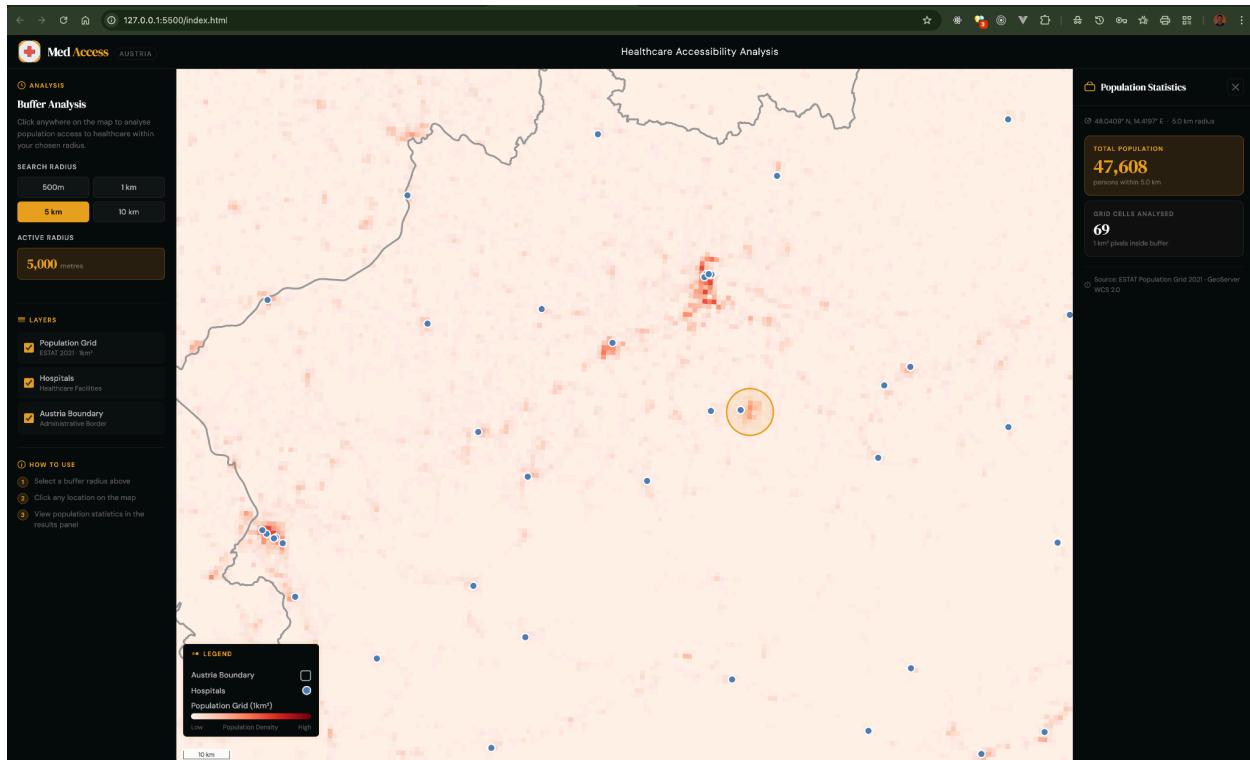


MedAccess Austria

MedAccess Austria is a WebGIS application developed to analyze and visualize accessibility to healthcare facilities across Austria. The application enables users to interactively assess population coverage within user-defined buffer distances around healthcare facilities, providing insights for healthcare planning, policy development, and resource allocation.

The system integrates geospatial data and real-time geoprocessing to estimate the number of population who can have access to healthcare facilities within specified distances (e.g., **500m, 1km, 5km, 10km**).



MedAccess Austria Web Interface

Objectives

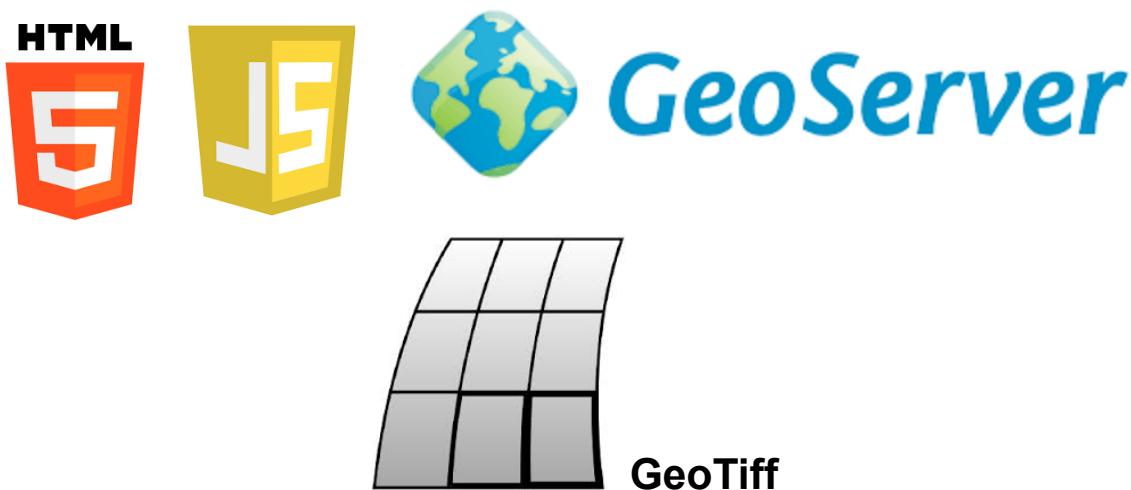
- To analyze spatial accessibility of residents to healthcare services in Austria using a geoprocessing technique
- To estimate population coverage within defined proximity or area to healthcare facilities within Austria.

- To provide an interactive and user intuitive web application to serve as evidence-based healthcare planning and decision-making in Austria .

Note: All codes and resources developed for the project can be accessed on [MedAccess Github Repository](#)

Tools Used

- **HTML:**
 - HyperTextMarkup Language is used to structure the web application interface layout
- **CSS:**
 - Used for styling the webpage, map control appearance, legend and the overall user interface
- **Javascript:**
 - The main language used for implementing the application logic and manipulating user interface based on interactivity.
- **Openlayers(v7.4.0):**
 - Javascript Mapping Library used for rendering the Map and layers
 - To handle user clicks and hover event on the map and buffer generation
 - To integrate the OGC Services (WFS, WMS and WCS) from Geoserver
 - To control map navigation like Zoom in and out, Map reset and Scale
- **Geoserver:**
 - The server engine used to host the datasets and publish the layers for use
 - Serve data via WMS (Web Map Service), WFS (Web Map Service) and WCS (Web Coverage Service).
 - To make buffer bounding box requests for raster pixel value extraction with the Web Coverage Service
- **GeoTiff javascript library:**
 - The library is used for reading and processing the population grid raster received from the Geoserver on the client-side for population estimation.



Technology & Tools used

Data Used

The following raster and vector datasets were prepared with **QGIS** in appropriate formats and uploaded to GeoServer (**Local** and **Online Geoserver**):

- [**Census 2021 Grid Raster \(1 km² \) - \(.tiff\)**](#)
 - Source: EuroStat Population Grid 2021
- [**Healthcare Facilities in geopackage \(.gpkg\)**](#)
 - Source: ESPON Database- Locations of hospitals in Europe 2021
- [**Austria Boundary in geopackage \(.gpkg\)**](#)
 - Source: European data - Administrative Boundaries (VGD) BEV Reference Date 1.4.2023

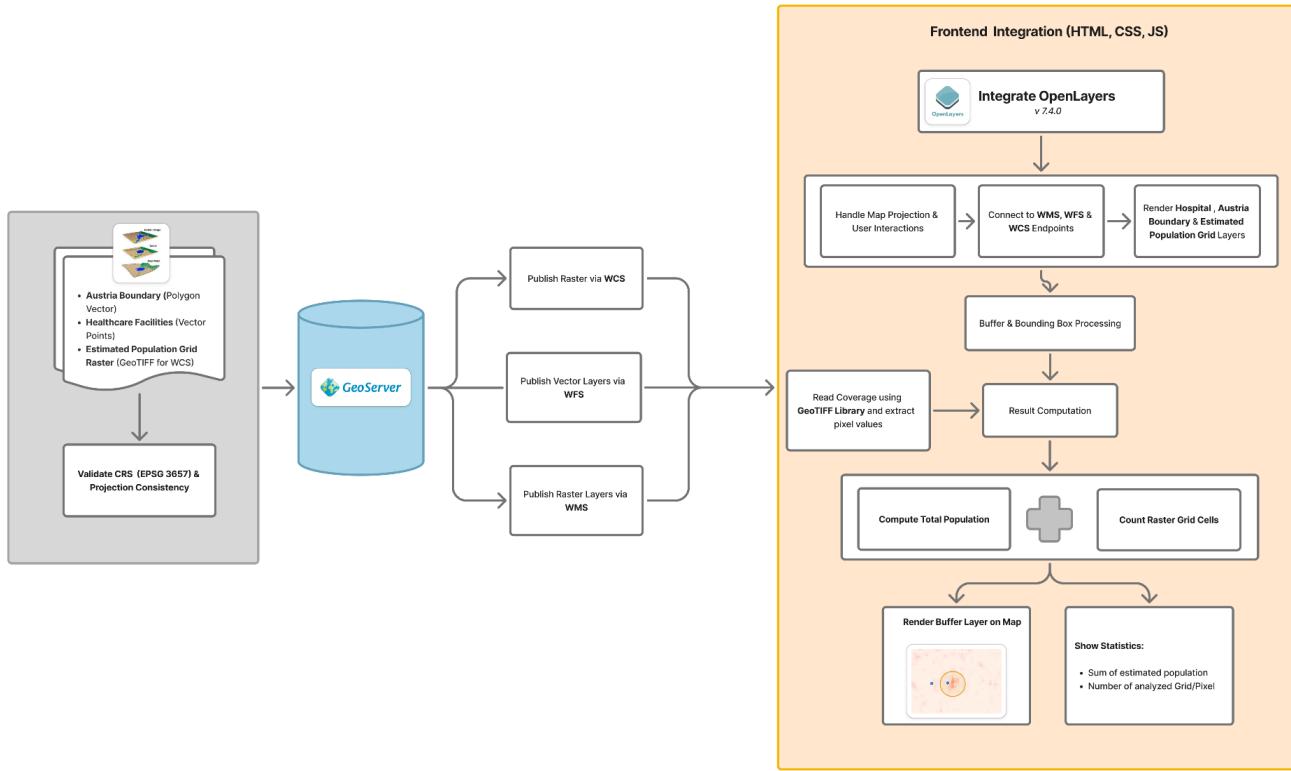
Application Features

- Displays layers: Europe Total Population Grid raster 2021, hospitals in Austria, Austria boundary and OSM basemap layer
- Interactive selection of the buffer (500m, 1km, 5km, 10km).
- Map Controls: Zoom in, Reset map and Zoom Out
- To estimate the population, sum all the values of the raster cell.
- Automatic legend updates depending on selected layers.
- Scale of the map dynamically displayed according to Zoom level.
- Shows buffer zone layer when the user clicks on the map

- Extraction of raster pixel values within the of boundin box the generated buffer zone layer
- Shows the total population and number of raster cell analyzed

Technical Methodology

The methodology used to develop MedAccess Austria follows the structure of first publishing raster and vector datasets with Geoserver and the WebMap integration using HTML, Javascript and OpenLayers (Map library).



Methodology Work Flow

Data Preparation

All datasets were first prepared with **QGIS** in appropriate spatial formats and projected to **EPSG:3857 (WGS 84 / Pseudo-Mercator)**, a standard projected coordinate system for web mapping .

- The **Census 2021 population raster (1 km² grid)** was formatted as a GeoTIFF suitable for WCS publishing.
- To style the raster layer, the style was exported in .sld format which would be used in Geoserver
- Healthcare facilities were prepared as a vector point layer in geopackage format
- The Austria boundary layer was prepared as a polygon vector dataset geopackage format

GeoServer Configuration

In development, a local Geoserver was configured and the prepared layers were added to different stores. To publish the layers from the stores the following OGC Services were enabled: **Web Map Service(WMS)**, **Web Feature Service (WFS)** and **Web Coverage Services (WCS)**.

Separate stores were created for all layers based on the datasets format and the appropriate bounding boxes and coordinate reference system were defined for each.

- The Estimate Population Grid Raster was published with the GeoTiff store
- Austria Boundary and Hospital Layers was published with the GeoPackage store

In the final code submission, the available online **Geoserver** -

<https://geoserver22s.zgis.at/geoserver/> by the school was used to publish only the vector layers for easy access without the need to set up a local geoserver to test the application.

Web Map Integration

The web interface was built using HTML, CSS, and JavaScript. OpenLayers was integrated to perform the following:

- To create the WFS, WMS and WCS url using the server baseurl and layer names

Development:

Geoserver Base URL(Raster Layer) - <http://localhost:8080/geoserver>

Estimated Population Grid Layer -
medaccess_austria:ESTAT_OBS-VALUE-T_2021_V2

Austria Boundary Layer - *medaccess_austria:austria_boundary*

Hospitals Layer - *medaccess_austria:hospital_aut*

Final Code Submission (Production):

Geoserver Base URL (Vector Layer) -

https://geoserver22s.zgis.at/geoserver/ipsdi_wt25/

Geoserver Base URL(Raster Layer) - <http://localhost:8080/geoserver>

Estimated Population Grid Layer -

medaccess_austria:ESTAT_OBS-VALUE-T_2021_V2

Austria Boundary Layer - **ipsdi_wt25:at_boundary**

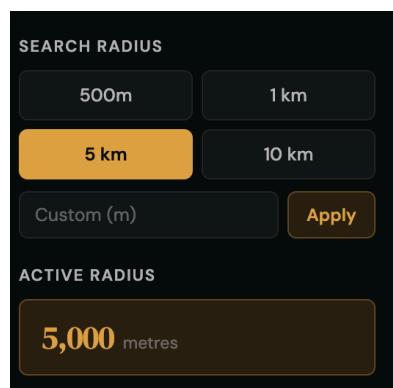
Hospitals Layer - **ipsdi_wt25:hospitals_AT**

- To render layers dynamically and ensure users can make each layer visible or not.
- To maintain map projection and coordinate for all layers.
- To handle all kinds of spatial interactions, buttons and such as click, hover events and rendering of results after necessary computations.

Buffer and Bounding Box Processing

When a user toggles a buffer distance and clicks on the map or exactly at one of the hospital points, Open Layer helps to perform the following;

- Using the active radius size i.e either **500m, 1km, 5km or 10km**, it generates a buffer geometry immediately on the map around the selected point or location on the map



Buffer radius selection

- To perform the buffer analysis and population the geometry boundary box (bbox) is then calculated and used to create a Web Coverage Service request of the ***ESTAT_OBS-VALUE-T_2021_V2 raster layer***

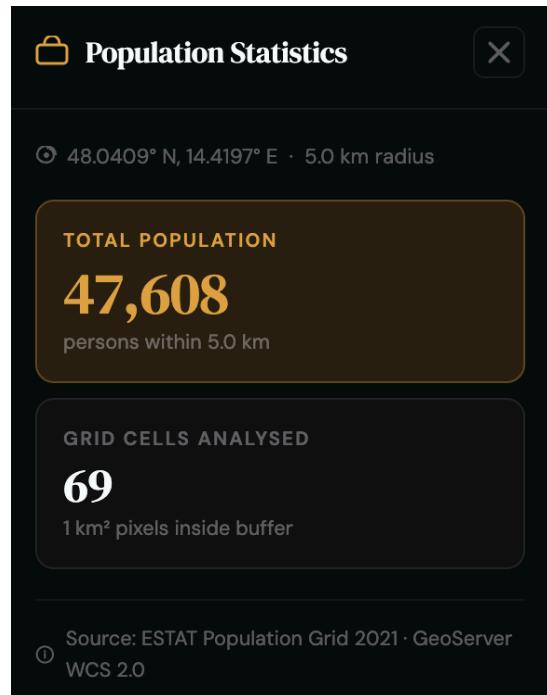
Raster Data Retrieval and Processing

Once the Web Coverage Service request is successful and retrieves the pixels within the buffer bounding box, the external **GeoTIFF** library is used to read the raster one by one to extract the pixel values (representing population per 1 km² grid cell). Finally, all pixel values are then summed up to calculate the total population within the buffer zone.

Result Computation and Display

To display the computed total population value computed, a side panel display is the populated with information to show the following

- Estimated Total Population
- The total number of raster grid cells analyzed.
- The buffer zone is overlaid on the map .



Side panel display

Challenges

Based on the initial idea of the project, I planned to use Web Processing Service (WPS) to perform the buffer analysis and calculate the estimated population value on the Geoserver but this method requires the following:

- Install the Web Processing Service (WPS) Plugin on the Geoserver
- Install the **gs:BufferFeatureCollection** facility points and **gs:ZonalStatistics** on the geoserver
- A good knowledge of writing a dynamic **XML** document for performing this process
- To properly handle raster data retrieval using the Web Coverage Service method.
- To ensure accurate buffer bounding box extraction for population estimation from the raster.
- To optimize the performance for real-time geoprocessing because it is all done on the client side.

AI Use Disclaimer

Artificial Intelligence tools were used to generate the initial page layout and CSS styling and also to understand how to sum up pixel values from the EstimatePopulationGrid raster layer using GeoTiff javascript library. The generated result was reviewed and modified to meet the need for the WebGIS Application

Conclusion

MedAccess Austria application shows how WebGIS can be combined with geo-processing to support spatial accessibility analysis of hospitals in Austria. However this method can easily be employed in any type of buffer analysis. The application also provides a scalable and interactive solution for healthcare accessibility assessment and spatial decision support for authorities in the health sector in austria.