Lab 2: Health Facility Access and Spatial Query in Uganda using QGIS

Introduction and Learning Objectives

In this lab, you will learn how to evaluate spatial access to health facilities using QGIS, a powerful open-source Geographic Information System (GIS) tool. We will use district boundaries, malaria prevalence data, and health facility coordinates to identify areas with high malaria burden that lack nearby health infrastructure.

By the end of this lab, you will understand and apply core spatial analysis techniques, including:

- Loading and converting coordinate data to spatial point layers
- Creating buffer zones around facilities
- Running spatial queries (e.g., districts without facility access)
- Combining spatial selection with health indicators
- Creating and exporting a final map layout

Key GIS Concepts and Tools

Term	Description
Delimited Text Layer	A table with geographic coordinates (e.g., CSV with Latitude/Longitude) loaded into QGIS as point data.
Shapefile	A common vector file format representing spatial features such as points, lines, or polygons.
Buffer	A zone created around a spatial feature to assess proximity—useful for evaluating service access.
Spatial Query	A way to identify relationships between spatial layers—e.g., which districts intersect or do not intersect with buffer zones.
CRS (Coordinate Reference System)	Defines how spatial data is projected. WGS 84 (EPSG:4326) is commonly used for GPS coordinates.
Print Layout	A cartographic interface in QGIS to design and export maps with legends, scale bars, and titles.

Materials Needed

- `Uganda_districts.gpkg` or equivalent shapefile (polygon boundaries)
- `malaria_prevalence_uganda.csv` (tabular health data)
- `health_facilities_uganda.csv` (with Latitude and Longitude columns)
- Completed QGIS project from Lab 1 (recommended)

Step-by-Step Instructions

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Objective:
Participants will learn how to analyze spatial access to health facilities using simple proximity analysis tools in QGIS. They will identify districts with high malaria prevalence that lack a nearby health facility, using buffer zones and spatial queries.

Materials Needed:

Uganda_districts.gpkg (or shapefile)

malaria_prevalence_uganda.csv

health_facilities_uganda.csv (XY table with facility coordinates)

Completed QGIS project from Lab 1 (optional)

Step-by-Step Instructions:

1. Load the Health Facilities Table and Create Points

This table contains 1,000 real health facility locations in Uganda, randomly sampled from a national dataset obtained through the Humanitarian Data Exchange (HDX).

Open the QGIS project from Lab 1 or start a new project.

Go to Layer > Add Layer > Add Delimited Text Layer.

Browse to select health_facilities_uganda.csv.

In the dialog:

Set the X field to Longitude

Set the Y field to Latitude

Set the geometry CRS to EPSG:4326 - WGS 84

Click Add. The table will load as a point layer.

Open the QGIS project from Lab 1 or start a new project.

Go to Layer > Add Layer > Add Delimited Text Layer.

Browse to select health_facilities_uganda.csv.

In the dialog:

Set the X field to Longitude

Set the Y field to Latitude

Set the geometry CRS to EPSG:4326 - WGS 84

Click Add. The table will load as a point layer.

1a. Convert the XY Layer to a Shapefile

Right-click the newly loaded health facilities layer in the Layers panel.

Select Export > Save Features As...

In the Format dropdown, select ESRI Shapefile.

Choose a filename (e.g., health_facilities_uganda.shp) and location.

Click OK to save the new shapefile.

Remove the temporary CSV layer from your project and use the shapefile for further analysis.

Open the QGIS project from Lab 1 or start a new project.

Go to Layer > Add Layer > Add Delimited Text Layer.

Browse to select health_facilities_uganda.csv.

In the dialog:

Set the X field to Longitude

Set the Y field to Latitude

Set the geometry CRS to EPSG:4326 - WGS 84

Click Add. The table will load as a point layer.

2. Visualize Facility Distribution

Change the symbol of the facilities layer to a distinct icon (e.g., cross or circle in red or blue).

Adjust size so facilities are clearly visible over the district layer.

3. Create a Buffer Around Facilities

Go to Vector > Geoprocessing Tools > Buffer.

Set parameters:

Input layer: Health facilities

Distance: 10,000 meters (10 km)

Segments: 20 (default)

Output: save to file or temporary layer

Click Run.

4. Identify Districts Without Nearby Facilities

Go to Vector > Research Tools > Select by Location.

Parameters:

Select features from: Districts layer

Where the features: do not intersect

By comparing to: Buffer layer

Click Run. Selected districts will highlight.

5. Filter for High Malaria Prevalence

Open the attribute table of the district layer.

Use the Select by Expression tool:

Expression: "Malaria_Prevalence_Percent" > 15

Combine the selection (e.g., manually or using logical AND) with the previously selected districts (those lacking facility access).

6. Save the Selected Districts

Right-click the districts layer > Export > Save Selected Features As.

Save as a new layer (e.g., high_risk_no_facility.gpkg).

7. Create a Map Layout

Add a new print layout.

Include the base district layer, buffer zones, and selected high-risk districts.

Add a title: "High Malaria Risk Districts Without Nearby Health Facilities".

Add legend, scale bar, and export the layout to PDF.

Outcome:
Participants will generate a map that visually highlights districts with high malaria burden and poor facility access, a valuable tool for public health decision-making and resource planning.

Optional Extensions:

Change the buffer distance (e.g., 5 km or 15 km) and compare outcomes.

Use population data to prioritize underserved, densely populated areas.

Create a heatmap of health facility density across Uganda.

Tip: Be sure to save your QGIS project frequently!