Package 'climniche'

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Type Package

Title Niche Climate Exposure

Version 0.0.1

Description Assesses niche climate exposure by interpreting projected climate change relative to the climate conditions a species currently occupies. Using occurrence records, range data or thresholded SDM suitability maps, current environmental rasters and future projections, the package separates climate change amount, change in distance to the current niche centre, composition change and exceedance beyond an empirical niche boundary.

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URL https://github.com/Bohao0813/climniche, https://bohao0813.github.io/climniche/

BugReports https://github.com/Bohao0813/climniche/issues

Encoding UTF-8

Imports grid, methods

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Contents

`boundary_exceedance` *Niche boundary exceedance*

Description

Niche boundary exceedance

Usage

```
boundary_exceedance(
  psi_future,
  boundary_value,
  scale = c("radial", "potential")
)
```

Arguments

`psi_future`	Future niche potential.
`boundary_value`	Empirical occupied-niche boundary in potential units.
`scale`	`"radial"` returns exceedance beyond the niche boundary distance; `"potential"` returns exceedance beyond squared niche potential.

Value

Numeric vector.

`climniche_diagram_data` *Build data for a niche climate exposure diagram*

Description

Build data for a niche climate exposure diagram

Usage

```
climniche_diagram_data(
  x,
  scope = c("current", "all"),
  max_arrows = 350L,
  seed = 1L
)
```

Arguments

`x`	A fitted climniche object.
`scope`	`"current"` for current occurrence, range or thresholded SDM cells; `"all"` for all evaluated cells.
`max_arrows`	Maximum number of current to future arrows to keep.
`seed`	Random seed used when subsampling arrows.

Value

A list of data frames used by `plot_climniche_diagram()`.

`climniche_report` *Build a climniche report*

Description

Build a climniche report

Usage

```
climniche_report(
  x,
  species = NULL,
  scope = c("current", "all"),
  top_variables = 5
)
```

Arguments

x	A fitted climniche_fit object.
species	Optional species name used in printed reports.
scope	"current" for current occurrence/range cells or "all" for all evaluated cells.
top_variables	Number of variable contributions to show.

Value

An object of class climniche_report.

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climniche_showcase_data

Build data for the climniche showcase figure

Description

Build data for the climniche showcase figure

Usage

```
climniche_showcase_data(
  x,
  scope = c("current", "all"),
  max_points = 6000L,
  seed = 1L,
  plane_bins = 45L,
  boundary_probs = seq(0.5, 0.99, 0.01),
  top_variables = 6L
)
```

Arguments

x	A fitted climniche object.
scope	"current" for current occurrence, range or thresholded SDM cells; "all" for all evaluated cells.
max_points	Maximum number of cells to keep for the exposure plane.
seed	Random seed used when subsampling cells.
plane_bins	Number of fixed bins used to summarize the exposure plane.
boundary_probs	Boundary quantiles used for the sensitivity curve.
top_variables	Number of variables to show.

Value

A list of data frames used by plot_climniche_showcase().

climniche_summary *Summarise climniche results*

Description

Summarise climniche results

Usage

```
climniche_summary(x, scope = c("current", "all"))
```

Arguments

x	A fitted climniche_fit object.
scope	"current" for current occurrence/range cells or "all" for all evaluated cells.

Value

A one-row data frame with key report metrics.

climniche_table *Extract a tidy climniche table*

Description

Extract a tidy climniche table

Usage

```
climniche_table(x, scope = c("current", "all"))
```

Arguments

x	A fitted climniche_fit object.
scope	"current" for current occurrence/range cells or "all" for all evaluated cells.

Value

A data frame with one row per evaluated cell.

`fit_climniche` *Fit niche climate exposure*

Description

Fit niche climate exposure

Usage

```
fit_climniche(
  current,
  future,
  occupied = NULL,
  occupied_threshold = 0,
  cnfa = NULL,
  center = NULL,
  sensitivity = NULL,
  A = NULL,
  metric = c("diag", "factor"),
  boundary = 0.95,
  scale = TRUE,
  global_mean = NULL,
  global_sd = NULL,
  conflict_ratio = 0.25
)
```

Arguments

`current`	Numeric matrix or data frame of current environmental values.
`future`	Numeric matrix or data frame of future environmental values.
`occupied`	NULL, logical vector, row indices, or a numeric vector with one value per row identifying current occurrence, range, or thresholded SDM cells.
`occupied_threshold`	Threshold used when `occupied` contains binary or continuous values.
`cnfa`	Optional CENFA model object.
`center`	Optional realised niche centre in standardised climate space.
`sensitivity`	Optional environmental sensitivity weights.
`A`	Optional niche metric matrix.
`metric`	Metric construction when `A` is not supplied.
`boundary`	Quantile defining the empirical realised niche boundary.
`scale`	Logical. If TRUE, standardise current and future values.
`global_mean`	Optional means used for standardisation.
`global_sd`	Optional standard deviations used for standardisation.
`conflict_ratio`	Minimum minority sign contribution share used to mark mixed variable responses. Set to NULL to disable this flag.

Value

An object of class `climniche_fit`.

`fit_climniche_raster` *Fit climniche to raster data*

Description

Fit climniche to raster data

Usage

```
fit_climniche_raster(
  current,
  future,
  occupied = NULL,
  occupied_threshold = 0,
  domain = NULL,
  domain_threshold = 0,
  ...
)
```

Arguments

`current`	Raster* object of current environmental layers.
`future`	Raster* object of future environmental layers.
`occupied`	Optional RasterLayer with binary or continuous occurrence, range, or SDM suitability values.
`occupied_threshold`	Values greater than this threshold are treated as current occurrence cells.
`domain`	Optional RasterLayer limiting cells where exposure is analysed.
`domain_threshold`	Values greater than this threshold define the domain.
`...`	Additional arguments passed to `fit_climniche()`.

Value

An object of class `climniche_fit` with raster outputs.

`fit_climniche_terra` *Fit climniche to terra raster data*

Description

Fit climniche to terra raster data

Usage

```
fit_climniche_terra(
  current,
  future,
  occupied = NULL,
  occupied_threshold = 0,
  domain = NULL,
  domain_threshold = 0,
  ...
)
```

Arguments

`current`	terra SpatRaster of current environmental layers.
`future`	terra SpatRaster of future environmental layers.
`occupied`	Optional one layer SpatRaster with binary or continuous occurrence, range, or SDM suitability values.
`occupied_threshold`	Values greater than this threshold are treated as current occurrence cells.
`domain`	Optional one layer SpatRaster limiting cells where exposure is analysed.
`domain_threshold`	Values greater than this threshold define the domain.
`...`	Additional arguments passed to `fit_climniche()`.

Value

An object of class `climniche_fit` with raster outputs.

niche_metric *Build a sensitivity-weighted niche metric*

Description

Build a sensitivity-weighted niche metric

Usage

```
niche_metric(sensitivity = NULL, cnfa = NULL, type = c("diag", "factor"))
```

Arguments

sensitivity	Numeric vector of climate-variable sensitivity weights.
cnfa	Optional CENFA cnfa object or list with sf, co, and eig.
type	Metric type. "diag" uses variable-level sensitivity weights. "factor" uses a factor metric when CNFA factor coordinates are available.

Value

A positive semi-definite matrix.

niche_percentile *Niche percentile shift*

Description

Niche percentile shift

Usage

```
niche_percentile(psi_current, psi_future, occupied)
```

Arguments

psi_current	Current niche potential for all cells.
psi_future	Future niche potential for all cells.
occupied	Current occurrence indices used to define the reference CDF.

Value

Data frame with current, future, and delta percentiles.

niche_potential *Niche potential*

Description

Niche potential

Usage

```
niche_potential(x, center, A)
```

Arguments

x	Standardized climate matrix.
center	Realized niche center.
A	Niche metric matrix.

Value

Numeric vector of quadratic niche displacement values.

niche_radius *Niche radius*

Description

Niche radius

Usage

```
niche_radius(psi)
```

Arguments

psi	Numeric niche-potential values.

Value

Numeric vector in sensitivity-weighted climate-distance units.

plot_climniche_classes *Plot climniche classes*

Description

Plot climniche classes

Usage

```
plot_climniche_classes(
  x,
  occupied = NULL,
  occupied_only = FALSE,
  occupied_threshold = 0,
  title = NULL
)
```

Arguments

x	A fitted climniche object with raster outputs.
occupied	Optional current occurrence/range RasterLayer to overlay.
occupied_only	If TRUE, mask the plotted classes to current occurrence cells.
occupied_threshold	Threshold used when occupied contains binary or continuous values.
title	Optional plot title. Use FALSE to suppress it.

Value

A ggplot object.

plot_climniche_class_summary *Plot climniche class proportions*

Description

Plot climniche class proportions

Usage

```
plot_climniche_class_summary(x, scope = c("current", "all"), title = NULL)
```

Arguments

x	A fitted climniche object.
scope	"current" for current occurrence/range cells or "all" for all evaluated cells.
title	Optional plot title.

Value

A ggplot object.

`plot_climniche_diagram` *Plot a niche climate exposure diagram*

Description

Plot a niche climate exposure diagram

Usage

```
plot_climniche_diagram(
  x,
  scope = c("current", "all"),
  type = c("summary", "sample"),
  max_arrows = 350L,
  seed = 1L,
  show_reference = FALSE,
  show_hulls = TRUE,
  boundary_shape = c("hull", "circle", "none"),
  show_boundary_label = TRUE,
  show_points = NULL,
  show_endpoints = FALSE,
  show_center = FALSE,
  show_variables = FALSE,
  variable_labels = NULL,
  title = NULL
)
```

Arguments

x	A fitted climniche object or data returned by `climniche_diagram_data()`.
scope	"current" for current occurrence, range or thresholded SDM cells; "all" for all evaluated cells.
type	"summary" draws class mean arrows; "sample" draws sampled cell arrows and future points.
max_arrows	Maximum number of current to future arrows to draw when type = "sample".

seed	Random seed used when subsampling arrows.
show_reference	Logical; draw the full analysed environmental domain.
show_hulls	Logical; draw current and future niche hulls.
boundary_shape	Boundary display. "hull" draws the empirical occupied niche polygon, "circle" draws a constant niche distance boundary, and "none" suppresses the boundary.
show_boundary_label	Logical; add reference-area explanations below the exposure-class legend.
show_points	Logical; draw future points when type = "sample".
show_endpoints	Logical; draw class mean future positions when type = "summary".
show_center	Logical; mark the realised niche centre.
show_variables	Logical; draw environmental variable directions.
variable_labels	Optional named vector replacing variable labels.
title	Optional plot title.

Value

A ggplot object.

`plot_climniche_distribution` *Plot a climniche metric distribution*

Description

Plot a climniche metric distribution

Usage

```
plot_climniche_distribution(
  x,
  metric = c("niche_distance_change", "climate_change_amount",
    "outside_niche_exceedance", "composition_change"),
  scope = c("current", "all"),
  title = NULL
)
```

Arguments

x	A fitted climniche object.
metric	Metric to plot.
scope	"current" for current occurrence/range cells or "all" for all evaluated cells.
title	Optional plot title.

Value

A ggplot object.

plot_climniche_exposure *Plot the climniche exposure plane*

Description

Plot the climniche exposure plane

Usage

```
plot_climniche_exposure(
  x,
  scope = c("current", "all"),
  max_points = 6000,
  seed = 1,
  title = NULL
)
```

Arguments

x	A fitted climniche object.
scope	"current" for current occurrence/range cells or "all" for all evaluated cells.
max_points	Maximum number of points to draw.
seed	Random seed used when subsampling.
title	Optional plot title.

Value

A ggplot object.

plot_climniche_map *Plot a climniche map*

Description

Plot a climniche map

Usage

```
plot_climniche_map(
  x,
  metric = c("niche_distance_change", "outside_niche_exceedance",
    "climate_change_amount", "composition_change", "change_alignment"),
  occupied = NULL,
  occupied_only = FALSE,
  occupied_threshold = 0,
  title = NULL,
  midpoint = 0
)
```

Arguments

x	A fitted climniche object with raster outputs, or a RasterLayer.
metric	Metric to plot.
occupied	Optional current occurrence/range RasterLayer to overlay.
occupied_only	If TRUE, mask the plotted raster to current occurrence cells.
occupied_threshold	Threshold used when occupied contains binary or continuous values.
title	Optional plot title. Use FALSE to suppress it.
midpoint	Midpoint for the niche distance change colour scale.

Value

A ggplot object.

---

plot_climniche_report *Plot a climniche report figure*

Description

Plot a climniche report figure

Usage

```
plot_climniche_report(x, scope = c("current", "all"))
```

Arguments

x	A fitted climniche object.
scope	"current" for current occurrence/range cells or "all" for all evaluated cells.

Value

A patchwork object when patchwork is installed, otherwise a named list of ggplot objects.

plot_climniche_showcase *Plot the climniche showcase figure*

Description

Plot the climniche showcase figure

Usage

```
plot_climniche_showcase(
  x,
  scope = c("current", "all"),
  max_points = 6000L,
  seed = 1L,
  plane_bins = 45L,
  boundary_probs = seq(0.5, 0.99, 0.01),
  top_variables = 6L,
  variable_labels = NULL,
  title = NULL
)
```

Arguments

x	A fitted climniche object or data returned by climniche_showcase_data().
scope	"current" for current occurrence, range or thresholded SDM cells; "all" for all evaluated cells.
max_points	Maximum number of cells to draw in the exposure plane.
seed	Random seed used when subsampling cells.
plane_bins	Number of fixed bins used to summarize the exposure plane.
boundary_probs	Boundary quantiles used for the sensitivity curve.
top_variables	Number of variables to show.
variable_labels	Optional named vector replacing variable labels.
title	Optional overall title when patchwork is installed.

Value

A patchwork object when patchwork is installed, otherwise a named list of ggplot objects.

plot_climniche_variable_contribution

Plot mean variable contribution

Description

Plot mean variable contribution

Usage

```
plot_climniche_variable_contribution(
  x,
  occupied_only = TRUE,
  variable_labels = NULL,
  title = NULL
)
```

Arguments

x	A climniche_fit object.
occupied_only	If TRUE, summarize occupied cells only.
variable_labels	Optional named vector replacing variable labels.
title	Optional plot title. Use FALSE to suppress it.

Value

A ggplot object.

plot_variable_contribution

Plot mean variable contribution

Description

Plot mean variable contribution

Usage

```
plot_variable_contribution(
  x,
  occupied_only = TRUE,
  variable_labels = NULL,
  title = NULL
)
```

Arguments

x	A climniche_fit object.
occupied_only	If TRUE, summarize occupied cells only.
variable_labels	Optional named vector replacing variable labels.
title	Optional plot title. Use FALSE to suppress it.

Value

A ggplot object.

---

simulate_climniche *Simulate a minimal climate niche change experiment*

Description

Simulate a minimal climate niche change experiment

Usage

```
simulate_climniche(
  n = 2000,
  p = 2,
  seed = 1,
  rho = 0,
  prevalence = 0.3,
  shift = 0.4
)
```

Arguments

n	Number of climate cells.
p	Number of climate variables.
seed	Random seed.
rho	Pairwise correlation among simulated climate variables.
prevalence	Proportion of background cells treated as true current occurrence locations under the virtual niche.
shift	Climate change amount imposed in the closer to niche and farther from niche scenarios.

Value

A list with current, future_toward, future_away, occupied, center, sensitivity and A.

variable_contribution *Variable contribution to change in niche potential*

Description

Variable contribution to change in niche potential

Usage

```
variable_contribution(current, future, center, A)
```

Arguments

current	Current standardized climate matrix.
future	Future standardized climate matrix.
center	Realised niche centre.
A	Niche metric matrix.

Value

Matrix whose rows sum to the change in niche potential.

write_climniche_report *Write a climniche report to Markdown*

Description

Write a climniche report to Markdown

Usage

```
write_climniche_report(report, file)
```

Arguments

report	An object returned by climniche_report().
file	Output Markdown file.

Value

Invisibly returns file.

Index