R for geographic map: Session 1

Training module designed for postdocs and alumni fellows in

the **Climap Africa** programme

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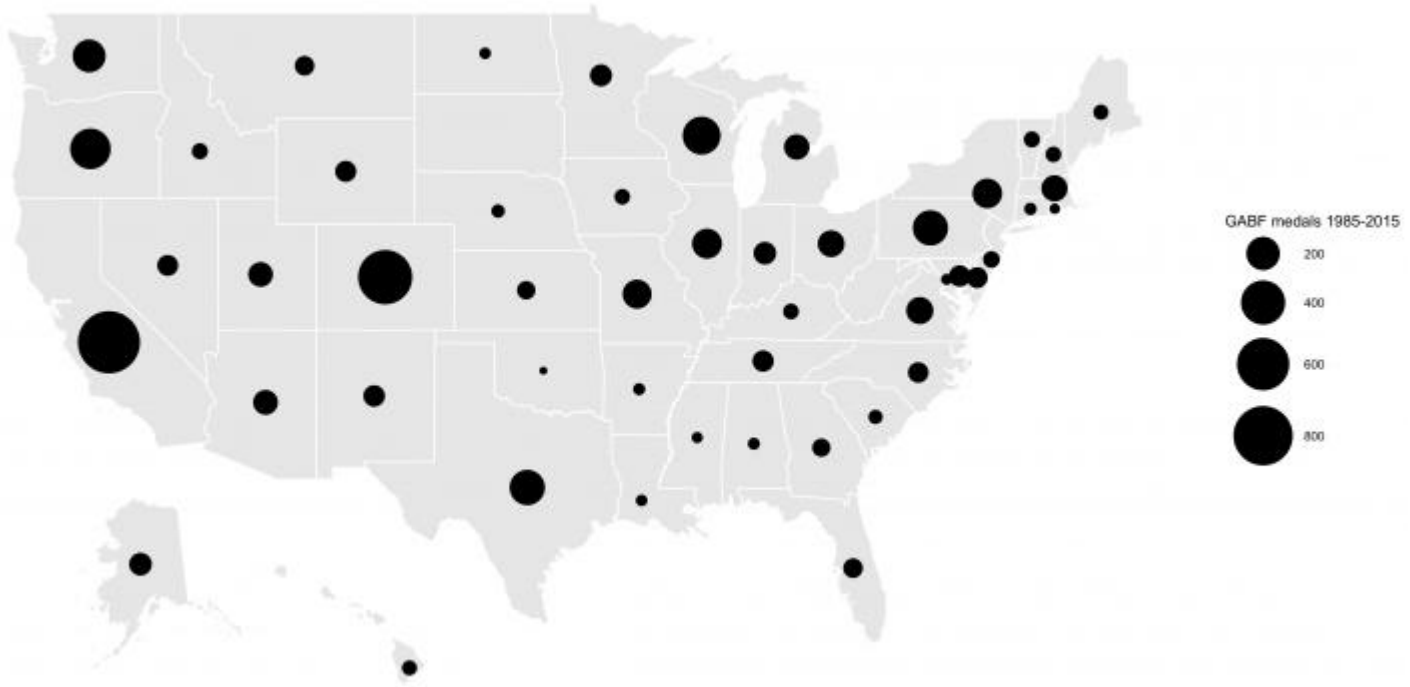
Course outline

1. **Working directory setting, data preparation and shapefile importation (5 mn)**
2. **Rendering a basic map in R using ggplot2 (10 min)**
3. **Rendering a choropleth map (20 min)**
4. **Add a scale bar and North Arrow (5 min)**
5. **Tips (5 min)**
6. **Q & A (15 min)**

R is it appropriate as a geocomputational tool?

Which kind of map R can render?

Plot your points



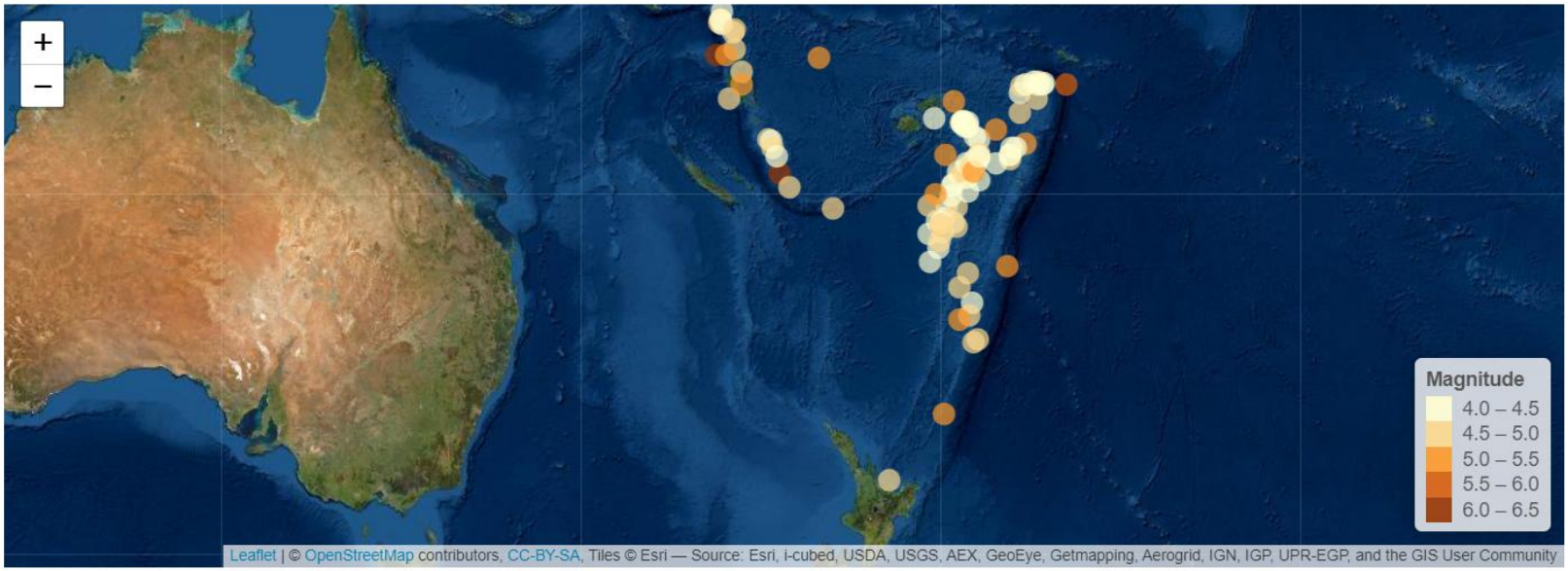
https://www.storybench.org/plot-state-state-data-map-u-s-r/

Roads Map

ggplot() map of roads, plots and study area
with north arrow and scale bar

https://www.earthdatascience.org/courses/earth-analytics/spatial-data-r/make-maps-with-ggplot-in-R/

Interactive map with R and leaflet



https://www.r-graph-gallery.com/19-map-leafletr.html

Choropleth Map

Specify a region of interest

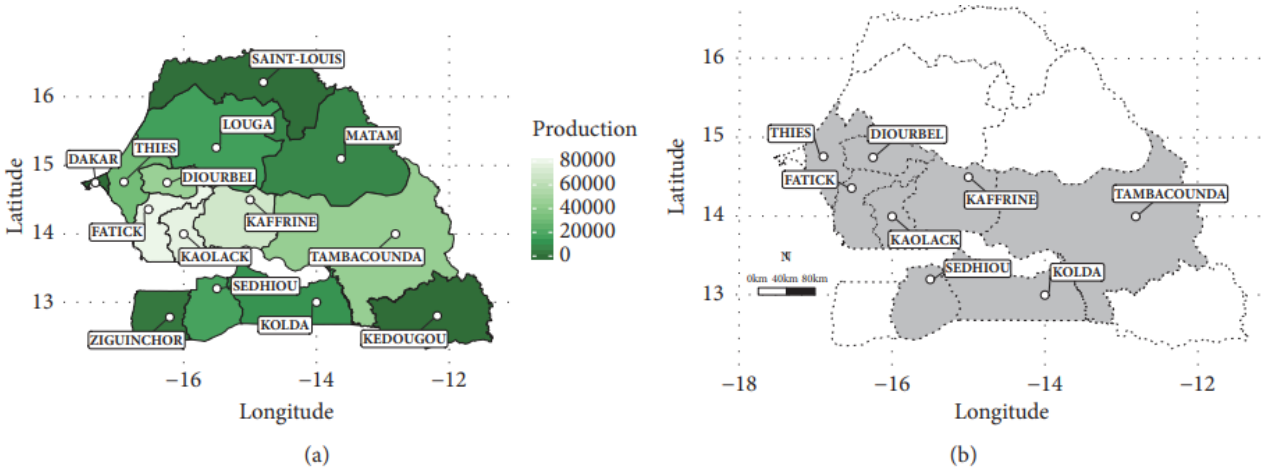


FIGURE 1: Map showing production (ton) of pearl millet in regions of Senegal during agricultural campaign 2014-2015: (a) gray-colored regions representing on-farm surveyed ones (production ≥ 15000 tons) during rainy season 2017 (b).

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6642752/pdf/TSWJ2019-1252653.pdf

Georeferencing

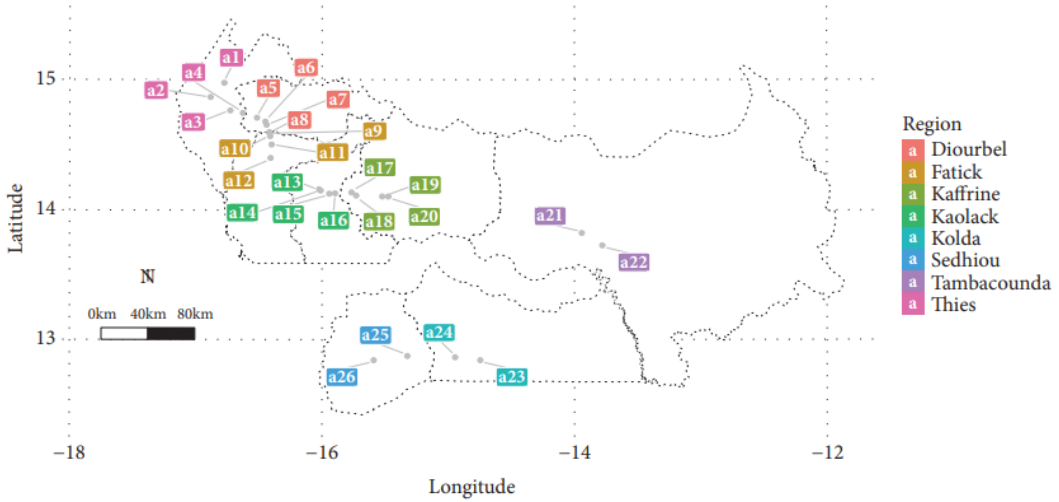


FIGURE 2: Map showing surveyed fields across the pearl millet productive regions of Senegal during rainy season 2017.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6642752/pdf/TSWJ2019-1252653.pdf

Informative Circle Map

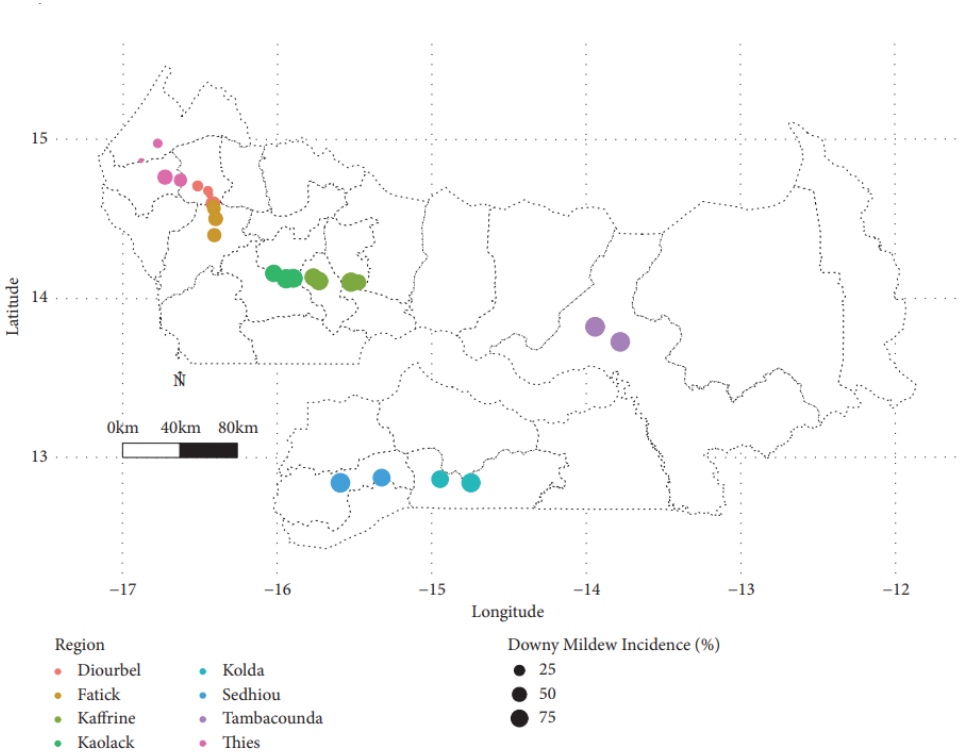
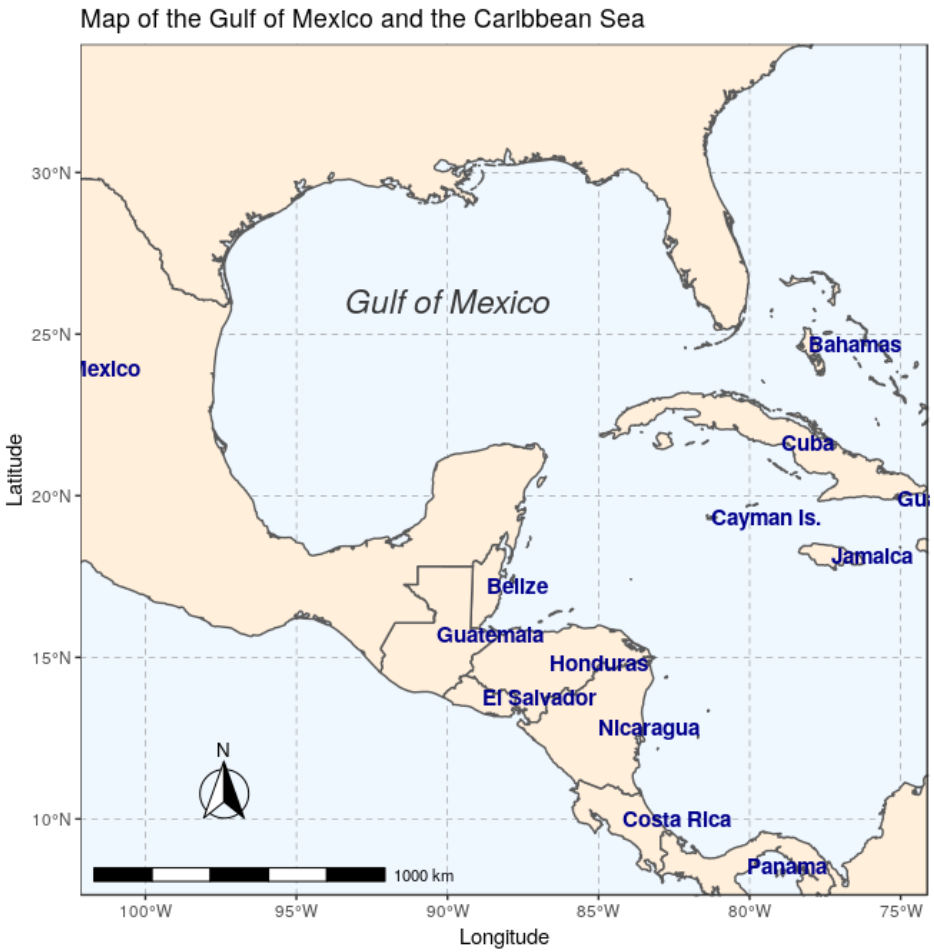


FIGURE 6: Map showing downy mildew incidence across surveyed field in Senegal during rainy season 2017.

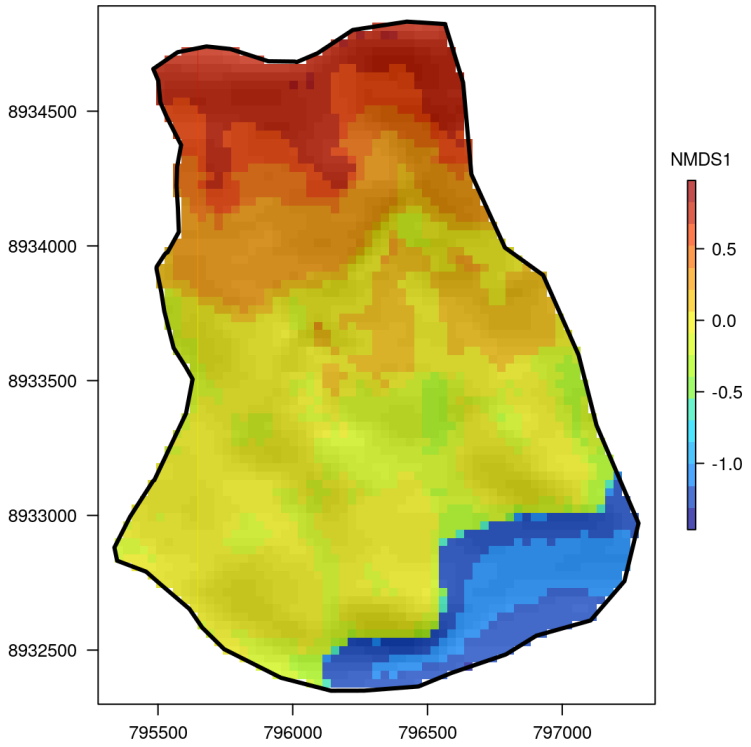
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6642752/pdf/TSWJ2019-1252653.pdf

Map



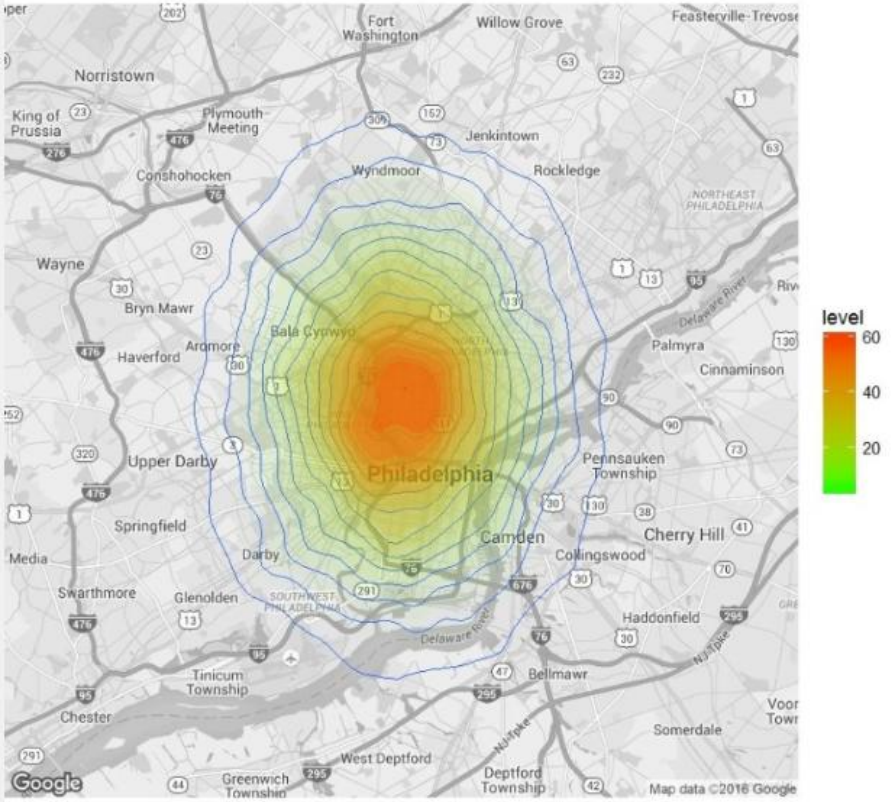
https://www.r-spatial.org/r/2018/10/25/ggplot2-sf.html

Predictive mapping of the floristic gradient clearly revealing distinct vegetation belts



https://bookdown.org/robinlovelace/geocompr/eco.html#modeling-the-floristic-gradient

Heat Map



Geographical heatmap produced using an effective population size density distribution, overlaid on a geographical map of Philadelphia.

https://www.molecularecologist.com/2016/03/geographical-heat-maps-in-r/

ETC…

Pre-requisites

•Install R and RStudio on Windows 7, 8 or 10. A tutorial for a beginner is here.

•Install the following packages before the course: rgdal, mapdata, mapproj, maps, ggplot2, ggrepel, legendMap, dplyr, scales, and ggmap. A tutorial for package installation in RStudio is here.

•Download the data for exercise here

Pre-requisites

- It is more easier to install CRAN packages at once by typing

```
install.packages(c("rgdal", "mapdata", "mapproj" ,"maps"
,"ggplot2", "ggrepel", "dplyr", "scales", "ggmap"))
```

For installation of the legendMap package, you need to install the devtools package first.

```
install.packages("devtools")
```

Then install legendMap

```
devtools::install_github("3wen/legendMap")
```

1. Working directory setting, data preparation and shapefile importation

1.1. Set the working directory

The working directory is the folder named R MAP. Please put all the shapefiles and data in your working directory. To set your working directory, type:

```
setwd""C:/Users/ANGE/Documents/R MAP""
```

1.2. Clean the R environment workspace

```
rm(list = ls())
```

1.3. Set shapefile path

```
mySHP = ("C:/Users/ANGE/Documents/R MAP")
```

1.4. Import the shapefile

```
myFile = readOGR(mySHP, layer = "SEN_adm1",

stringsAsFactors = FALSE)
```

1.5. Check the class of the shapefile

```
class(myFile)
```

1.6. Check the variables names

```
names(myFile)
```

1.7. Check the regions names

```
print(myFile$NAME_1)
```

1.5. Loading multiple packages at once

```
Packages = "rgdal", "mapdata", "mapproj" ,"maps" ,"ggplot2",

"ggrepel", "legendMap", "dplyr", "scales", "ggmap")

lapply(Packages, library, character.only = TRUE)
```

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2. Rendering a basic map in R using ggplot2

2.1. Change in dataframe format for ggplot2

```
myDF = fortify(myFile, region = "NAME_1")
```

2.2. Overview of the data myDF

```
Type: head (myDF, 4)
```

long	lat	order	hole	piece	id	group
-17.16056	14.89375	1	FALSE	1	Dakar	Dakar.1
-17.16004	14.89333	2	FALSE	1	Dakar	Dakar.1
-17.16000	14.89335	3	FALSE	1	Dakar	Dakar.1
-17.15683	14.89042	4	FALSE	1	Dakar	Dakar.1

2.3. Change long to Longitude and lat to Latitude

```
myDF = rename(myDF, Longitude = long, Latitude = lat)
```

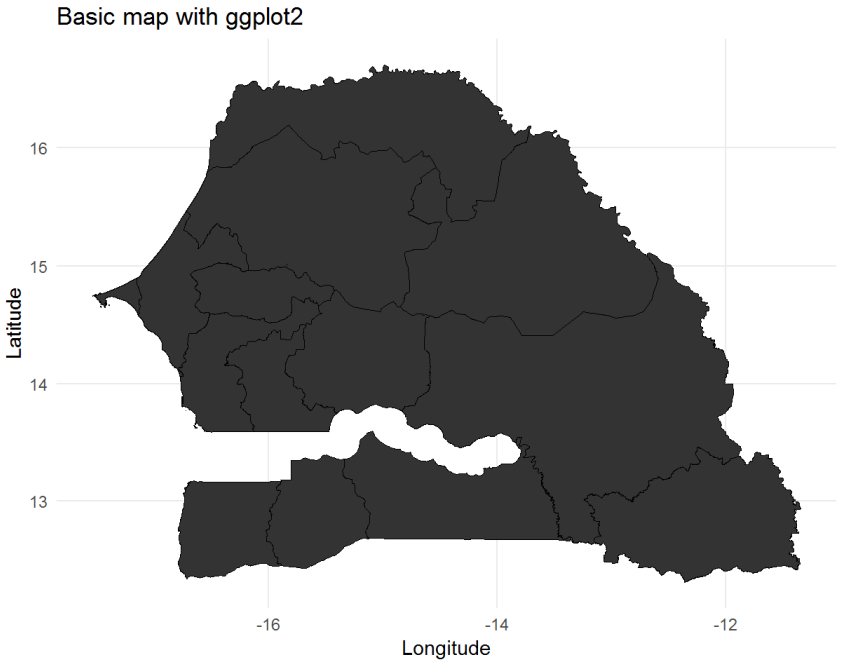
2.4.Overview of the myDF

```
Type: head(myDF, 4)
```

Longitude	Latitude	order	hole	piece	id	group
-17.16056	14.89375	1	FALSE	1	Dakar	Dakar.1
-17.16004	14.89333	2	FALSE	1	Dakar	Dakar.1
-17.16000	14.89335	3	FALSE	1	Dakar	Dakar.1
-17.15683	14.89042	4	FALSE	1	Dakar	Dakar.1

2.5. Make the basic plot

```
p <- ggplot() + geom_polygon(data = myDF, aes(x =
Longitude, y = Latitude, group = group), color = "black",
size = 0.25) + coord_map() + theme_minimal() +
ggtitle("Basic map with ggplot2")
```



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3. Rendering a choropleth map

3.1. Import the data we want to plot on the map.Here that is the production of pearl millet per region

```
mydata = read.csv("production_data.csv", header = TRUE, sep = ";")
```

3.2. Import the the regions names for annotation step

```
mydata1 = read.csv("region_names.csv", header = TRUE, sep = ";")
```

3.3. Overview of the data mydata

Type: `head(mydata, 4)`

long	lat	id	Production
-17.33	14.75	Dakar	0
-16.25	14.75	Diourbel	46231
-16.53	14.36	Fatick	80000
-12.18	12.80	KÃ©dougou	152

3.4 Overview of the data mydata1

Type: `head(mydata1, 4)`

Region	long	lat
DAKAR	-17.33	14.75
DIOURBEL	-16.25	14.75
FATICK	-16.53	14.36
KAOLACK	-16.00	14.00

3.4. Join the data and the shapefle

```
plotData <- left_join(myDF, mydata)
```

3.5. Overview of plotData

Type: `head(plotData)`

Key point: Note that myDF and mydata has id as a common variable

myDF

Longitude	Latitude	order	hole	piece	id	group
-17.16	14.89	1	FALSE	1	Dakar	Dakar.1
-17.16	14.89	2	FALSE	1	Dakar	Dakar.1
-17.16	14.89	3	FALSE	1	Dakar	Dakar.1
-17.15	14.89	4	FALSE	1	Dakar	Dakar.1

mydata

long	lat	id	Production
-17.33	14.75	Dakar	0
-16.25	14.75	Diourbel	46231
-16.53	14.36	Fatick	80000
-12.18	12.80	KÃ©dougou	152

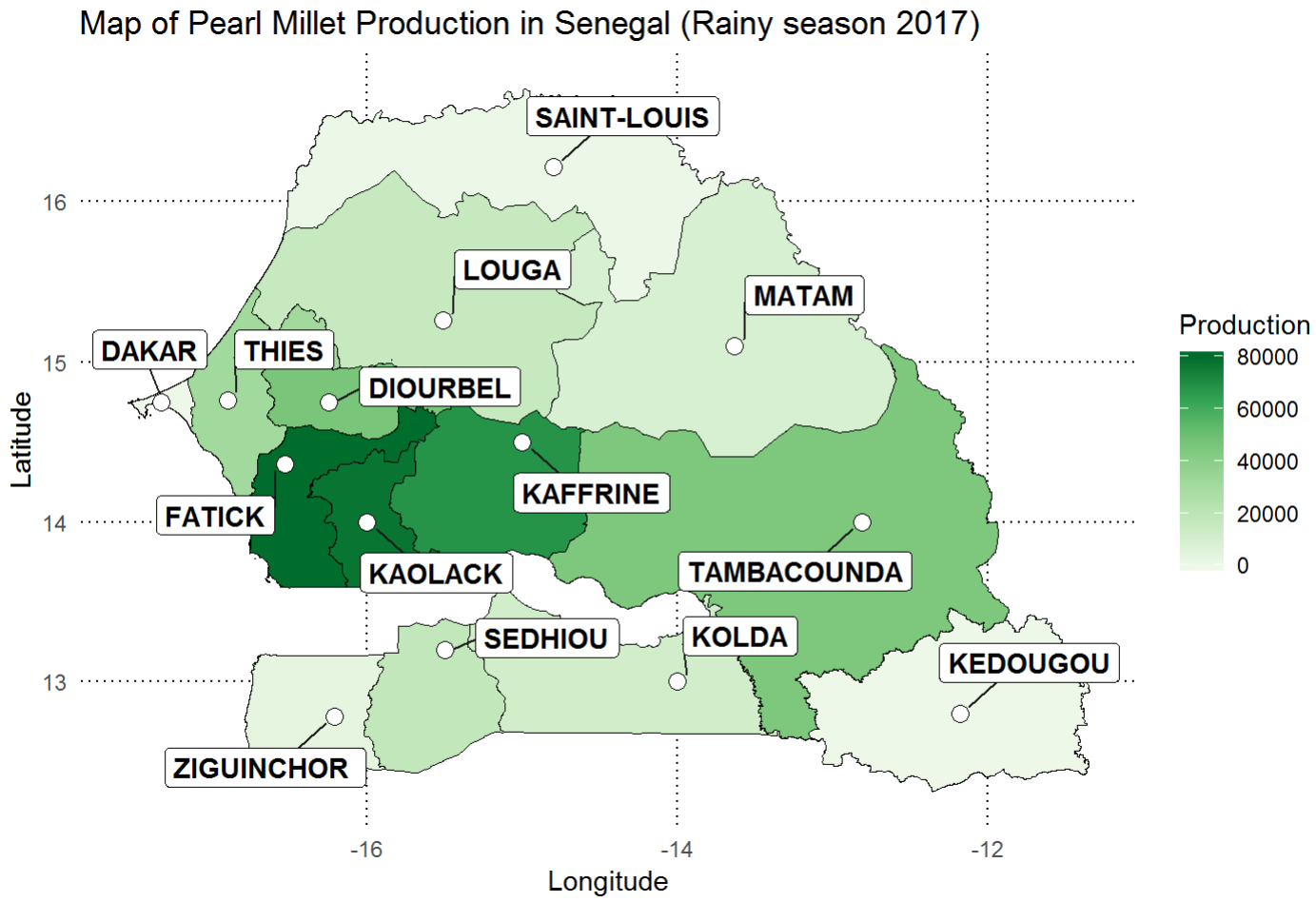
plotData

Longitude	Latitude	order	hole	piece	id	group	long	lat	Production
-17.16	14.89	1	FALSE	1	Dakar	Dakar.1	-17.33	14.75	0
-17.16	14.89	2	FALSE	1	Dakar	Dakar.1	-17.33	14.75	0
-17.16	14.89	3	FALSE	1	Dakar	Dakar.1	-17.33	14.75	0
-17.15	14.89	4	FALSE	1	Dakar	Dakar.1	-17.33	14.75	0

3.6 Make the plot

```
p <- ggplot() +
     geom_polygon(data = plotData,
          aes(x = Longitude, y = Latitude,
                    group = group, fill = Production),
                    color = "black", size = 0.25) +
     coord_map() +
     scale_fill_distiller(palette = "Greens", direction = 1) +
     geom_point(data = mydata1,
     aes(x = long, y = lat),shape = 21, fill = "white", size = 3, color = "black") +
     geom_label_repel(data = mydata1,
     aes(x = long, y = lat, label = Region),
     fontface = "bold", color = "black", box.padding = 0.35, point.padding = 0.5,
     segment.color = "grey10") + theme_minimal() +
     theme(panel.grid.major = element_line(colour = "black", size = 0.5, linetype =
     "dotted")) +
     theme(plot.background = element_rect(colour = "white", size = 1)) +
     ggtitle("Map of Pearl Millet Production in Senegal (Rainy season 2017)")
```

Map rendering



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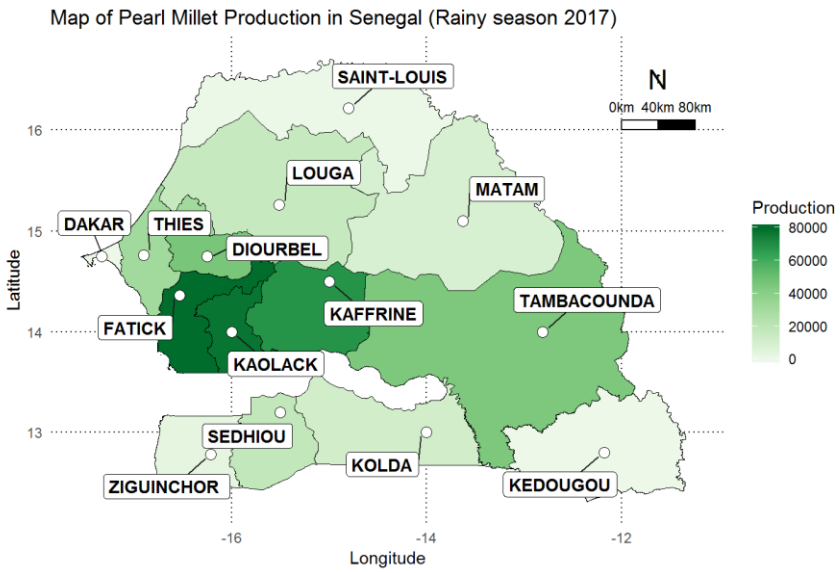
4. Add scale bar and north arrow

```
scale_bar(
    lon = -12,
    lat = 16,
    distance_lon = 40,
    distance_lat = 10,
    distance_legend = 25,
    dist_unit = "km",
    arrow_length = 10,
    arrow_distance = 50,
    arrow_north_size = 6)
```



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Export a high quality map

PDF format

```
ggsave(p,
    file = "carte.pdf",
    limitsize = FALSE,
    width = 12,
    height = 10.5,
    dpi=500 )
```

Export a high quality map

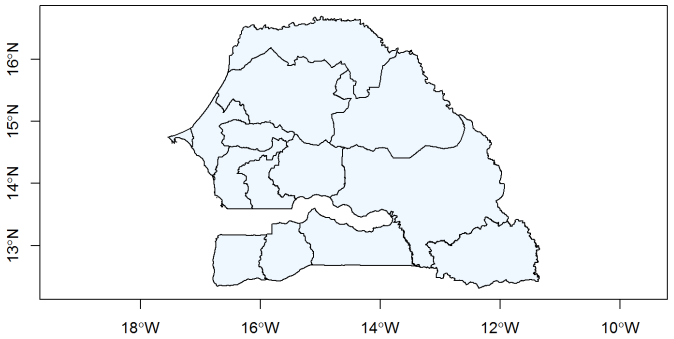
PNG Cairo Format

```
ggsave(p,
    file = "carte.png",
    limitsize = FALSE,
    width = 10,
    height = 6.5,
    type = "cairo-png",
    dpi=500)
```

5. Tips

To find out a desirable position for scale bar or any adjustment, it is possible to plot the map with the basic R by typing:

```
plot(myFile, axes = T, col = "aliceblue")
```



and then typing:

```
locator(n=2)
```

2 is just an example. You can define many number as much as possible and using your mouse, click on the position you want. You will get the coordinates.

References

•Pebesma EJ, Bivand RS (2005). “Classes and methods for spatial data in R.” R News, 5(2), 9–13. https://CRAN.R-project.org/doc/Rnews/.

•Bivand RS, Pebesma E, Gomez-Rubio V (2013). Applied spatial data analysis with R, Second edition. Springer, NY. https://asdar-book.org/.

•Wickham H (2016). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York. ISBN 978-3-319-24277-4, https://ggplot2.tidyverse.org.

Q & A

THANK YOU VERY

MUCH

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For reproducibility, a permanent online access of this tutorial is available here:

https://github.com/Yedomon/R-for-geographic-map-Session-1/

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