 5 crop types

Author(s)

Pascal Sauer

---

toolDownscaleMagpieClassic *toolDownscaleMagpieClassic*

Description

classic MAgPIE downscaling method using `luscale::interpolate2` as downscaling function.

Usage

```
toolDownscaleMagpieClassic(x, xTarget, xTargetLowRes, mapping)
```

Arguments

x	magclass containing land to be downscaled
xTarget	magclass target land use dataset for initialization year
xTargetLowRes	magclass target land use dataset for initialization year in low resolution (like x)
mapping	mapping between x and xTarget

Value

downscaled land use dataset

Author(s)

Jan Philipp Dietrich, Pascal Sauer

toolExtrapolate *toolExtrapolate*

Description

Extrapolate a dataset into the future. A linear model is fitted for each combination of spatial entity and category, and then used to predict the value of the last requested extrapolation year. If the linear model is not significant (p > 0.05) the historical mean is used instead. A spline-based interpolation is used to create a smooth transition from historical values to the predicted value.

Usage

```
toolExtrapolate(x, years)
```

Arguments

x	A magpie object with "year" as the temporal dimension and without any NAs
years	A vector of years to extrapolate to

Value

A magpie object like x but with the extrapolated years only

Author(s)

Pascal Sauer

toolFillYearsSpatRaster *toolFillYearsSpatRaster*

Description

Fill data for missing years using linear interpolation.

Usage

```
toolFillYearsSpatRaster(x, years = NULL)
```

Arguments

x	SpatRaster with years in layer names
years	data for these years will be added if they are not already present, if years is NULL all years between the first and last year in x will be filled

Value

SpatRaster with filled years

Author(s)

Pascal Sauer

---

toolGetHarmonizer *toolGetHarmonizer*

Description

Get a harmonizer function by name.

Usage

```
toolGetHarmonizer(harmonizerName)
```

Arguments

harmonizerName	name of a harmonizer function, currently offset, fade, fadeForest

Value

harmonizer function

Author(s)

Pascal Sauer

See Also

toolHarmonizeOffset, toolHarmonizeFade, toolHarmonizeFadeForest

toolGetSmallerArea *toolGetSmallerArea*

Description

The function creates a transition data set based on a state dataset which contains for every possible connection (land type A <-> land type B) the area of the smaller of these land types. This information is relevant if transitional shares should be calculated based on the smaller area of the two (assuming that the smaller area is determining how much transitions there will be).

Usage

```
toolGetSmallerArea(states)
```

Arguments

`states`	magpie dataset containing states information

Value

A land type x land type data set containing for each possible combination the smaller area of the two land types

Author(s)

Jan Philipp Dietrich

toolHarmonizeFade *toolHarmonizeFade*

Description

Tool function for creating a harmonized data set with a smooth s-shaped transition from historic target data to simulated input data.

Usage

```
toolHarmonizeFade(xInput, xTarget, harmonizationPeriod, level = 3)
```

Arguments

`xInput`	input data as magpie object
`xTarget`	target data as magpie object
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets
`level`	passed to toolReplaceExpansion

Value

harmonized data set as magpie object with data from input for years before the harmonization period, data from target for years after the harmonization period and a smooth transition in between.

Author(s)

Jan Philipp Dietrich, Pascal Sauer

---

toolHarmonizeFadeForest

toolHarmonizeFadeForest

Description

Harmonize using `toolHarmonizeFade`, then sum up primf + secdf, then disaggregate again in a way that minimizes primf to secdf conversion, without exceeding linear extrapolation of primf.

Usage

```
toolHarmonizeFadeForest(xInput, xTarget, harmonizationPeriod)
```

Arguments

`xInput`	input data as magpie object
`xTarget`	target data as magpie object
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets

Value

harmonized data set as magpie object with data from input for years before the harmonization period, data from target for years after the harmonization period and a smooth transition in between.

Author(s)

Pascal Sauer

toolHarmonizeOffset *toolHarmonizeOffset*

Description

Harmonize datasets using the offset method as implemented in mip::harmonize, originally implemented in Python as part of aneris.

Usage

```
toolHarmonizeOffset(xInput, xTarget, harmonizationPeriod)
```

Arguments

`xInput`	magpie object to fade to, usually model projections
`xTarget`	magpie object to fade from, usually historical data, this argument is called "target" for consistency with argument names of other functions, it is somewhat misleading here, because data after the harmonizationPeriod will not be taken from target, but from input
`harmonizationPeriod`	Two integer values, before the first given year the target dataset is used, after the second given year the input dataset is used, in between harmonize between the two datasets

Value

magpie object with harmonized data

Author(s)

Pascal Sauer

toolLandCategoriesMapping *toolLandCategoriesMapping*

Description

Computes a land category mapping between input and target data set via retrieving mappings from these sources to an internally defined reference categorization and merging them to a direct input-to-target mapping. Mappings to reference categories are stored internally in the package and have to be added to it if new input and/or target data should be supported.

Usage

```
toolLandCategoriesMapping(input, target)
```

Arguments

`input`	name of an input dataset, options: "magpie", "witch"
`target`	name of the land target source to be used

Author(s)

Jan Philipp Dietrich

`toolMaxExpansion` *toolMaxExpansion*

Description

Return the maximum expansion from one timestep to the next.

Usage

```
toolMaxExpansion(x, ..., removeNA = FALSE)
```

Arguments

`x`	A magclass object
`...`	Reserved for future use
`removeNA`	A logical indicating whether NA values should be ignored

Value

A numeric value indicating the maximum expansion

Author(s)

Pascal Sauer

toolMaxHarvestPerYear *toolMaxHarvestPerYear*

Description

Calculate the maximum possible harvest area per year based on the given land data.

Usage

```
toolMaxHarvestPerYear(land, split = TRUE, timestepAdjust = TRUE)
```

Arguments

`land`	magpie object with at least the following categories: c("primf", "secdf", "pltns", "primn", "secdn")
`split`	if TRUE: split secdf to secyf and secdmf, rename secdf to secnf, and add dim "wood_harvest_area"
`timestepAdjust`	if TRUE: divide values for primary land by timestep length. This makes sense, because once primary land has been harvested, it is converted to secondary land and thus cannot be harvested again. Might introduce unintended spikes when timestep length changes.

Value

magpie object with the maximum possible yearly wood harvest area

Author(s)

Pascal Sauer

toolPrimExpansionCheck *toolPrimExpansionCheck*

Description

Check that primary forest (primf) and primary nature/nonland (primf) are never expanding using toolExpectTrue. If they are expanding, a warning including the maximum expansion is thrown. Categories not present in x are skipped.

Usage

```
toolPrimExpansionCheck(x)
```

Arguments

x	A magclass object

Author(s)

Pascal Sauer

---

toolReplaceExpansion *toolReplaceExpansion*

Description

Expansion from one timestep to the next of one land type is replaced with another land type.

Usage

```
toolReplaceExpansion(
  x,
  from,
  to,
  ...,
  noteThreshold = 10^-10,
  warnThreshold = 10^-5,
  level = 1
)
```

Arguments

x	a magpie object
from	name of a land category, e.g. "primf" Expansion of this category happening from one timestep to the next will be replaced. If missing in x return x unchanged
to	name of another land category, e.g. "secdf" Expansion of 'from' will be replaced with expansion of 'to'
...	not used, will throw an error if supplied
noteThreshold	expansion greater than this will trigger a note that expansion was replaced
warnThreshold	expansion greater than this will trigger a warning that expanding considerably
level	passed to toolStatusMessage

Value

a magpie object with expansion of 'from' replaced by 'to'

Author(s)

Pascal Sauer

toolResolutionMapping *toolResolutionMapping*

Description

See description of calcResolutionMapping. Here we are assuming target resolution is finer than what mapping already provides.

Usage

```
toolResolutionMapping(mapping, targetGrid)
```

Arguments

mapping	a data.frame with columns x, y, lowRes
targetGrid	a terra SpatRaster with the target resolution

Value

a data.frame with columns x, y, lowRes, country

Author(s)

Pascal Sauer

toolScaleConstantArea *toolScaleConstantArea*

Description

Scale x to make the sum of all land types is constant over time.

Usage

```
toolScaleConstantArea(x, ..., noteThreshold = 10^-10, warnThreshold = 10^-5)
```

Arguments

x	a magpie object
...	not used, will throw an error if supplied
noteThreshold	if the maximum difference between the scaled and the original data is greater than this, a note is triggered
warnThreshold	if the maximum difference between the scaled and the original data is greater than this, a warning is triggered

Value

x scaled

Author(s)

Pascal Sauer

---

toolTransitionsBasic *toolTransitionsBasic*

Description

tool function to extract transitions between categories from a land data set with at least 2 time steps. The approach is rather simplistic by assuming that expansion happens proportionally in all affected classes (equal preference of transitions across all categories).

Usage

```
toolTransitionsBasic(x, gross = FALSE)
```

Arguments

x	magpie data set containing land data with at least two time steps to extract net transitions from
gross	either boolean or a magpie object containing bidirectional transition shares relative to the area of the involved land pools (transition divided by the area of the land pool in the "from" sub dimension). If set to FALSE only net transitions will be returned. If set to TRUE an internal gross transition estimate based on average gross transitions in LUH2 in the period from 1995 to 2015 will be used.

Details

In addition to the net effect it can also estimate gross transition. For that purpose a reference data set containing bidirectional transition shares must be provided.

If the time step length is longer than 1 year the returned object contains reference years for each period which can be repeated to retrieve the full transition between two time periods, e.g. if you provide two time steps 2000 and 2005 the return value will be the transition for year 2001. Repeating the same transition also in 2002, 2003, 2004 and 2005 will give the full transition from 2000 to 2005.

Author(s)

Jan Philipp Dietrich

`toolWarnIfExpansion` *toolWarnIfExpansion*

Description

Warn if expansion is detected one of the given variables, giving the maximum expansion in each respective variable.

Usage

```
toolWarnIfExpansion(x, variable)
```

Arguments

`x`	A magclass object
`variable`	A vector of variables to be checked

Author(s)

Pascal Sauer

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