User Manual: Geo-Spatial Dam Site Suitability Analysis

This manual provides a step-by-step guide for any new user to replicate the dam site suitability analysis project. It explicitly details which files are required as **Inputs** and which files are created as **Outputs** for each step, ensuring a clear and understandable project workflow.

1. Phase 1: Data Collection & Initial Processing

This phase covers the initial steps of gathering and preparing the raw data for analysis.

Step 1: Raw Data Collection

- **Purpose:** To download the foundational datasets for your project.
- **Inputs:** None (This is the starting point of the project).
- **Outputs:**
  - **DEM** tiles (from USGS Earth Explorer)
  - **Landsat Level-1** satellite images (from USGS Earth Explorer)
  - **River Network** shapefile (from QGIS QuickOSM plugin)

Step 2: Merging DEM and NDVI

- **Purpose:** To combine multiple raw DEM tiles and individual NDVI rasters into single, continuous maps.
- **Run merge_rasters.ipynb:**
  - **Instructions:** Open the script in Jupyter Lab. Ensure your raw files are in the correct input directories as specified in the script. Run all cells in the notebook.
  - **Inputs:**
    - Raw DEM files in Data/DEM_Raw/
    - Individual NDVI files in Data/Processed_Rasters/NDVI_Individual/
  - **Outputs:**
    - **DEM_Merged_Final.tif**
    - **NDVI_Merged_Final.tif**

Step 3: Reprojection and Hydrological Analysis (QGIS)

- **Purpose:** To convert the DEM to a metric system and derive key hydrological factors.
- **Reproject DEM (QGIS):**
  - **Instructions:**
    1. In QGIS, load **DEM_Merged_Final.tif**.
    2. Go to the top menu and select **Raster > Projections > Warp (Reproject)**.
    3. Set the Target CRS to **WGS 84 / UTM zone 43N (EPSG:32643)** to get a metric DEM.

    4. Save the output file.
  - **Input: DEM_Merged_Final.tif**
  - **Output: DEM_Merged_Final_UTM.tif**
- **Fill Sinks (QGIS):**
  - **Instructions:**
    1. In QGIS, load **DEM_Merged_Final_UTM.tif**.
    2. Go to **Processing > Toolbox** and search for **Fill sinks (Wang & Liu)** under the SAGA menu.
    3. Set the Input DEM to **DEM_Merged_Final_UTM.tif**.
    4. Save the output file.
  - **Input: DEM_Merged_Final_UTM.tif**
  - **Output: DEM_Filled.tif**
- **Calculate Depression Depth (QGIS):**
  - **Instructions:**
    1. Go to **Raster > Raster Calculator**.
    2. Enter the expression: **"DEM_Filled@1" - "DEM_Merged_Final_UTM@1"**.
    3. Save the output file.
  - **Inputs: DEM_Filled.tif** and **DEM_Merged_Final_UTM.tif**
  - **Output: Depression_Depth_Corrected.tif**
- **Hydrological Analysis (QGIS):**
  - **Instructions:**
    1. In QGIS, use the **GRASS > r.watershed** tool on DEM_Filled.tif.
    2. Set a Threshold for stream initiation (e.g., 100).
    3. Save the output files for Flow accumulation and Stream segments.
  - **Input: DEM_Filled.tif**
  - **Outputs:**
    - **Flow_Accumulation.tif**
    - **Stream_Network.tif**

Step 4: Factor Derivation (Python)

- **Purpose:** To calculate the raw factor layers that our model will use.
- **Run NDVI_Calcilation.ipynb:**
  - **Input: Landsat Level-1** files in Data/Landsat_Raw/
  - **Output:** Individual NDVI rasters in Data/Processed_Rasters/NDVI_Individual/
- **Run slope_calculation.ipynb:**
  - **Input: DEM_Merged_Final_UTM.tif**
  - **Output: Slope_Degrees.tif**
- **Run Distance_to_Rivers.ipynb:**
  - **Inputs: River_Data_Final_for_Python.shp** and **DEM_Merged_Final_UTM.tif**
  - **Output: Distance_to_Rivers.tif**

2. Phase 2: Reclassification & Weighted Overlay

This phase takes all the raw factor layers and converts them into a single suitability score.

Step 5: Reclassification (Python)

- **Purpose:** To convert the raw factor values into a standardized 1-5 suitability score.
- **Instructions:** For each of the five Reclassify_*.ipynb scripts, open it in Jupyter Lab, adjust the rules based on your data's histogram, and run all cells.
- **Inputs:**
  - **NDVI_Merged_Final.tif**
  - **Slope_Degrees.tif**
  - **Distance_to_Rivers.tif**
  - **Depression_Depth_Corrected.tif**
  - **Flow_Accumulation.tif**
- **Outputs:**
  - **NDVI_Suitability.tif**
  - **Slope_Suitability.tif**
  - **Distance_Suitability.tif**
  - **Depression_Suitability.tif**
  - **Flow_Accumulation_Suitability.tif**

Step 6: Weighted Overlay (Python)

- **Purpose:** To combine all five reclassified layers into a final suitability map.
- **Run Weighted_Overlay.ipynb:**
  - **Instructions:** Open the script, verify the weights, and run all cells.
  - **Inputs:** All five **_Suitability.tif** layers.
  - **Output: Final_Dam_Suitability.tif**

3. Phase 3: Final Output

This phase refines the final map and extracts the precise dam locations.

Step 7: Final Site Identification (Python)

- **Purpose:** To extract the final dam polygons from the suitability map.
- **Run Final Dam Site Identification.ipynb:**
  - **Instructions:** Open the script, adjust the SUITABILITY_THRESHOLD (e.g., 4.5), and run all cells.
  - **Input: Final_Dam_Suitability.tif**
  - **Output: Final_Candidate_Dam_Sites.shp**, a vector file with your final dam locations.

4. Final Step: Visualization in QGIS

- **Purpose:** To create professional maps of your results for your report.
- **Instructions:**
  1. Load the **Final_Candidate_Dam_Sites.shp** file into QGIS.

2. Overlay it with your base maps, such as DEM_Merged_Final_UTM.tif and Stream_Network.tif, for context.
3. Adjust the symbology (e.g., bright red for the dam polygons) to create a professional map for your report.