

Supported by:



Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety



Federal Agency for
Nature Conservation



EOCap4Africa

6 Introduction to handling Spatial Data in QGIS and RStudio

a) Handling Vector Data



INES Ruhengeri
Institute of Applied Sciences



Learning Objectives



Import and export vector data in QGIS and RStudio

Learn how to visualise Vector Data

Perform basic vector manipulations (selecting, filtering, buffering)

Use both QGIS and R to work with vector data



Part 1:

Handling Vector Data in QGIS

Tasks



1. Start your QGIS application
2. Create a new Project
3. Load in the World Vector Map from last time
---> You can check the slides from Lecture 5b)



Exploring the Attribute table

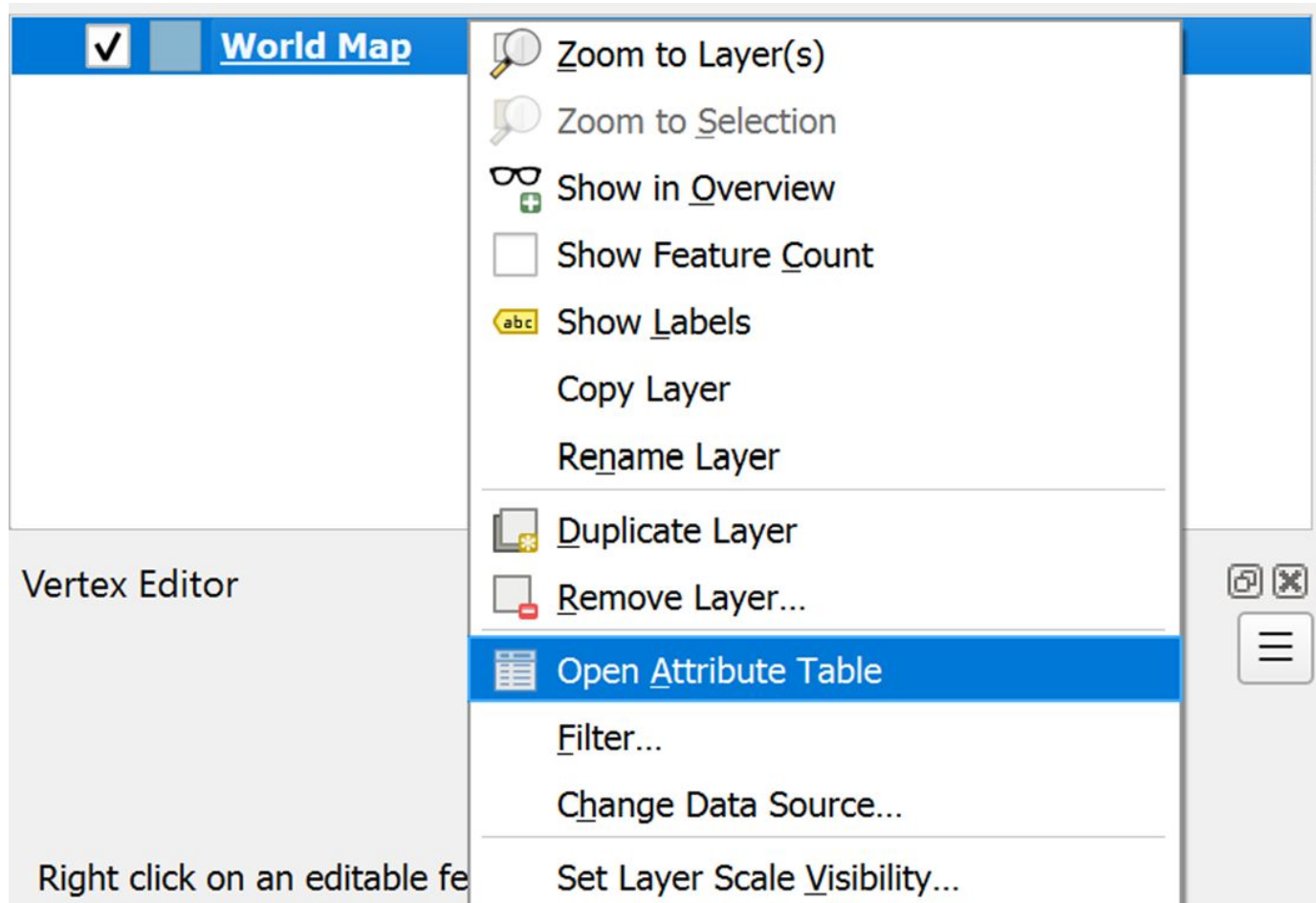
What is an Attribute Table?

- The attribute table stores non-spatial information (metadata) about a vector features
- Each row represents a spatial feature (point, line, or polygon)
- Each column represents an attribute (e.g., name, population, area, elevation)

Common Operations in QGIS Attribute Table

- Sorting & Filtering → Use the "Select by Expression" tool (population > 1000000)
- Editing Fields → Enable "Editing Mode" to modify values
- Adding New Fields → Use Field Calculator to create new attributes (e.g., population density)
- Joining Tables → Combine external data (CSV, database) with vector attributes

Exploring the Attribute table



- You can explore the "World Map" dataset by opening the attribute table

Explore the attribute table!

What data does it contain?
Are there different types of data in the attribute table?



Load in your own Vector Data

1. Download the shapefile and unzip it
2. Move the folder of the shapefile to your desired location
3. Load in the Data

Tip!

After you have started a project do not move or rename your files!

Method 1)

Just pull the .shp file from your explorer into QGIS

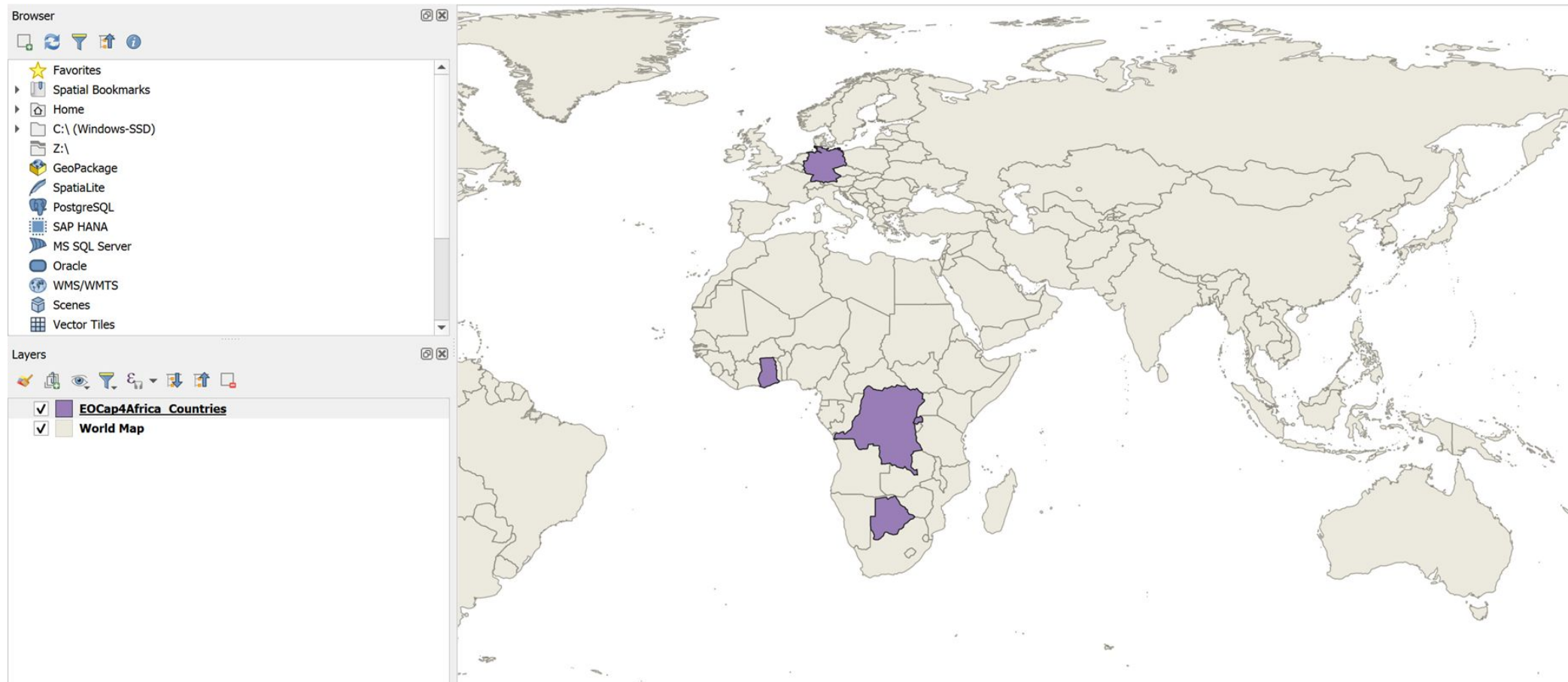
Method 2)

- 1) Go to Layer in the Menu Bar
- 2) Add Layer
- 3) Add Vector Layer
- 4) Go to the shapefile and doubleclick it



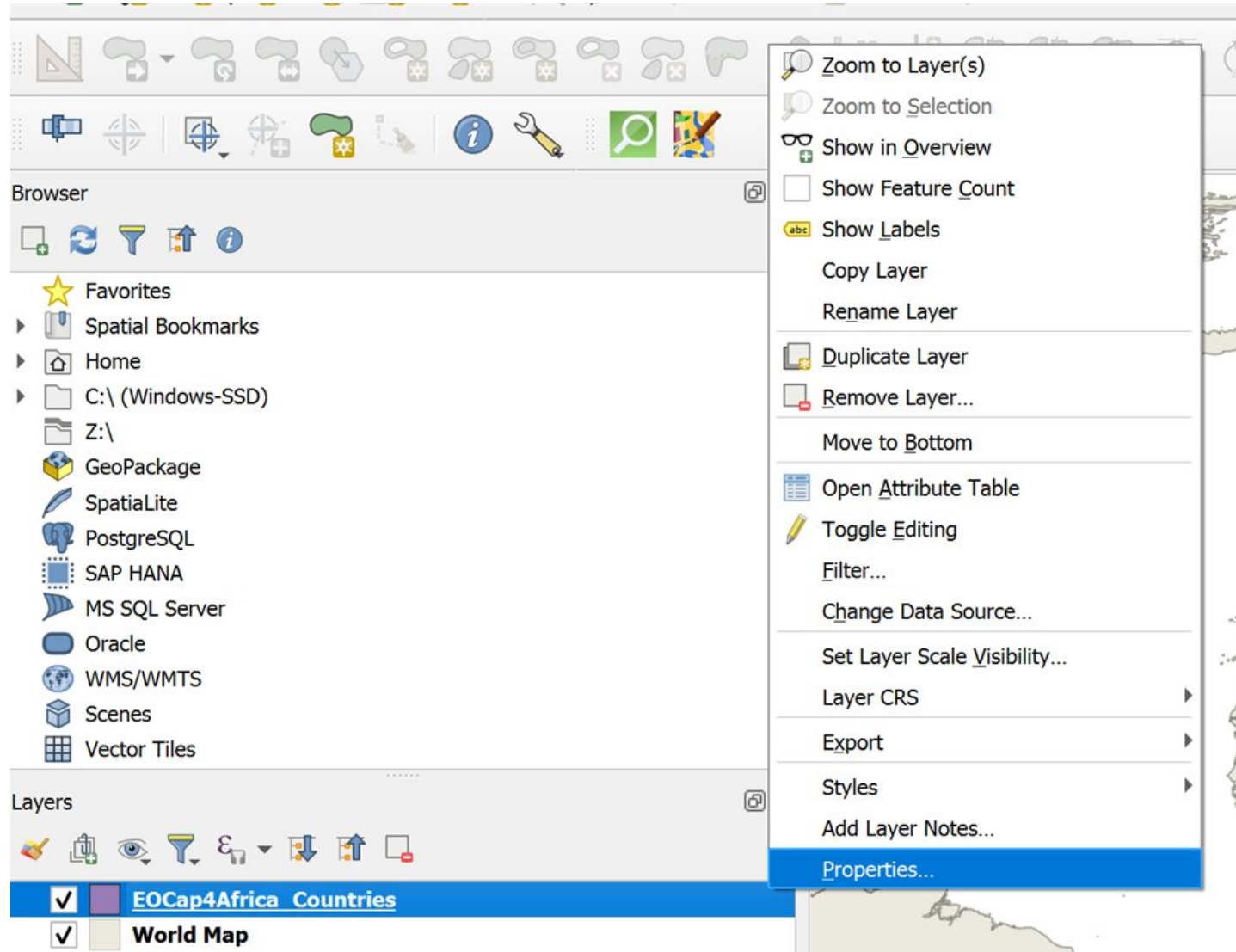
Load in your own Vector Data

The result should look something like this:





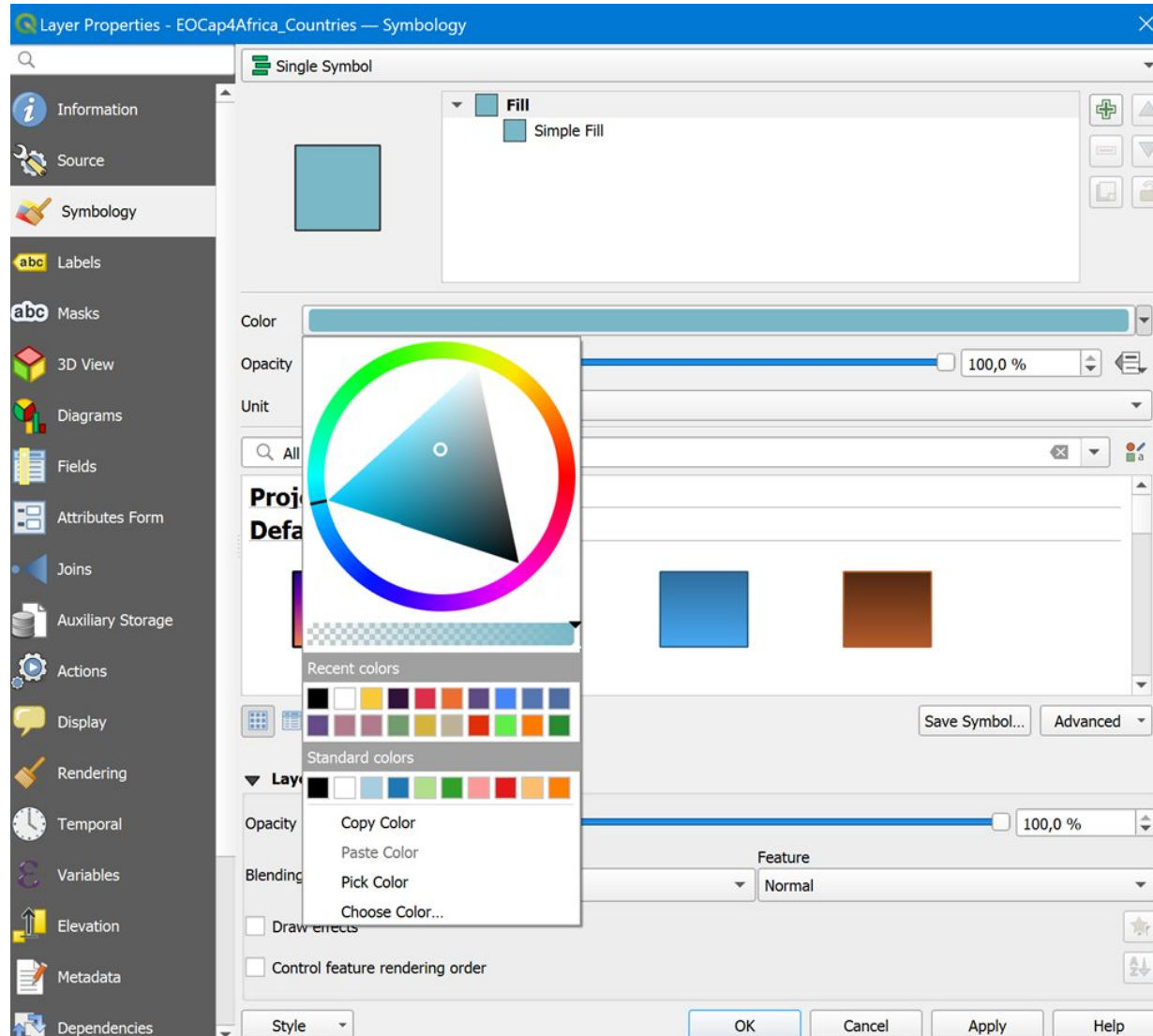
Vector Properties



- Right Click on your new vector layer
- Under properties you can find all sort of information and options to work with your data



Vector Symbolology



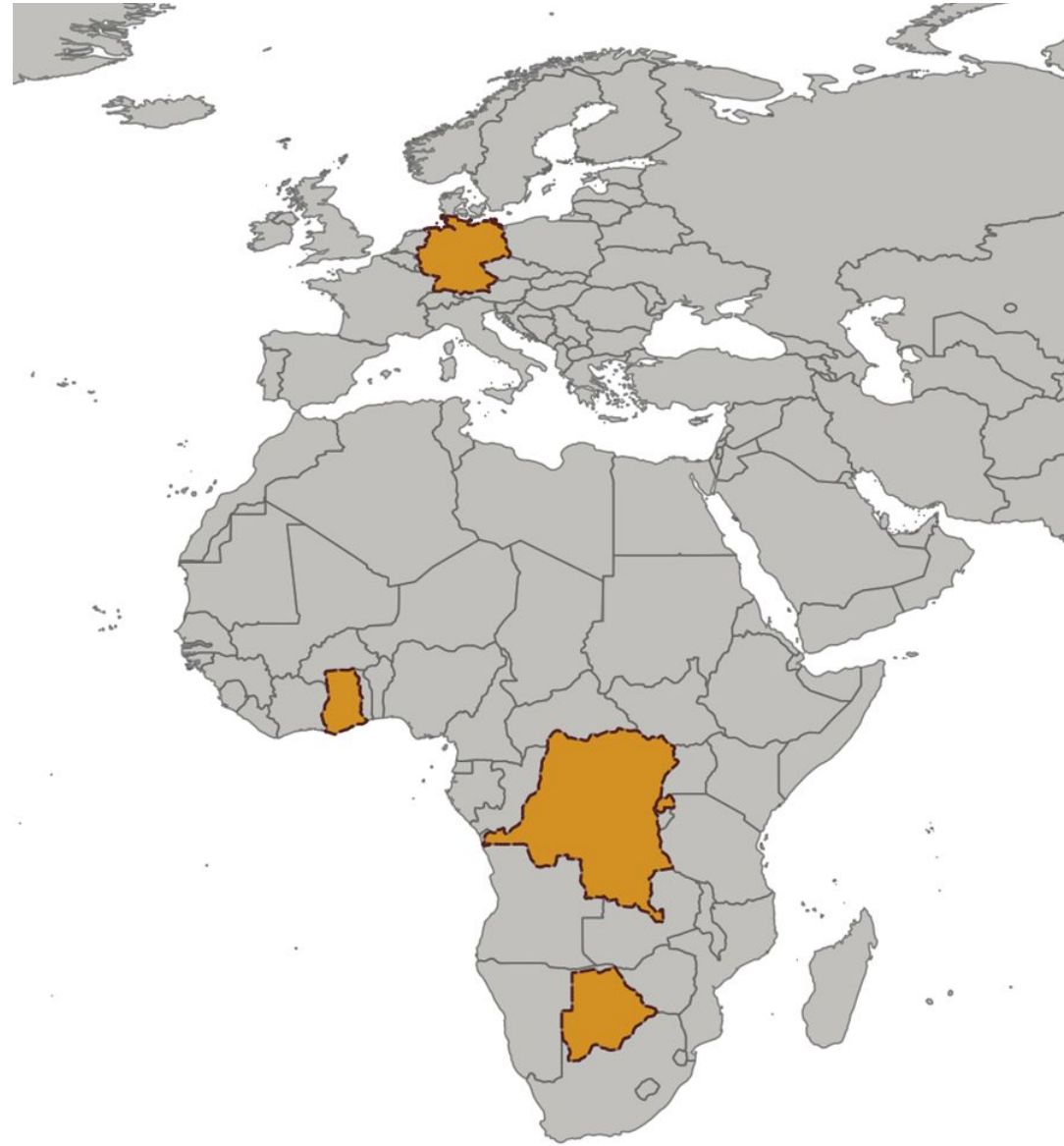
- Under the symbology tab you can stylize your layer in whatever way you see fit
- By pressing Ok (closes the window) or Apply you change the style!

Play around with the symbology options and change the color, transparency and border of the two vector data sets!

Vector Symbolology



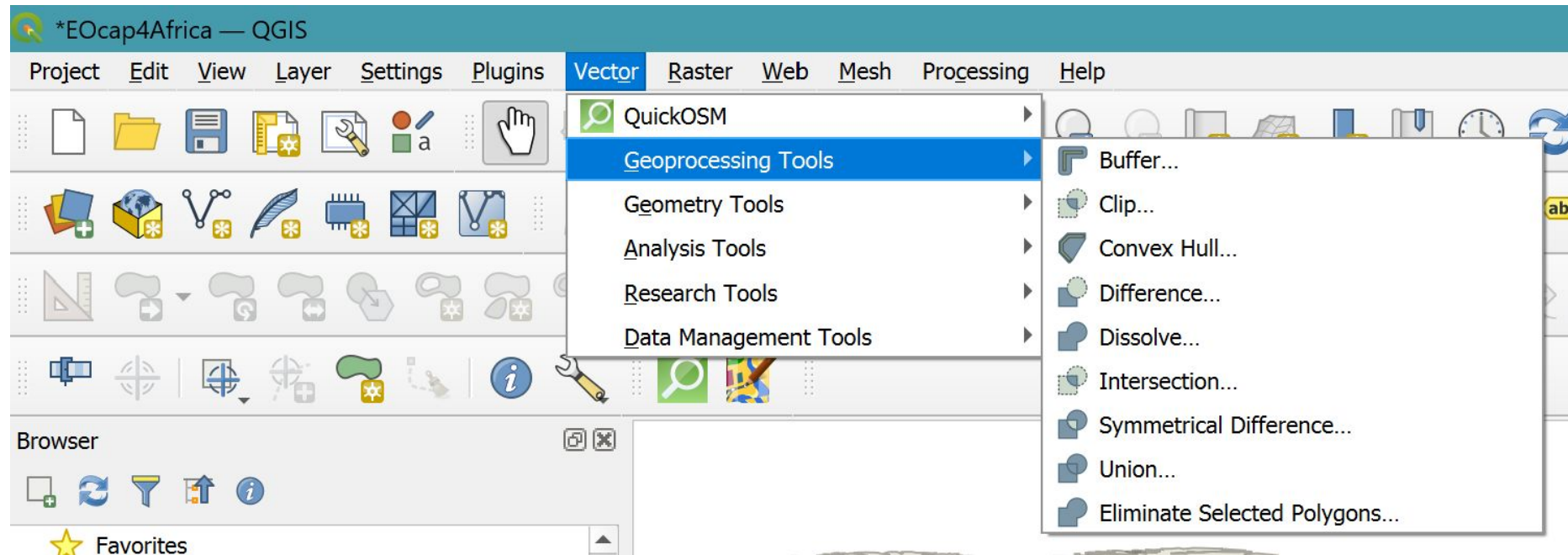
In this example I adjusted the color scheme, the transparency and the border style of the vector layers





Simple Vector Manipulation - Buffer

- creates two areas: one area that is within a specified distance to selected real world features and the other area that is beyond
- area that is within the specified distance is called the buffer zone



Simple Vector Manipulation



Tool Name	Category	Function
Buffer	Geoprocessing	Creates a zone around features at a specified distance (e.g., 500m buffer around roads).
Clip	Geoprocessing	Extracts features from one layer based on the boundaries of another layer (e.g., cutting a road layer by a country boundary).
Union	Geoprocessing	Merges two layers, keeping all features from both (e.g., combining two administrative boundary layers).
Dissolve	Geoprocessing	Merges features within the same layer based on a shared attribute (e.g., merging regions with the same land use).
Merge Vector Layers	Data Management	Combines multiple vector layers into one (e.g., merging multiple city shapefiles into one).
Extract by Attribute	Selection	Selects features based on attribute values (e.g., select all cities with a population > 1 million).

Simple Vector Manipulation - Buffer

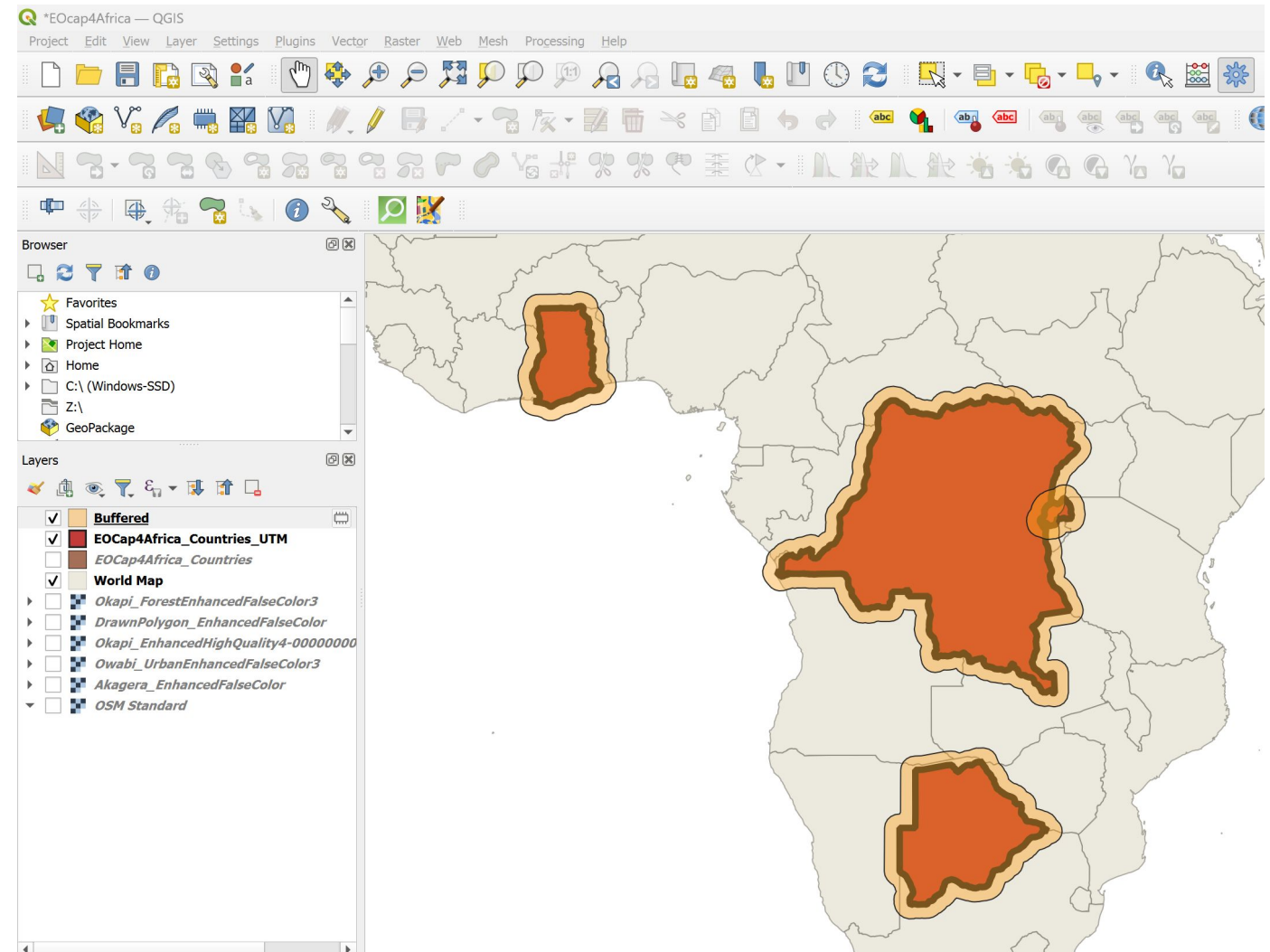


1. Reproject the Dataset you want to buffer to a suitable projected coordinate system
2. Use the Buffer Tool

Simple Vector Manipulation - Buffer



Result of applying a 100 km Buffer





Part 2:

Handling Vector Data in RStudio

Tasks



1. Double click on the downloaded and unzipped R-file
"6a_How_to_handle_Vector_Data.r."
2. The file that will open in RStudio



Getting the Vector Data

1. We are using freely available data from natural earth and defining it to the variable "url"
2. Next we download the file and unzip it

```

# Download example vector data
# Example: Using a sample dataset of natural Earth admin boundaries
url| <- "https://naturalearth.s3.amazonaws.com/110m_cultural/ne_110m_admin_0_countries.zip"
download.file(url, "ne_countries.zip")
unzip("ne_countries.zip", exdir = "ne_countries")

# Read the Shapefile into R using `st_read` from `sf`
shapefile_path <- "ne_countries/ne_110m_admin_0_countries.shp"
countries <- st_read(shapefile_path)
  
```

- 3) We assign the unzipped shapefile to the variable "shapefile_path"
- 4) And read it out using "st_read" in the variable "countries"

Assessing the Meta Data



- Head() gives you the first few rows of all attributes in the attribute table
- Summary() displays all attributes and their data type as well as a range of information about the geometry

```

# 3. Check the Metadata
# Check the structure of the loaded data and access the attribute data
head(countries) # Inspect the first few rows of attribute data
summary(countries) # Summary of attributes and geometry types
    
```



Visualising the Vector Data

- We can use ggplot2 to visualise maps
- We define our variable "countries" as the data
- Using "geom_sf" we can describe the aesthetic of our map
- "labs" lets you set the labels of the map
- "theme_minimal()" sets the overall design of the map

```

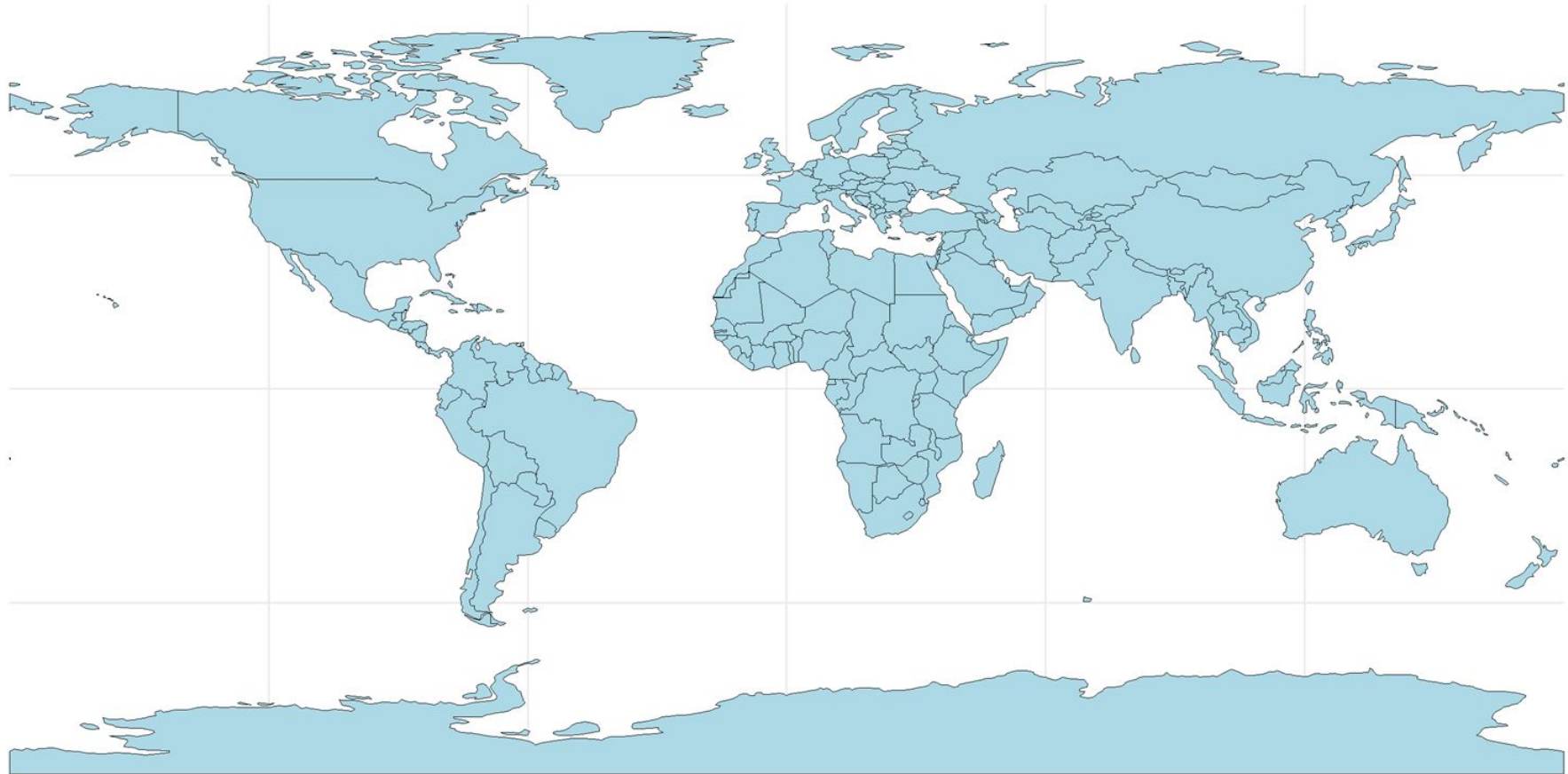
# 4. visualize the data: Create a basic map
# Use ggplot2 to create a simple map of the countries
ggplot(data = countries) +
  geom_sf(fill = "lightblue", color = "black", size = 0.2) +
  labs(title = "World Map", subtitle = "Basic visualization of vector data") +
  theme_minimal()
    
```

Visualising the Vector Data

The result should look something like this:

World Map

Basic visualization of vector data





Visualising the Vector Data

- Using "geom_sf(data=" we can ask R to show the attribute "Ghana" in a different color on the map

```

# Select and plot specific attributes
# Example: Highlight a single country (e.g., Ghana)
Ghana <- countries[countries$NAME == "Ghana", ]
ggplot(data = countries) +
  geom_sf(fill = "gray90", color = "black", size = 0.2) +
  geom_sf(data = Ghana, fill = "green", color = "darkgreen", size = 0.5) +
  labs(title = "Highlighting Ghana", subtitle = "Example of subsetting spatial data") +
  theme_minimal()

```


Visualising the Vector Data

The result should look something like this:

Highlighting Ghana

Example of subsetting spatial data



Tasks



1. Create another map highlighting any country of your choice
2. Adjust the symbology and change the colorscheme of the map

Summary & Key Takeaways



Vector data can be imported and exported in both QGIS and RStudio

Basic vector manipulations include selecting, filtering, buffering, and clipping

QGIS is great for interactive vector editing, while R enables automation and advanced spatial analysis

Supported by:



Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety



Federal Agency for
Nature Conservation



Thank you for your attention!

Dr. Insa Otte, Hanna Schulten
 (on behalf of the EOCap4Africa Team)
 and colleagues

insa.otte@uni-wuerzburg.de



INES Ruhengeri
 Institute of Applied Sciences

