

## **Technical Appendix for ERP Dissertation**

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## 1. Overview

This appendix provides detailed technical steps to ensure the reproducibility of the dissertation research. It covers data acquisition, QGIS preprocessing, Python-based analysis, and verification of outputs.

## 2. Data Sources

Dataset	Source	Format	Resolution/Unit
OpenStreetMap (POIs)	Geofabrik	.gpkg	Points; lines
Global Relative Deprivation Index (GRDI)	NASA SEDAC (CIESIN)	.tif	Raster, 1 km
WorldPop	WorldPop Project	.tif	Raster, 100m
GADM Level-2 boundaries	GADM	.shp	Polygons

## 3. QGIS Preprocessing (using Uganda as example)

### 3.1 Import OSM Data

Source: Geofabrik extracts for Ghana and Uganda.

File format: gis\_osm\_pois\_free\_1.shp; gis\_osm\_transport\_free\_1.shp

### 3.2 Select Infrastructure Categories

Filter by fclass attribute:

(a) From gis\_osm\_pois\_free\_1.shp

- Education → school, college, university, kindergarten, education institutions

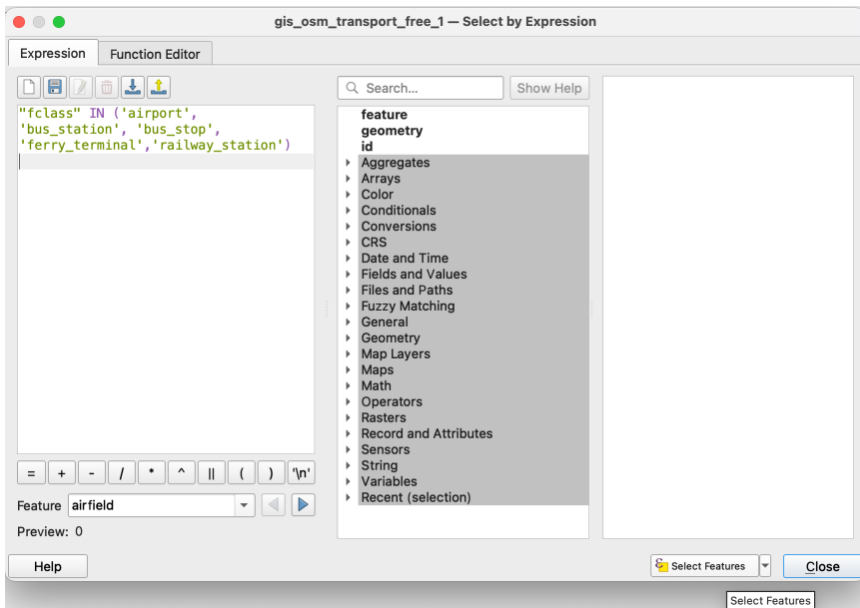
- Health Care → hospital, clinic, doctors, pharmacy

- Commerce → supermarket, convenience, market\_place

- Green Space → park, playground, pitch, playground, sport\_centre

(b) From gis\_osm\_transport\_free\_1.shp

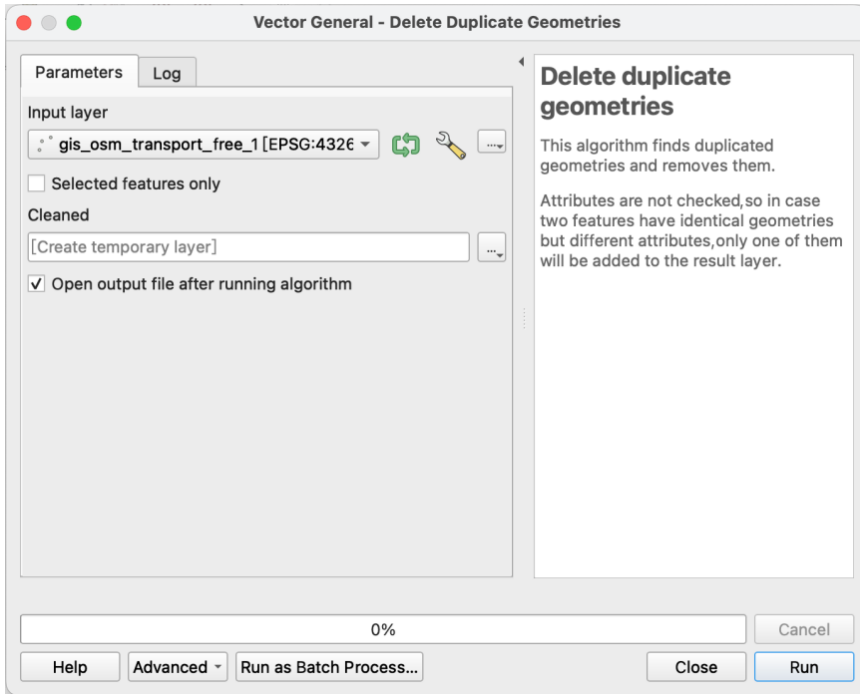
- Public Transport → airport, bus\_station, bus\_stop, ferry\_terminal, and railway\_station



### 3.3 Geometry Operations

#### (a) Delete Duplicate Geometries

- Menu: Processing → Toolbox → Geometry General → Delete Duplicate Geometries
- Purpose: remove overlapping or duplicate POIs to avoid double-counting.

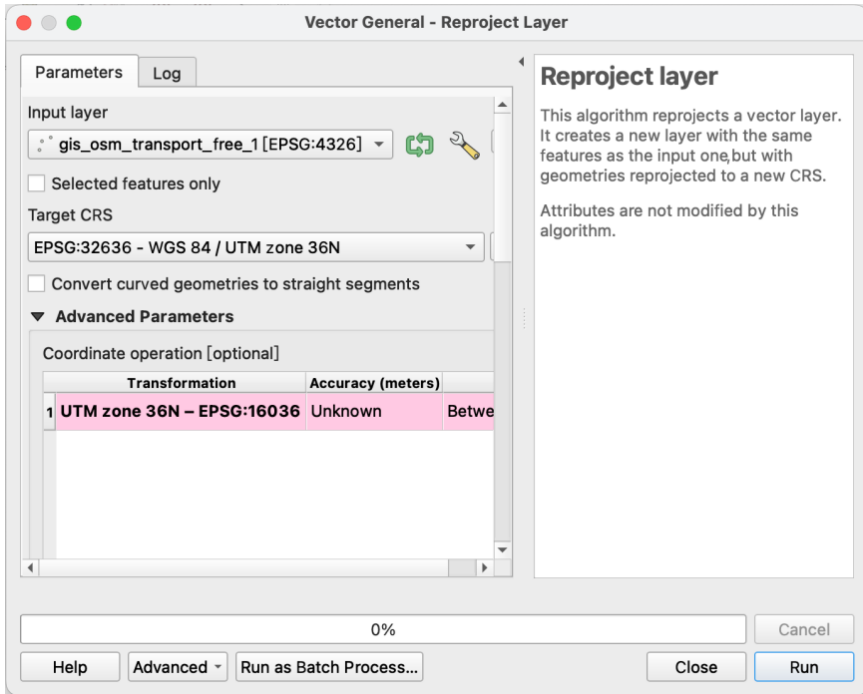


## (b) Reproject Layers

Ghana → EPSG:32630 (UTM Zone 30N)

Uganda → EPSG:32636 (UTM Zone 36N)

Menu: Processing → Toolbox → Geometry General → Reproject Layer

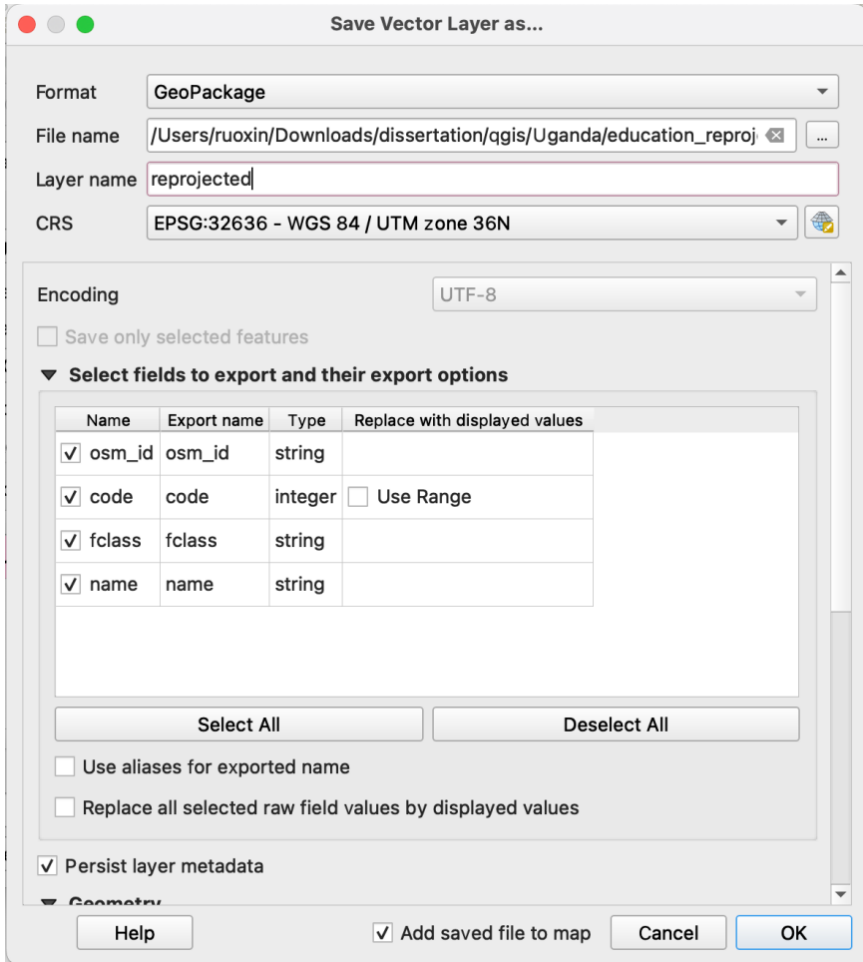


### 3.4 Export to GeoPackage

Export each category as .gpkg

Naming convention: <theme>\_reprojected.gpkg

Example: shop\_reprojected.gpkg, education\_reprojected.gpkg



Save Vector Layer as...

Format: **GeoPackage**

File name: **/Users/ruoxin/Downloads/dissertation/qgis/Uganda/education\_reproj**

Layer name: **reprojected**

CRS: **EPSG:32636 - WGS 84 / UTM zone 36N**

Encoding: **UTF-8**

☐ Save only selected features

▼ **Select fields to export and their export options**

Name	Export name	Type	Replace with displayed values
<input checked="" type="checkbox"/> osm_id	osm_id	string	
<input checked="" type="checkbox"/> code	code	integer	<input type="checkbox"/> Use Range
<input checked="" type="checkbox"/> fclass	fclass	string	
<input checked="" type="checkbox"/> name	name	string	

**Select All** **Deselect All**

☐ Use aliases for exported name

☐ Replace all selected raw field values by displayed values

☒ Persist layer metadata

▼ **Geometry**

**Help** ☒ Add saved file to map **Cancel** **OK**

## **4. Python Analysis Workflow**

RUN the Code in the Github with Jupyter Notebook

4.1 Accessibility Indicators

4.2 Composite Infrastructure Index (PCA)

4.3 Regression Models (OLS & SEM)

4.4 Verification

Outputs included in /outputs/: composite index (CSV), regression results (CSV).

Minor differences may occur if OSM or WorldPop data are re-downloaded.

## **5. Dependencies**

Python 3.10

QGIS 3.42

Packages: geopandas, shapely, rasterio, rasterstats, scikit-learn, statsmodels, pysal, matplotlib