Barcelona Supercomputing Center
Centro Nacional de Supercomputación

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Tutorial: `ghrexplore`

🧭 Table of Contents

Here's what we'll cover in this notebook:

1. Introduction

2. Setup and Data Loading

```
In [1]:  options(warn = -1)
```

```
In [2]:  install.packages('devtools')

         path_cstools      <- './dependencies/bsc_libraries/cstools-master.tar.gz'
         path_startr       <- './dependencies/bsc_libraries/startR-master.tar.gz'

         install.packages(path_cstools, repos = NULL, type = "source")
         install.packages(path_startr , repos = NULL, type = "source")
```

```
Installing package into 'C:/Users/rcapella/AppData/Local/R/win-library/4.4'
(as 'lib' is unspecified)
```

```
package 'devtools' successfully unpacked and MD5 sums checked

The downloaded binary packages are in
        C:\Users\rcapella\AppData\Local\Temp\RtmpaeTtxh\downloaded_packages
```

In [3]:
```r
setwd("dependencies/ghr_libraries/ghrexplore/")
devtools::load_all()
devtools::document()
```

ℹ Loading ghrexplore
ℹ Updating ghrexplore documentation
ℹ Loading ghrexplore

In [4]:
```r
# Load data
# dengue_MS is spatiotemporal data
data(dengue_MS)
# dengue_SP is timeseries data
data(dengue_SP)
# dengue map
data("map_MS")

### make testing data sets ----
data.test <- dengue_MS %>%
  filter(micro_code != "50001") %>%
  mutate(tmin = case_when(
    date == "2000-01-01" & micro_code == "50002" ~ NA,
    T ~ tmin
  ))
```
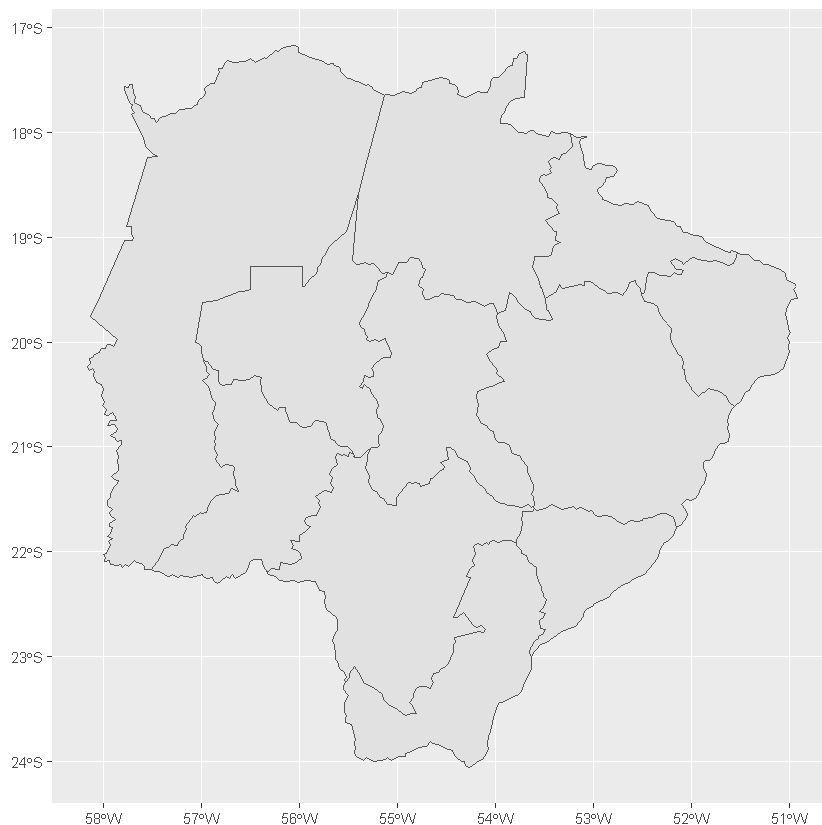
3. Statistics

🗺 Map of Mato Grosso do Sul

Let's start by visualizing the **map of Mato Grosso do Sul**, Brazil. This map will help us understand the **spatial distribution** of dengue cases across its administrative micro-regions.

In [5]:
```r
# Show the map that we are going to use
ggplot() +
  geom_sf(data = map_MS)
```
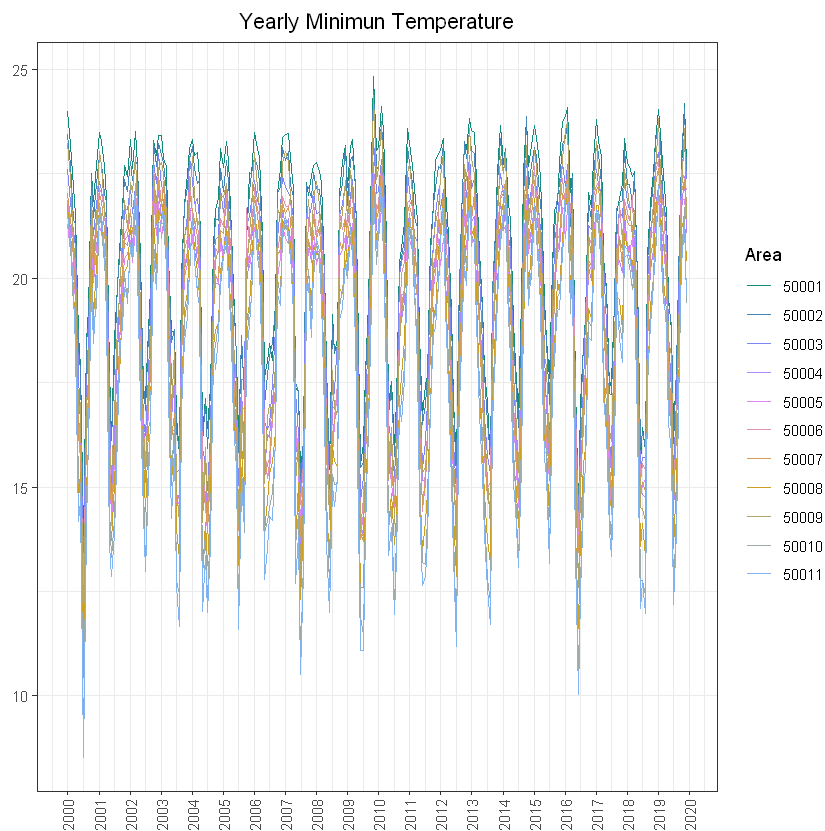
🌡️ 📈 **Yearly Minimum Temperature Across Micro-Regions**

This time series plot shows the **minimum daily temperature** (`tmin`) aggregated monthly across the 11 micro-regions of **Mato Grosso do Sul**.

By visualizing these trends, we can explore how **temperature variations** over time may influence **dengue transmission dynamics**, as mosquito activity is often **climate-sensitive**.

```
In [6]:  dengue_MS %>%
           plot_timeseries(var = "tmin",
                           type = "cov",
                           time = "date",
                           area = "micro_code",
                           title = "Yearly Minimun Temperature")
```
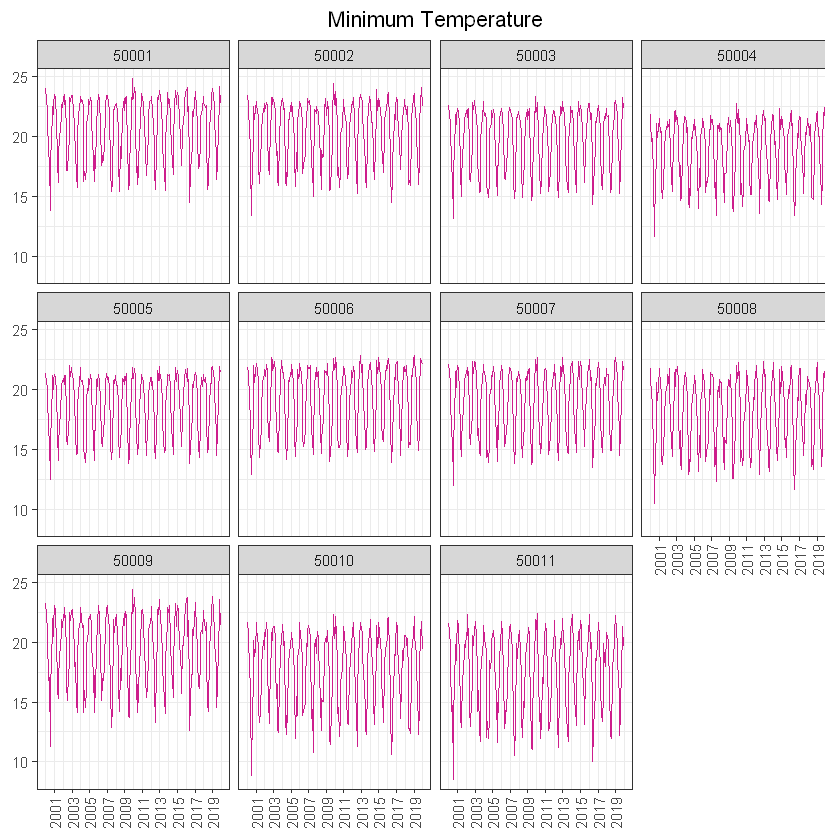
Yearly Minimun Temperature

🌡️ 📊 **Time Series of Temperature Variables (Plotted Separately)**

In the following section, we'll generate **separate time series plots** for key temperature-related variables across all micro-regions of **Mato Grosso do Sul**.

In [7]:
```
# Plot TS of temperature: plots in separate graphs
dengue_MS %>%
  plot_timeseries(var = "tmin",
                  time = "date",
                  area = "micro_code",
                  panel = TRUE,           # The multiple plots
                  var_label= "Minimum Temperature",
                  palette = "violetred")
```

Minimum Temperature

🗺️ 📉 **Average Minimum Temperature by Meso-Region and Year**

This time series plot shows the **average minimum temperature (`tmin`)** across the **meso-regions** of **Mato Grosso do Sul**, aggregated **yearly**.

```
In [8]:   dengue_MS %>%
            plot_timeseries(var = "tmin",
                            time = "date",
                            area = "micro_code",
                            aggregate_space = "meso_code",   # The target for aggregation
                            aggregate_space_fun = "mean",    # Function for aggregation
                            aggregate_time = "year",
                            palette = "Colorblind")
```
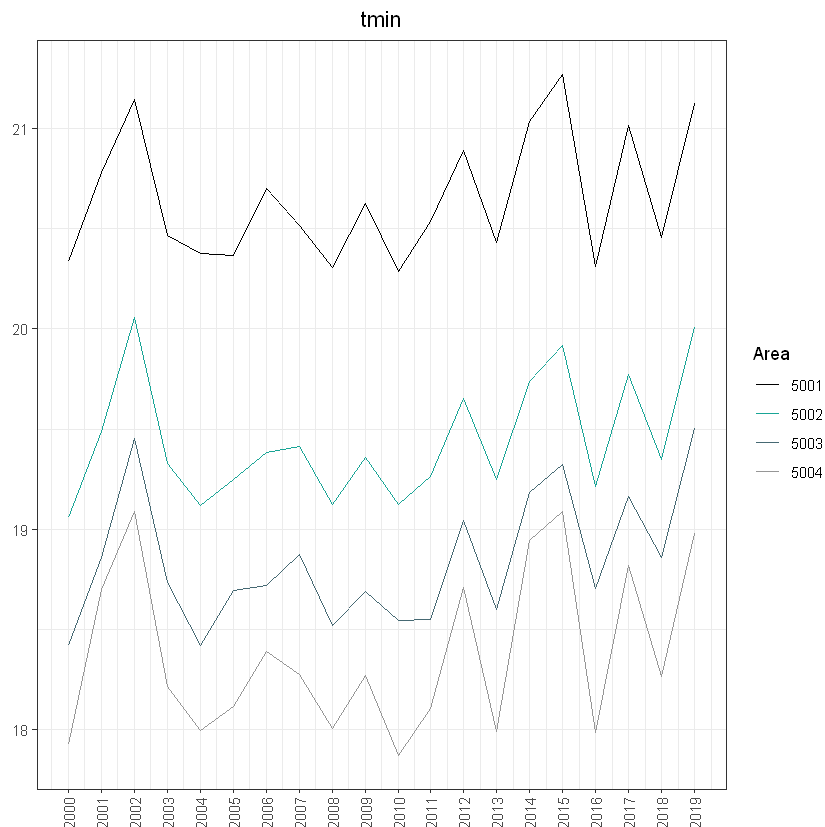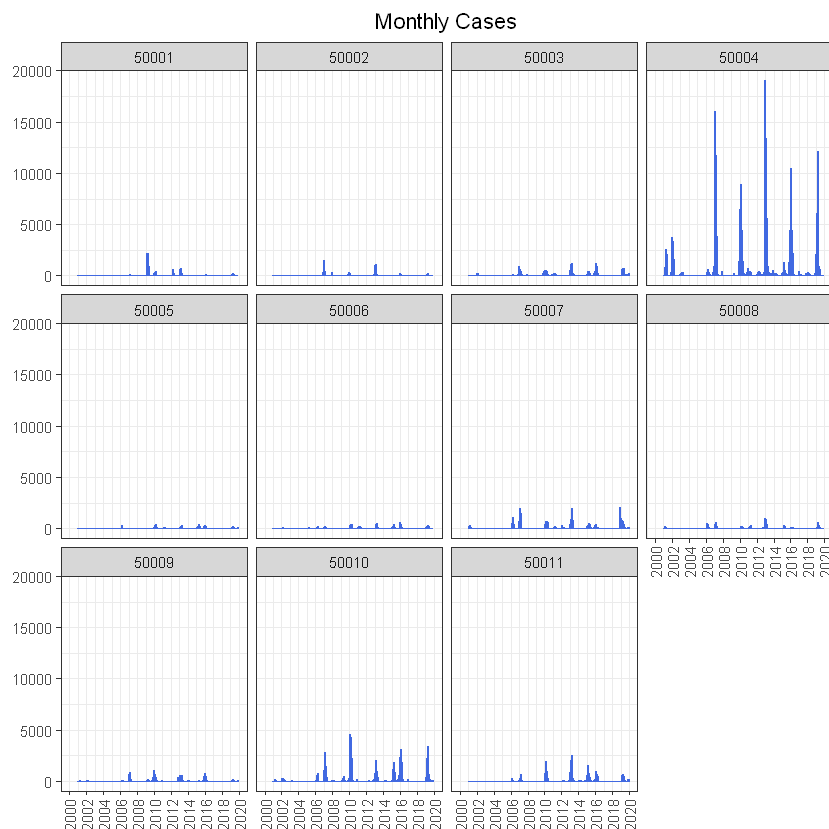
🦟 📅 Monthly Dengue Cases by Micro-Region

This time series plot displays the **monthly number of reported dengue cases** across all **micro-regions** of **Mato Grosso do Sul**.

```
In [9]:  dengue_MS %>%
           plot_timeseries(var = "dengue_cases", # Variable defining the cases
                           type = "counts",
                           time = "date",          # Variable defining the date "dd-mm-yyyy"
                           area = "micro_code",    # Variable defining the spatial unit
                           title= "Monthly Cases",
                           palette = "royalblue")
```

Monthly Cases

🦟 📈 **Dengue Incidence Over Time – Faceted by Micro-Region**

This plot shows the **incidence of dengue cases** over time, broken down into **individual panels for each micro-region** in **Mato Grosso do Sul**.

In [10]:
```
# Plot TS of incidence: with panels by area
dengue_MS %>%
  plot_timeseries(var = "dengue_cases", # Variable defining the cases
                  type = "inc",
                  pop = "population",
                  time = "date",        # Variable defining the date "dd-mm-yyyy"
                  area = "micro_code",   # Variable defining the spatial unit
                  panel = TRUE,          # The multiple plots
                  palette = "#800080",
                  pt=1)
```
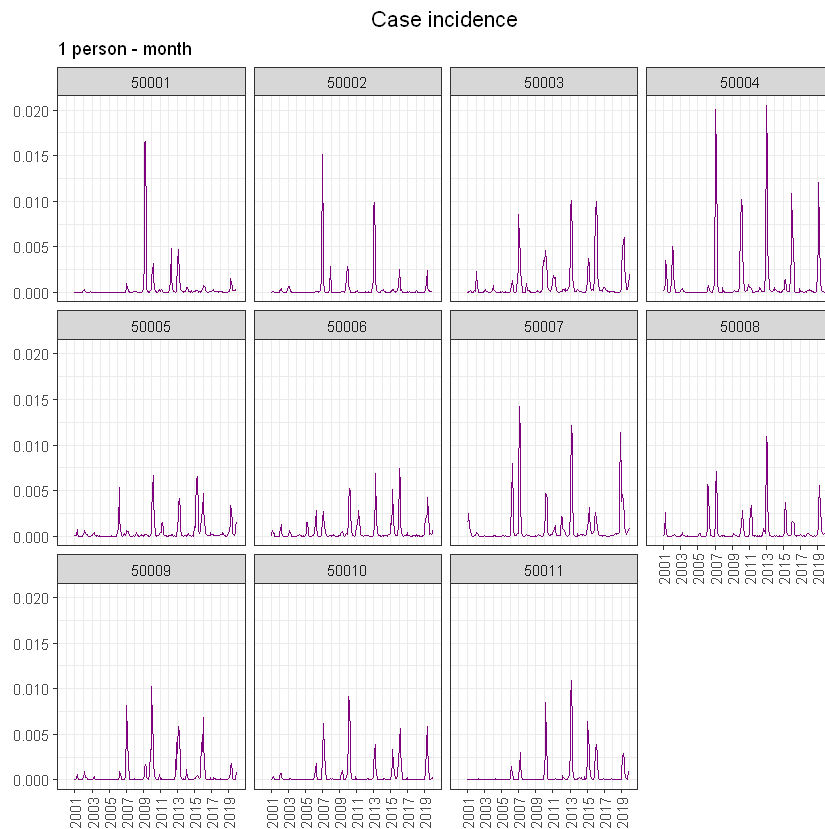
Case incidence

🌡️ 🔥 **Heatmap of Minimum Temperature – Aggregated Across Micro-Regions**

This heatmap displays the **minimum temperature (`tmin`)** over time, aggregated **across all micro-regions** in **Mato Grosso do Sul**.

```
In [11]:  # Plot Heatmap of temperature: aggregate across space
          dengue_MS %>%
            plot_heatmap(var = "tmin",
                         time = "date",
                         area = "micro_code",
                         aggregate_space = "meso_code",    # Aggregation target
                         aggregate_space_fun = "mean",     # Function for aggregation
                         palette = "Reds")
```
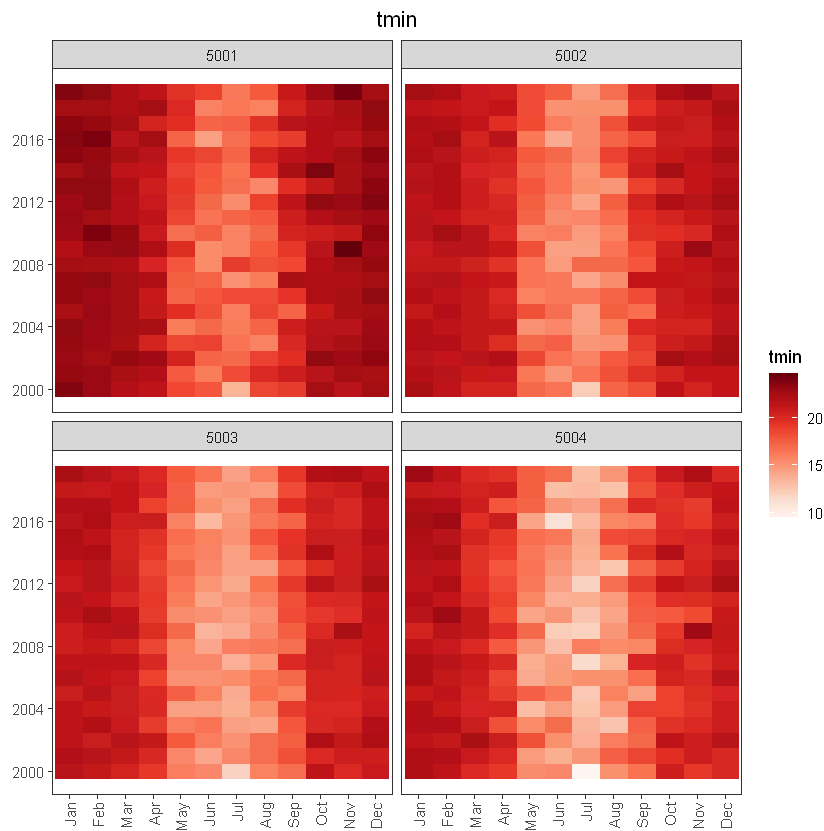
🌡️ 🦟 Heatmap of Dengue Case Counts – Custom Centering

This heatmap visualizes the **number of dengue cases** over time for each **micro-region** in **Mato Grosso do Sul**, using a **custom color centering** to enhance interpretability.
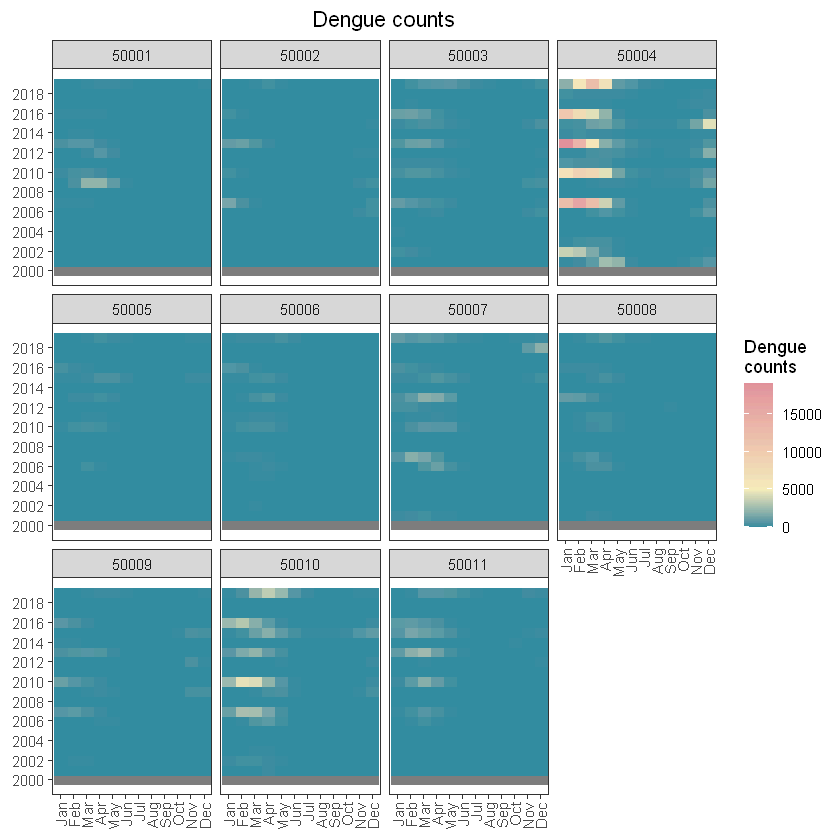
```
In [12]:  # Plot Heatmap of case counts custom centering
          dengue_MS %>%
            plot_heatmap(var = "dengue_cases", # Variable defining the cases
                         type = "counts",
                         time = "date",           # Variable defining the date "dd-mm-yyyy"
                         area = "micro_code",
                         palette = "BlYlRd",
                         title = "Dengue counts",
                         var_label = "Dengue \ncounts",
                         centering = 5000)
```

Dengue counts

☁️ 📅 Seasonal Patterns in Climate Covariates

In this section, we explore the **seasonality of key environmental covariates**, such as **temperature**, **precipitation**, or **humidity**, across the micro-regions of **Mato Grosso do Sul**.

```
In [13]:  ## plot_seasonality  covariates ----
          dengue_MS %>%
            plot_seasonality(var = "tmin",              # Variable to be plotted
                             time = "date",             # Variable defining the date "d
                             area = "micro_code",
                             var_label = "Minimum Temperature",
                             palette= "Reds")
```

Minimum Temperature
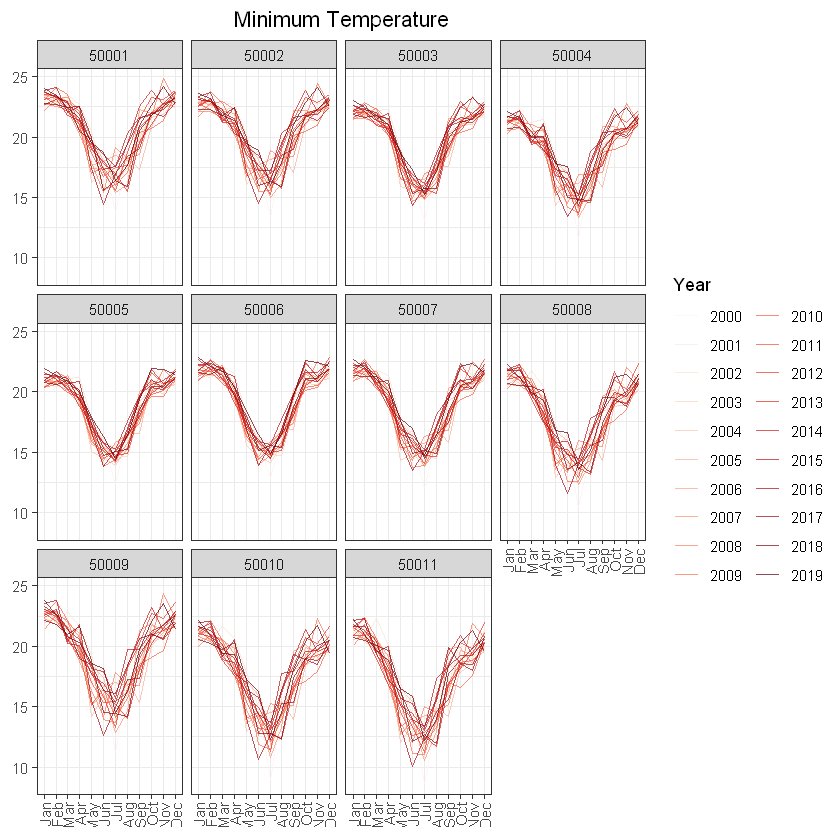
🗺️ 📊 Yearly Mean Dengue Cases by Micro-Region

This map illustrates the **average number of dengue cases per year** for each **micro-region** in **Mato Grosso do Sul**.
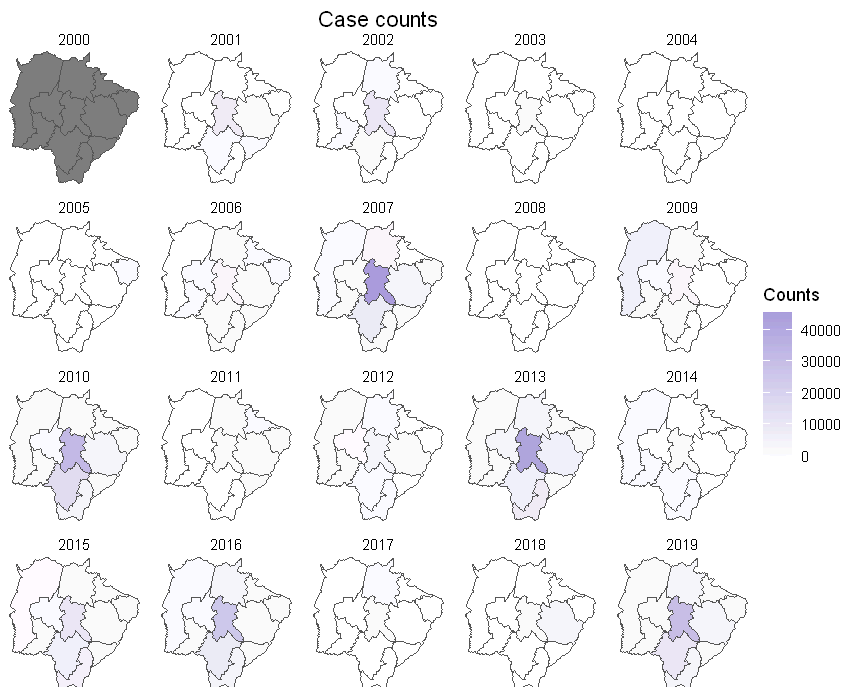
```
In [14]:  # Yearly mean cases
          dengue_MS %>%
            plot_map(var = "dengue_cases",        # Variable to be plotted
                     type = "counts",
                     time = "date",         # Variable defining the date "dd-mm-yyyy"
                     area = "micro_code",   # Variable defining area in the dataframe
                     pop = "population",
                     map = map_MS,          # the sf object for the map
                     map_area = "code",
                     palette = "Purp")
```

Case counts

📍 🗺️ Spatial Average of Dengue Cases Across Micro-Regions

In this section, we calculate the **spatial average** of dengue cases across all micro-regions in **Mato Grosso do Sul** for each time point.

```
In [15]:  # Spatial average
          dengue_MS %>%
            plot_map(var = "dengue_cases",        # Variable to be plotted
                     type = "inc",
                     time = "date",          # Variable defining the date "dd-mm-yyyy"
                     area = "micro_code",    # Variable defining area in the dataframe
                     pop = "population",
                     map = map_MS,           # the sf object for the map
                     map_area = "code",      # Variable defining the area in the sf object
                     by_year = FALSE)
```
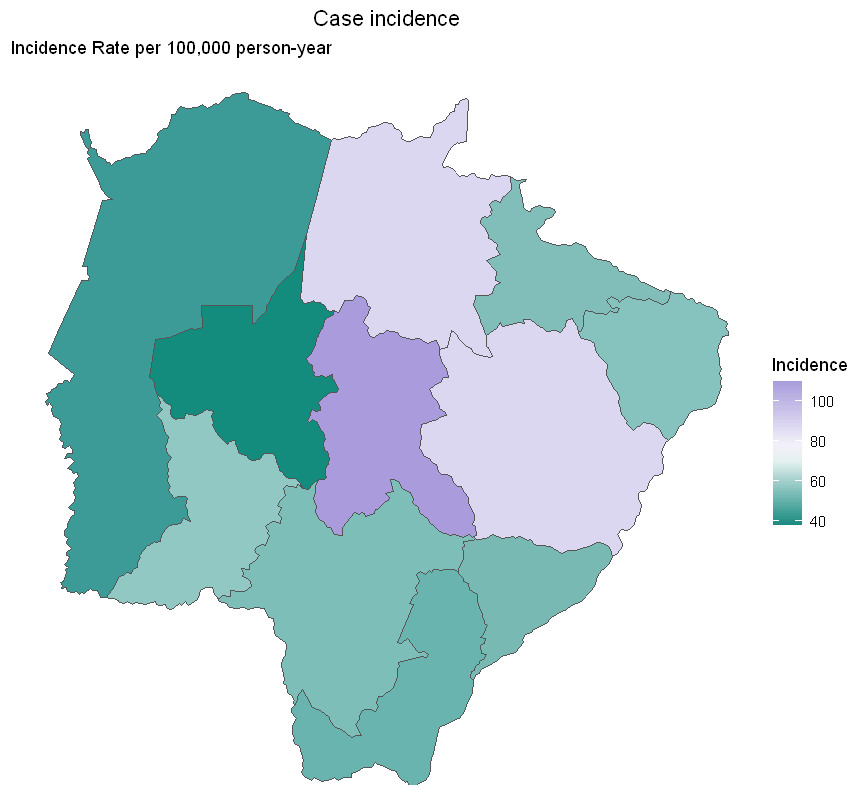
Case incidence

Incidence Rate per 100,000 person-year

Incidence

100

80

60

40

🔗 📊 Correlation Matrix – Exploring Variable Relationships

In this section, we generate a **correlation matrix** to examine how different variables (such as dengue cases, temperature, precipitation, etc.) are **related** to one another across the dataset.

```
In [16]:  # Correlation matrix
          dengue_MS %>%
            plot_correlation(var = c("dengue_cases","pop_density",
                                     "tmax", "tmin", "pdsi", "urban",
                                     "water_network", "water_shortage"),
                          method = "pearson",
                          var_label = c("dengue cases","pop. density",
                                        "max temp", "min temp", "drought index", "urbaniza
                                        "water network", "water shortage"),
                          print=TRUE)
```

	Dengue_cases	Pop_density	Tmax	Tmin	Pdsi
Dengue_cases	1.00000000	0.2846834	0.04097108	0.090767913	0.088593789
Pop_density	0.28468336	1.0000000	-0.19703073	-0.120210133	0.062315195
Tmax	0.04097108	-0.1970307	1.00000000	0.879162401	-0.038970901
Tmin	0.09076791	-0.1202101	0.87916240	1.000000000	-0.009183573
Pdsi	0.08859379	0.0623152	-0.03897090	-0.009183573	1.000000000
Urban	0.16762448	0.4193885	0.18075960	0.050611064	0.097575520
Water_network	0.09275016	0.1722578	0.06406097	0.089436190	-0.016236066
Water_shortage	0.02652887	0.2693830	-0.18720845	-0.185504467	0.144991012

	Urban	Water_network	Water_shortage
Dengue_cases	0.16762448	0.09275016	0.02652887
Pop_density	0.41938850	0.17225783	0.26938302
Tmax	0.18075960	0.06406097	-0.18720845
Tmin	0.05061106	0.08943619	-0.18550447
Pdsi	0.09757552	-0.01623607	0.14499101
Urban	1.00000000	0.41163089	-0.02399848
Water_network	0.41163089	1.00000000	-0.21886669
Water_shortage	-0.02399848	-0.21886669	1.00000000