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CeTLeR
Centre for Tourism and Leisure Research

Behind the MIRANDA tool – A technical report on a decision support tool for tourism and travel investments

Omar Alnyme

Tobias Heldt

Daniel Brandt

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Abstract

This report provides a brief explanation of the MIRANDA tool and its links to the D.U.GIS platform. The report also presents system components and data sources used within the MIRANDA tool.

The starting point for the development of the MIRANDA tool has been the call for better understanding of the scale and scope of tourism at the local and regional levels. The purpose of the MIRANDA project was to develop a micro-based decision support to be used by public planners for more efficient and sustainable decisions regarding infrastructure investments in connection with destination development.

This report gives a brief introduction to the project before starting out with an overview of the MIRANDA-tool's software architecture. This is followed by a description of the Coding languages, a section giving information on the Class libraries, as well as the type of data used. Following this are two sections describing APIs and the system model, before a final section concludes by giving an outlook for future development options for the MIRANDA tool.

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1 Introduction

Calls for better understanding of the scale and scope of tourism at the local and regional levels have led to the MIRANDA project being set out, with the purpose of developing a micro-based decision support to be used by public planners for more efficient and sustainable decisions regarding infrastructure investments in connection with destination development.

The project's further developed model has enabled better forecasts of local and regional effects of tourism, which has contributed to an increased understanding of the national effects of tourism to be used for planning infrastructure investments linked to tourism.

The intention of this report is to provide a brief explanation of the MIRANDA tool and its links to the D.U.GIS system.

Early on in the project, a need for different data from various sources was identified as essential; then, integrating these different data sources into a single view was considered essential in order to be able to perform the required analysis, and these requirements led to the birth of the D.U.GIS system.

The D.U.GIS system was developed in-house by the MIRANDA research team. The system contains several components, including a mapping engine, an MSSQL database to store all the GEO data and the economic data, an IIS server that hosts the custom-developed API's and the mapping engine.

The D.U.GIS application is supported by two other sub-Systems:

- An online GEO database sub-system (developed by the researcher team) that is used to perform data quality checks on the companies and workplaces data that are stored within the MSSQL database.
- Data configuration sub-system, used to set tourism shares by SNI, and configure the survey values.

The main result of the MIRANDA project is a methodology for data collection including a model for describing effects, as well as a BI tool for visualizing tourism volumes and effects. The project's results are expected to be able to meet the need of planners at several levels to be able to better describe both the business and socio-economic effects of tourism. Heldt et al. 2022 provides a description of the MIRANDA tool from a user perspective[1].

The remainder of this report is structured as follows. The next section presents the components and data sources used within the MIRANDA tool. The report then provides a software architecture overview, a description of the Coding languages, and information on the Class libraries as well as the type of data used. There are also two sections describing APIs and the system models.

[1] Heldt, T., Alnyme, O. and Brandt, D. (2022) MIRANDA 1.0 – Ett beslutsstöd för hållbart turismresande och infrastrukturplanering. CeTLeR report no. 2022:3, Borlänge, Sweden.

2 System architecture overview

This section will describe the system context, high-level view of the user interaction, and data flow.

2.1 System Context

The D.U.GIS system major components, subsystem, and external interfaces are outlined in Figure 1. The D.U.GIS sub-system's and its submodules, and components are represented inside the red container.

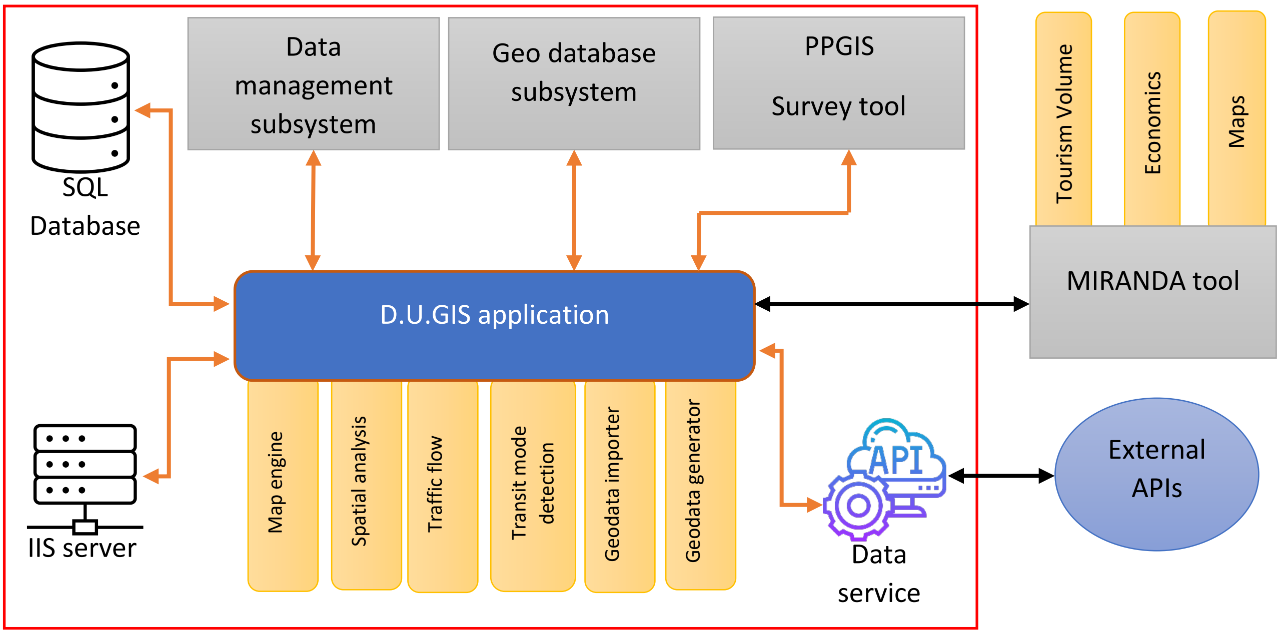


Figure 1. Context diagram of the D.U.GIS system

2.2 User interactions

The high-level view of the user interaction with D.U.GIS system is shown in Figure 2. The computer contains the application that will be used by the urban planners. The application will connect to the data access layer to access the system database and connect to the IIS server to access the GIS engine to perform the spatial and statistical analysis. The application can access the D.U.GIS servers and services from anywhere using Internet access.

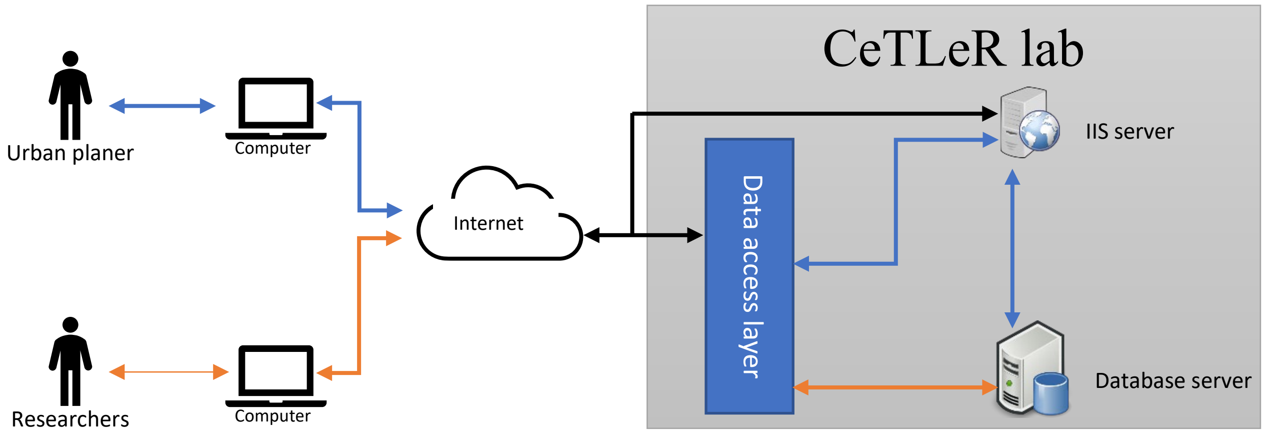


Figure 2. User and researcher interaction with the D.U.GIS system

2.3 Data flow

The basic flow of data into and out of the system and its sub-systems at a high level is shown in Figure 3. The D.U.GIS system deals with data creation, data importing from different sources, and storing it temporarily for analysis purposes. There are two types of data: data that are imported on request using APIs and data that are stored locally within the system database server.

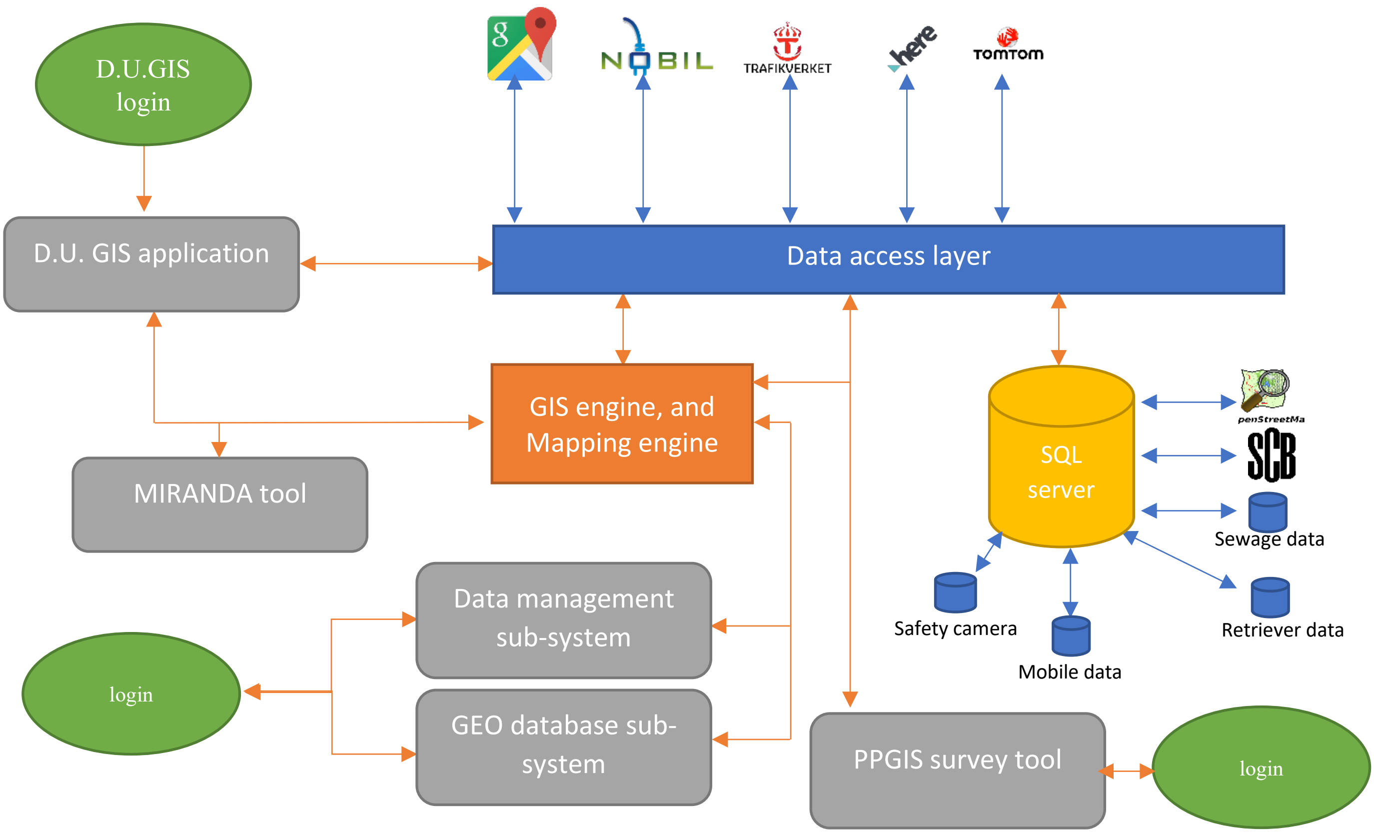


Figure 3. Data flow

3 Software source code languages:

Different coding languages were used combined in the development of the D.U.GIS system:

- C#
- C++
- JavaScript
- jQuery
- HTML
- CSS
- XML
- AJAX (Asynchronous JavaScript and XML)
- SQL script

As for the development environment, Visual Studio has been used, which is an integrated development environment from Microsoft.

4 Class library

The Class Library (DLL) contains program code, data, and resources that can be used by other programs and easily implemented into other projects.

The application uses one external library and two libraries that are custom developed by the MIRANDA engineers.

List of used DLLs:

- Leaflet v1.8.0. The Leaflet is the leading open-source JavaScript library for mobile-friendly interactive maps.
- GIS v1.1. Developed in-house by the MIRANDA engineers, the DLL provides all the required GIS spatial analysis techniques (clustering, grid analysis, route, reachable range analysis, distance analysis, and buffer analysis) that are required to answer the project research questions.
- Statistics v1.2. Developed in-house by the MIRANDA engineers, the DLL provides all the statistical analysis techniques that is required by the application different models.

5 Type of used data and their sources

The system is connected to several different data sources, some of which are imported and saved on the system database server, and others are imported as they are requested using the APIs.

This section will present the different data sources that are connected to D.U.GIS system.

5.1 Google

D.U.GIS system integrates google place API within its data access layer. The different data places that can be imported is found at this link.
https://developers.google.com/maps/documentation/places/web-service/supported_types

5.2 Nobil

The system integrates Nobil API within its data access layer. The API provides information regarding vehicle charging stations.

5.3 SCB

Data are downloaded, restructured, and imported into the system database server. Data types that have been extracted are:

- Statistics on the population registered that are distributed on square kilometres of space.
- Holiday homes. A holiday home area is a concentrated development with at least 50 holiday homes and a maximum of 150 meters between the holiday homes. Holiday homes are detached houses without a population register, where the type of code is:
  - 120 (agricultural unit, built-up area)
  - 213 (detached house, building value < SEK 50,000)
  - 220 (detached house unit, year-round housing)
  - 225 (building on undeveloped land/other land)
- Trading area. Statistics Sweden's retail trade areas are concentrations of local units with the industry code SNI 47 Retail trade, which together form a geographically delimited area, consisting of:
  - At least five retail trade enterprises, or
  - Four retail trade enterprises, together having at least 100 employees

- Lodging details:
    - Guest nights
    - Arrivals

5.4 Sewage data

Data are obtained from the various sewage facilities and include polygon presenting the sewage operation area, daily flow and BOD7.

5.5 Mobile data

Population data that are aggregated from mobile data and provided by Telenor. The data are stored at the system database server.

5.6 HERE Technology

The system uses the two following APIs from HERE.

5.6.1 HERE Geocoding & Search API

The API provides information regarding places (POIs). For a list of places that can be imported, click on the following link: https://developer.here.com/documentation/geocoding-search-api/dev_guide/topics-places/places-category-system-full.html

5.6.2 Transit API

Used to discover stations and next departures of transit services around a given location, and calculate the most efficient and relevant transit routes between a given pair of locations.

5.7 Trafikverket

Two types of techniques are used to extract data from Trafikverket:

- On request using the API:
    - Road condition data
    - Situation data
    - Weather station
- Data that are downloaded and imported into the system database server:
    - Safety camera, vehicles flow data
    - ÅDT (traffic flow)

5.8 Open street data

The data are downloaded, restructured, and imported into system database server. The data are updated every six months.

Data types that are provided:

- Places. Types of places that are available can be found at this link: https://wiki.openstreetmap.org/wiki/Map_features#Accommodation
- Land use
- Road network
- Railway network
- Buildings
- Waterway

5.9 Retriever Business

Companies and workplaces information categorized by SNI have been downloaded, restructured, and imported to the system database server. The data will be updated yearly.

5.10 Safety camera

Data provided by Trafikverket. Used in traffic flow module to provide traffic flow within the selected camera. The data present vehicle counts with 95 percent confidence.

6 APIs

The system communicates with the database server and the various online data services through a set of APIs. The DU API is developed in-house and through this API the system sends requests to different online data sources using their designated APIs. See Figure 4.

List of used APIs:

- DU API: Used by the D.U.GIS system to connect to the system database and to several external APIs
- Google place API
- HERE Geocoding & Search API
- HERE transit API
- TomTom place API
- Trafikverket APIs
- Nobil API

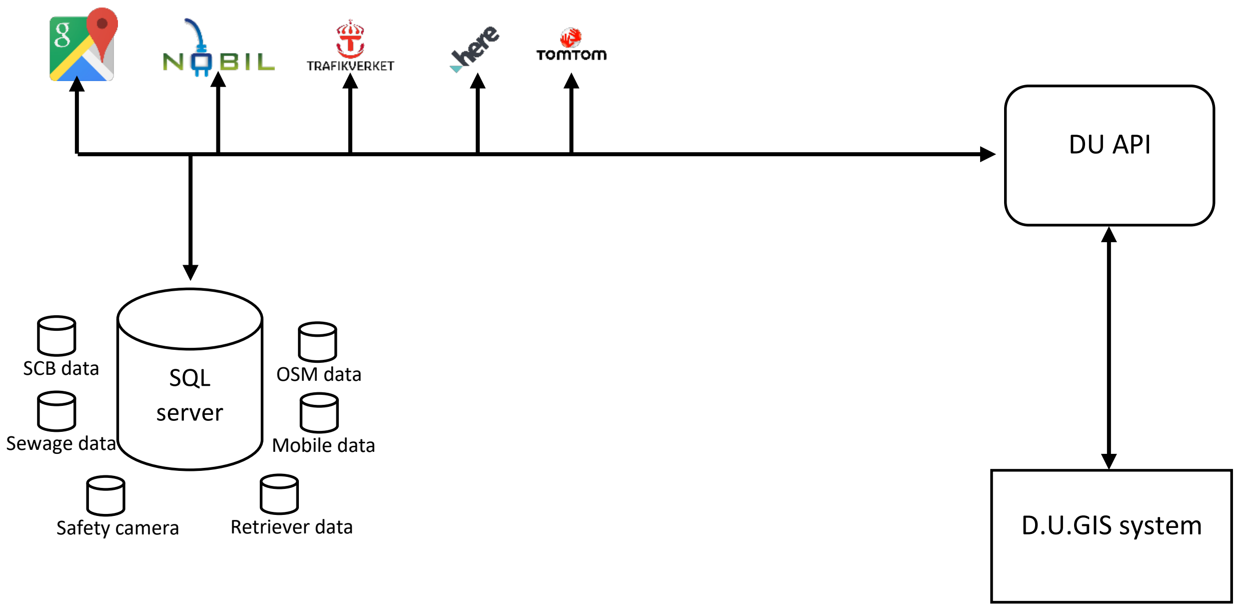


Figure 4. API connection flow

7 System modules and subsystems

This section explains the system's different modules and subsystems and provides a brief explanation of the functionality of each module.

7.1 GEO analysis module

The module gives the users the ability to perform different spatial analysis techniques using GEO data that are obtained from the local and the different online data sources.

7.1.1 Buffering analysis

Users can perform buffer analysis (with a selected radius) on any type of point of interest: hotels, schools, bus stops, hospitals, etc.

For demonstration purposes, we will perform a study to investigate the availability of EV charging stations within a 250m radius of each lodging that is located at Helsingborg. Figure 5 is a screen capture of the D.U.GIS system buffer analysis page.
The results show that there are 55 different lodgings and 59 EV charging stations within Helsingborgs stad. Of the 55 lodgings, only 25 (45.5 percent) contain EV charging stations within its 250m radius, and only 16 of the 59 EV charging stations (27.1 percent) are within a lodging 250m radius. In conclusion, Helsingborgs stad needs to improve its EV charging schemes to include the tourism industry as a factor. See Figure 5.

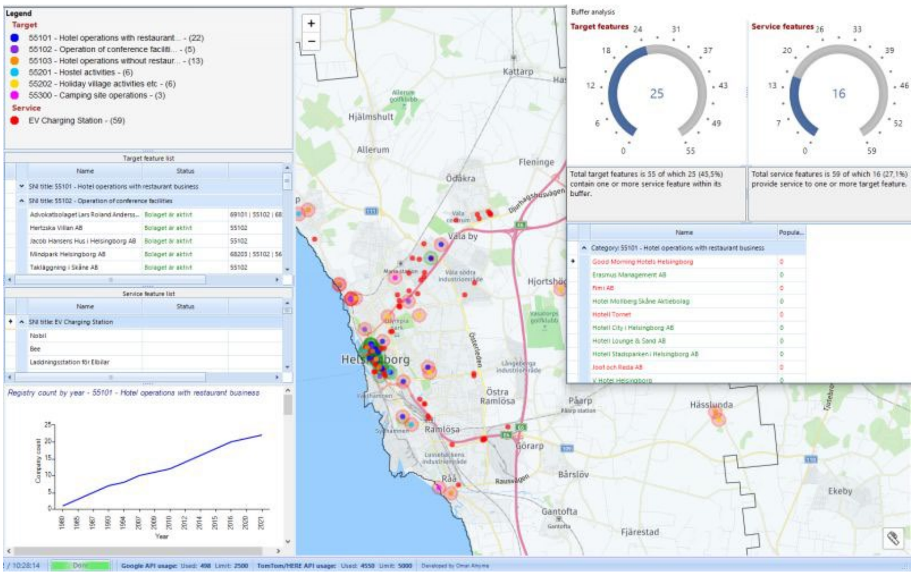


Figure 5 Buffer analysis

7.1.2 Grid analysis

Used to analyze large spatial data sets, it partitions geographic areas into identifiable grid cells. For example, to divide a large region into smaller units for indexing purposes or slice the geographic area into subunits over which we want to summarize a spatial variable.

The module is comprised of squares and hexagons. Users can perform grid analysis (with custom diagonal) on any type of point of interest: hotels, schools, bus stops, hospitals, etc.

Figure 6 is a capture screen of a Hexagonal Grids analysis with a 500m diagonal on the lodging industry in Stockholm.

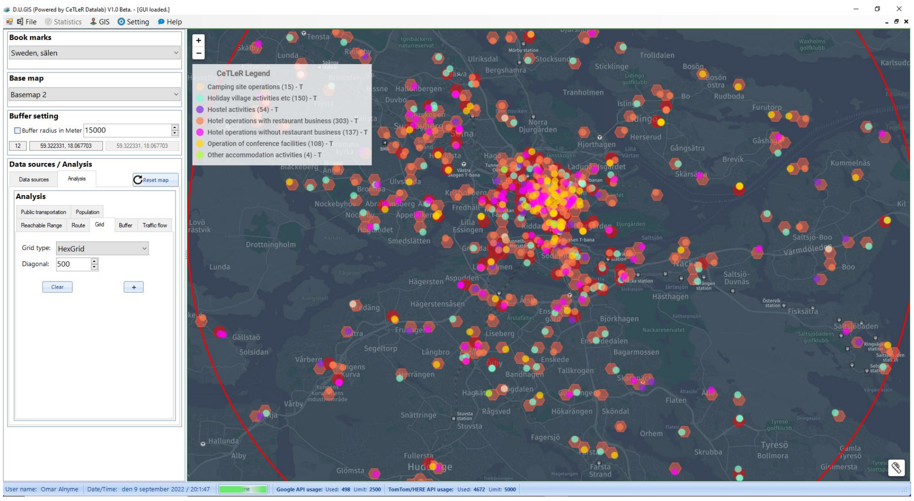


Figure 6. Hexagonal grids analysis

7.1.3 Reachable reach analysis

Users can perform reachable range analysis to identify the distance that a person can reach using different types of transit within certain periods. Certain parameters can be set to customize the analysis:

- Route type. The provided options:
  - ✓ Fastest
  - ✓ Shortest
  - ✓ Eco
- Transit mode. The provided options:
  - ✓ Car
  - ✓ Truck
  - ✓ Taxi
  - ✓ Bus
  - ✓ Motorbike
  - ✓ Bicycle
  - ✓ Pedestrian

- Traffic data. Either to include or exclude traffic data in the route aggregation.
- Departure or arrival date and time.

Example: Reachable range analysis from Stockholm center station is performed, transit type is pedestrian and for the time periods 5, 15, and 30 minutes. The distance for each period is presented with a different color polygon. The results are shown in Figure 7.

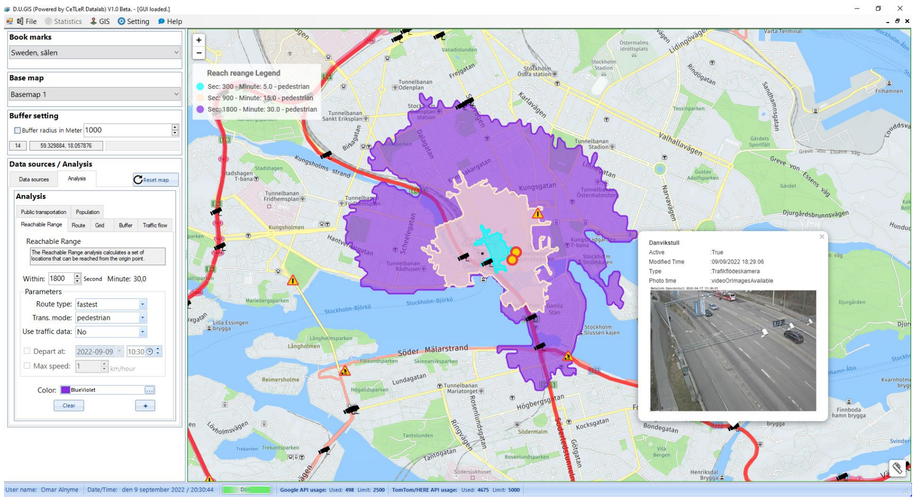


Figure 7. Reachable range analysis

7.1.4 Route analysis

Route analysis can be performed between two points on the map, with the provided parameters the user can customize the analysis according to his needs. The parameters are:

- ✓ Route departure and arrival points
- ✓ Route type:
  - Fastest
  - Shortest
  - Eco
- ✓ Max Alternatives. Here users can enter number of routes to be generated and displayed, values are from 0–3.
- ✓ Use traffic data. Either to include or exclude traffic data in the route aggregation.
- ✓ Departure date and time, or
- ✓ Arrival date and time
- ✓ Vehicle max speed
- ✓ Vehicle commercial. To identify whether the vehicle is a commercial vehicle or not. This means that the vehicle is either allowed or not allowed on certain roads depending on the selected option.

Figure 8 is a capture screen for the route analysis that is generated by the system.

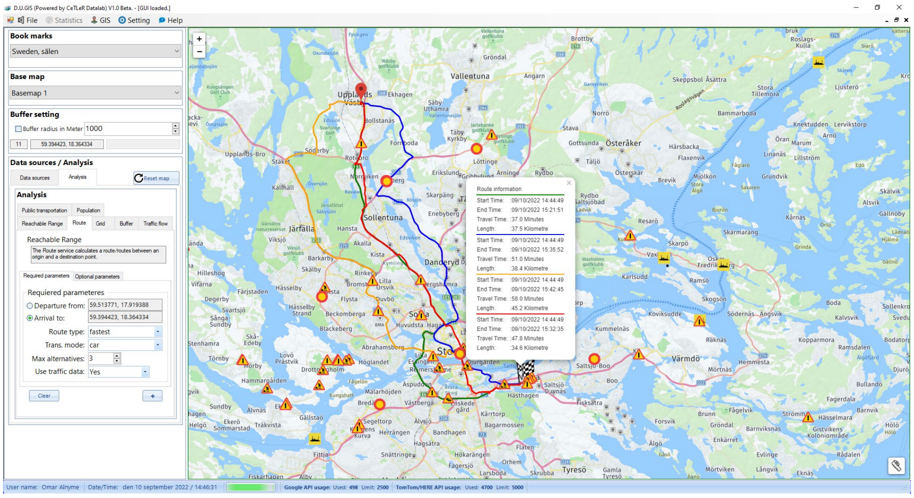


Figure 8. Route analysis

7.1.5 Population analysis

Allows users to perform spatial analysis between population and POIs; for example, public transport availability (bus stops) for each one square kilometer of population.

The results will be displayed as population squares with different border coloring; if the square contains one or more bus stops, then the square border will be colored green, as the count of bus stops increases the darker the green is (see Figure 9).

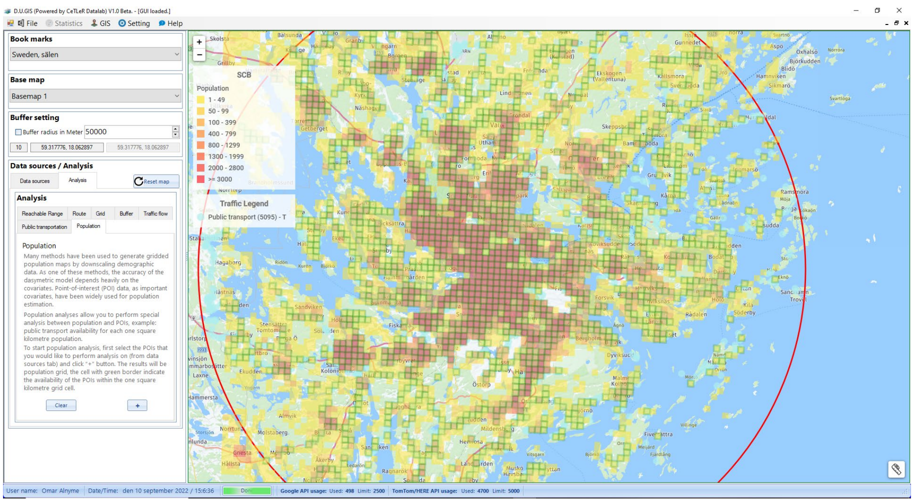


Figure 9. Population analysis with bus stops

7.1.6 Public transport stations analysis

Users can request a list of public transit stations within a given geo-location (maximum of 50 bus stops per request). The results also show a list of transit lines operating from those stations, as well as the direction (or head-signs) of these services (see Figure 10).

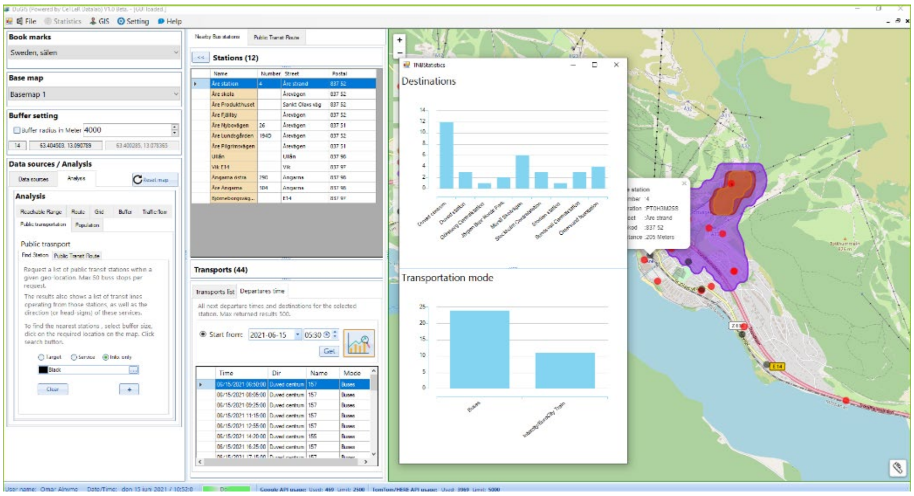


Figure 10. Public transport stations analysis

7.1.7 Public transport routing analysis.

Users can request a public transit route between any two points on the map. The required parameters are as follows:

- ✓ Departed point
- ✓ Arrival point
- ✓ Departure date and time, or
- ✓ Arrival date and time

7.1.8 Traffic flow analysis on specific road section

Users can request for current traffic status for specific section of a road (see Figure 10). The provided data are:

- ✓ Travel speed
- ✓ Current travel time
- ✓ Travel distance

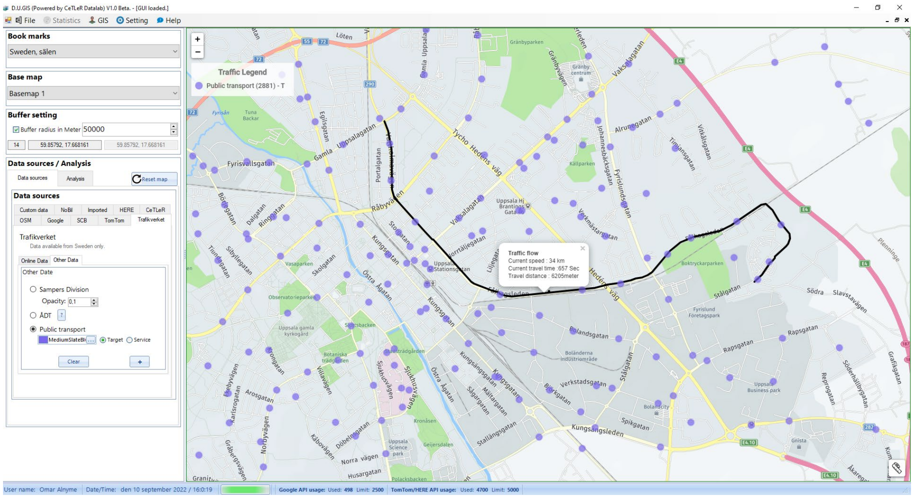


Figure 11. Traffic flow analysis on a specific road section.

7.1.9 Import external data

Users can import their data into the system. The user can set the color of the imported features either manually, by selecting a specific property that holds the feature color, or even from a selected property value and divide it into equal intervals of the certain value entered by the user.

Users can also select specific properties to be displayed when the feature has been clicked.

Users can perform filter and math aggregation on certain properties within the imported GeoJSON file.

7.2 Traffic flow module

The module is divided into two submodules, each of which uses different types of data sources for the flow analysis.

7.2.1 Using GPS data

Using GPS data that is imported from TomTom using the API, the module provides real-time traffic analysis for the selected area on the map.

There are two types of analysis absolute and relative. Figure 12 shows a relative traffic flow analysis for the center of Stockholm.

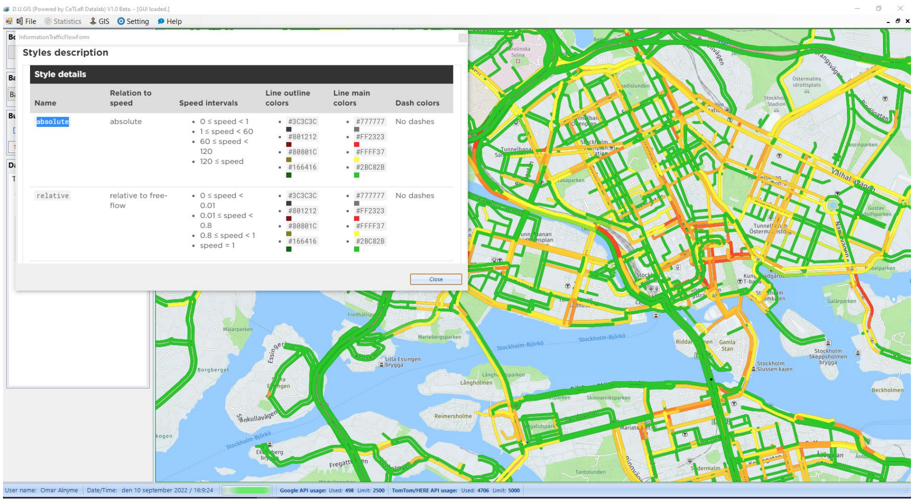


Figure 12. Relative traffic flow analysis using GPS data for center Stockholm

7.2.2 Using safety camera data

Provides traffic flow analysis using safety camera data that is provided by Trafikverket. The user selects the region of interest and the module will project all the available safety cameras within the selected regions with its pointing bearing (see Figure 13).

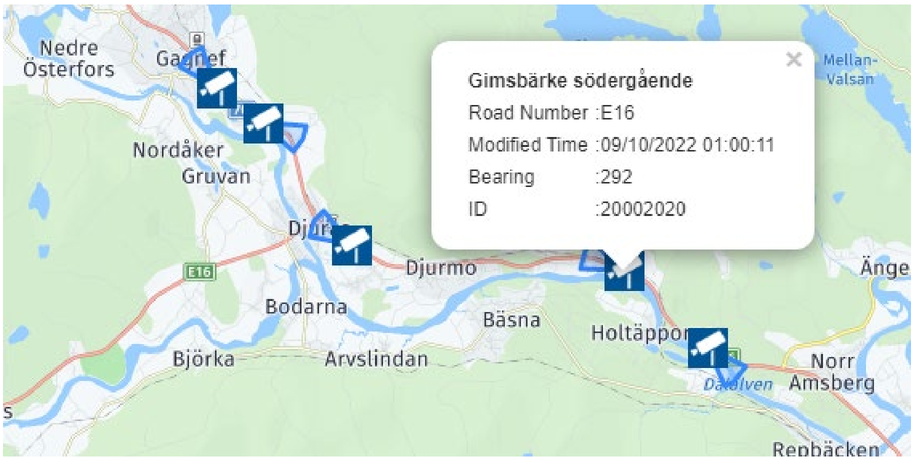


Figure 13. Safety camera projection

By clicking the camera, a new popup window will show that will provide hourly, daily, and monthly vehicle flow count (see Figure 14).

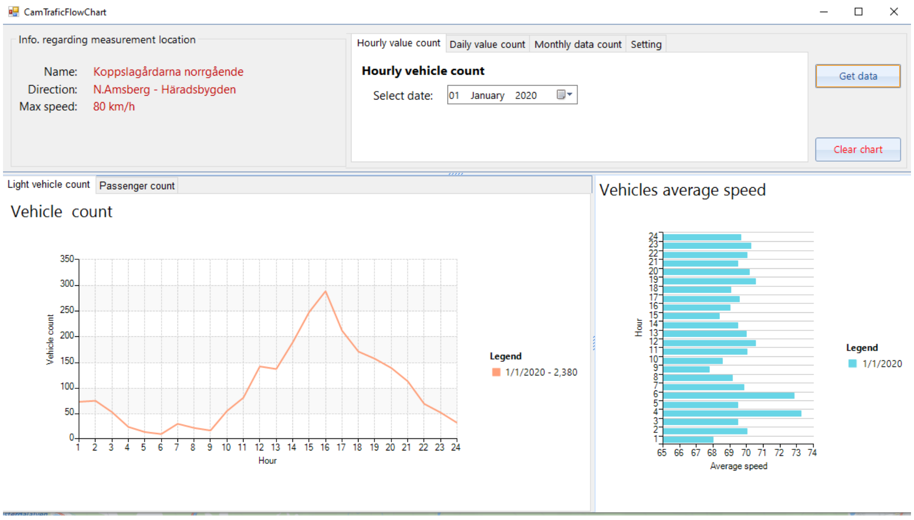


Figure 14. Hourly vehicles count for the selected camera.

7.3 Tourism volume

The module makes use of three types of data sources (SCB, Sewage, and Mobile data) to estimate the tourism volume categorized by municipality and year.

7.3.1 Data from SCB

The data are extracted from Statistics Sweden. The analysis provides monthly and yearly total guest nights, total arrivals, and average nights stayed per arrival.

Type of analysis:

- By one municipality for one year
- By one municipality for several years
- By more than one municipality per one year

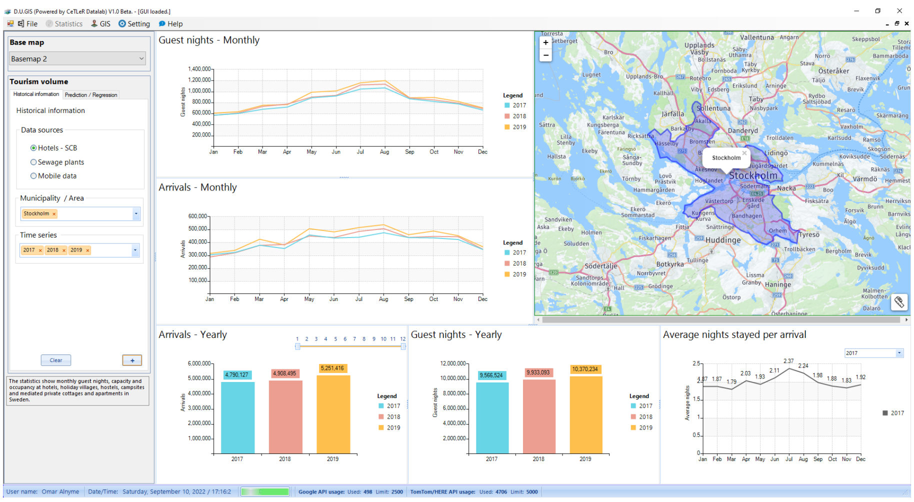


Figure 15. Tourism volume using data from SCB

Tourism volume for Stockholm for year 2017, 2018, and 2019 are shown in Figure 15.

7.4 Sewage data

The data are provided by sewage facilities; using this data, the module aggregates the weekly average population categorized by year.

Figure 16 shows the resulting analysis for the population from three sewage facilities (Kläppen, Stöten, and Sälfjället).

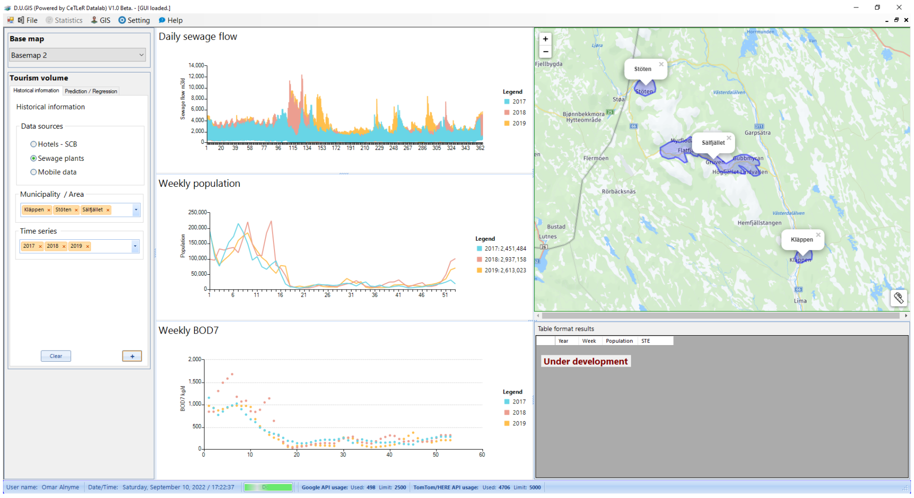


Figure 16. Tourism volume using sewage data

7.5 Mobile data

Using the mobile data provided by Telenor, the module provides the total daily population for a certain selected period that is categorized by area, and selected population type (total, work, home, or others).

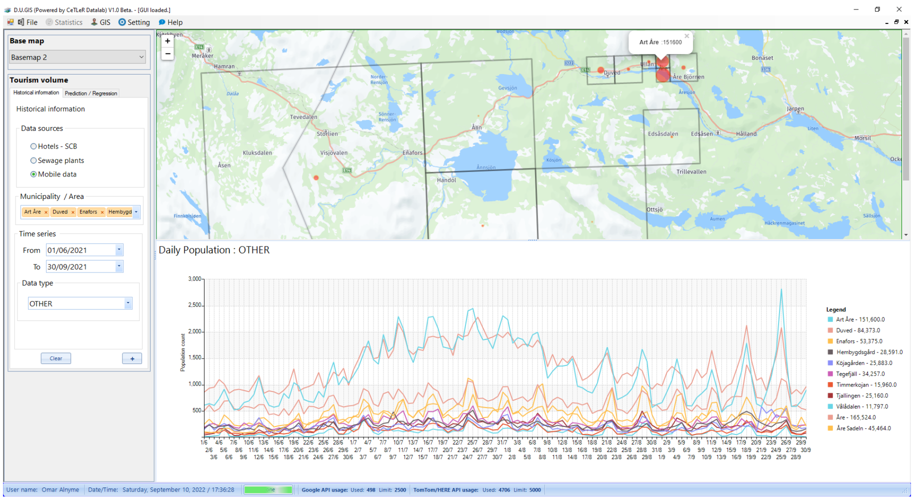


Figure 16. Daily tourism volume using mobile data

7.6 Geo database subsystem

Used by subject experts to perform data quality checks.

7.7 Data management subsystem

The module is mainly used by researchers to configure:

- Tourism shares for each SNI code and location
- Configure the survey data

7.8 GEO data generator model

Creates new geodata for simulation purposes. The newly created data can be shared with other system users by the data owner.

7.9 Economic module

The module is divided into two submodules, each of which works with a different set of data:

- *Subvmodule1* uses data that is imported from the retriever business
- *Submodule2* integrates data from the tourism volume module with survey data

7.9.1 Submodule 1

The module aggregates economic effect by using two spatial analysis techniques, either by using custom selected area or clustering.

The module also includes other spatial analysis techniques (buffer analysis, grid analysis, and Voronoi analysis).

7.9.1.1 Custom area selection

Select an area by drawing a polygon around the area of interest using the drawing tool; see Figure 17.

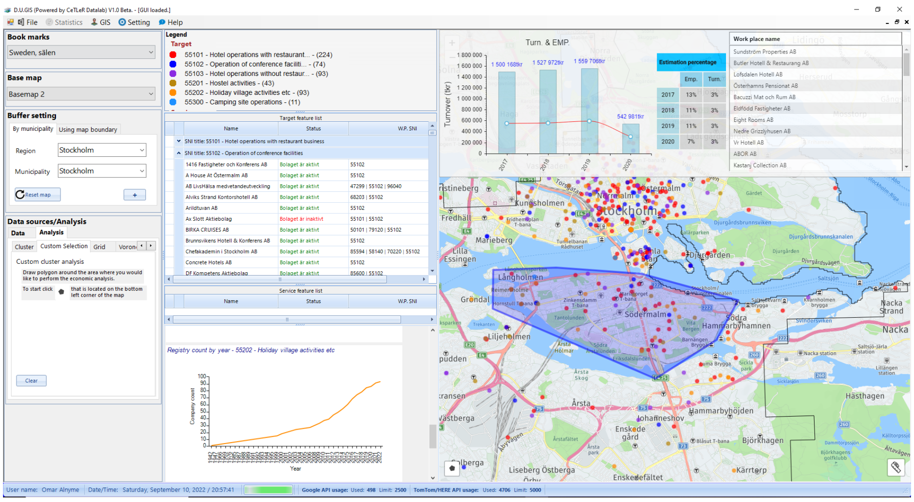


Figure 17. Economic analysis using custom selected area

7.9.1.2 Clustering

There are two types of clustering algorithms that are available within the system:

- ❖ DBSCAN
- ❖ OLA: (Developed in-house by MIRANDA engineers

There are two input parameters for the clustering algorithm:

- ✓ EPS: Distance between each node to consider them as neighbors
- ✓ Min point. minimum neighbor nodes to be considered as a cluster.

The clustering is evaluated using Silhouette coefficient and Dumm index (see Figure 18).

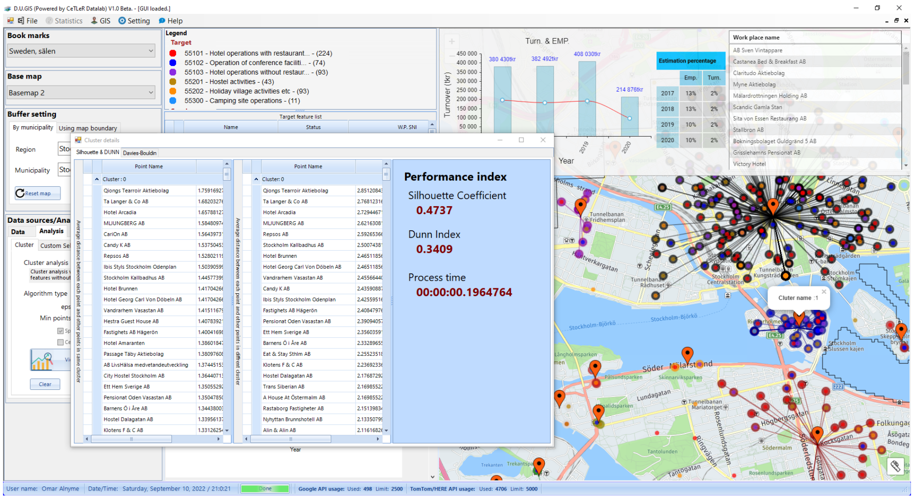


Figure 18. Economic analysis using clustering with 300m EPS and 2 as min points.

7.9.1.3 Buffer analysis

The buffer analysis provides spatial analysis between different types of POIs, such as bus stop availability for schools (see Figure 19). The buffer analysis can also be used to identify the population count within certain radius from selected POIs; for example, identify population count within 1 200m from each school within Falun municipality (see Figure 20).

The module will also identify type of population (male, female, age group) within certain radius of each selected POIs, this option is still under development.

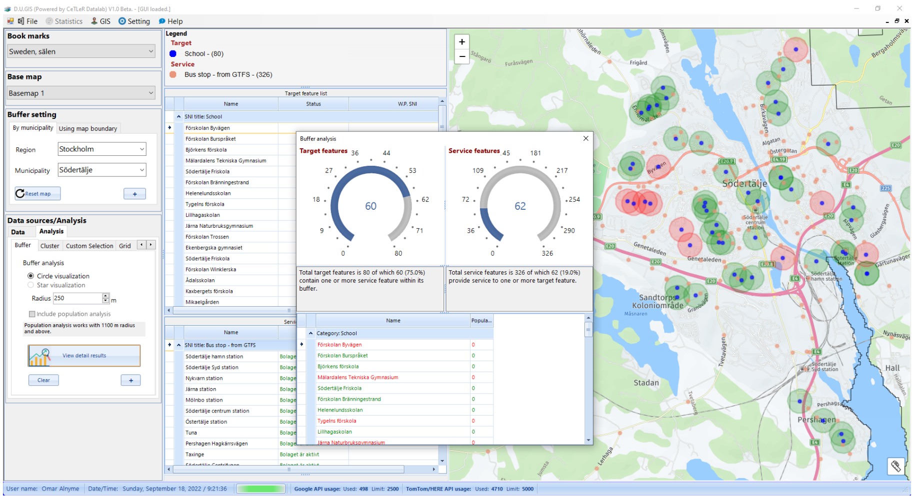


Figure 19. Buffer analysis between schools and bus stops within Södertälje.

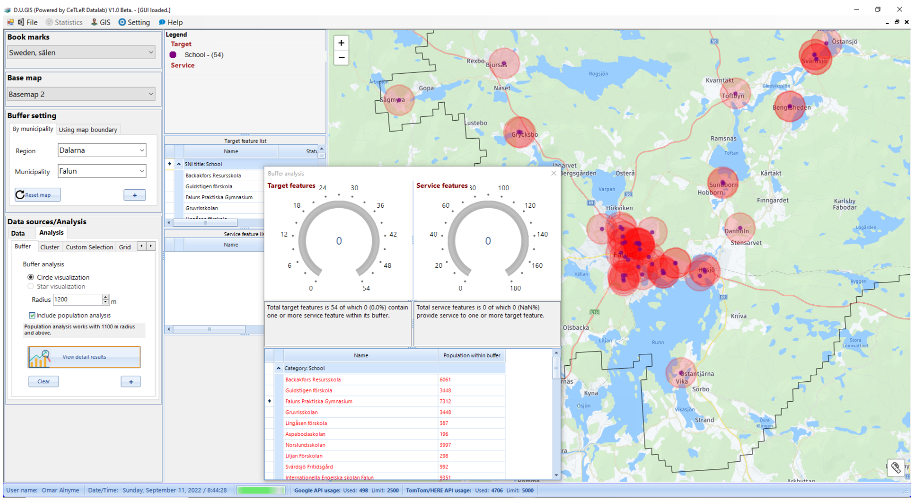


Figure 20. Population counts within each buffer.

7.9.1.4 Grid analysis

There are three parameters that need to be set: grid type, grid cell diagonal and color segments. The results will be grid cells with different color depending on the POIs count within each grid cell (see Figure 21).

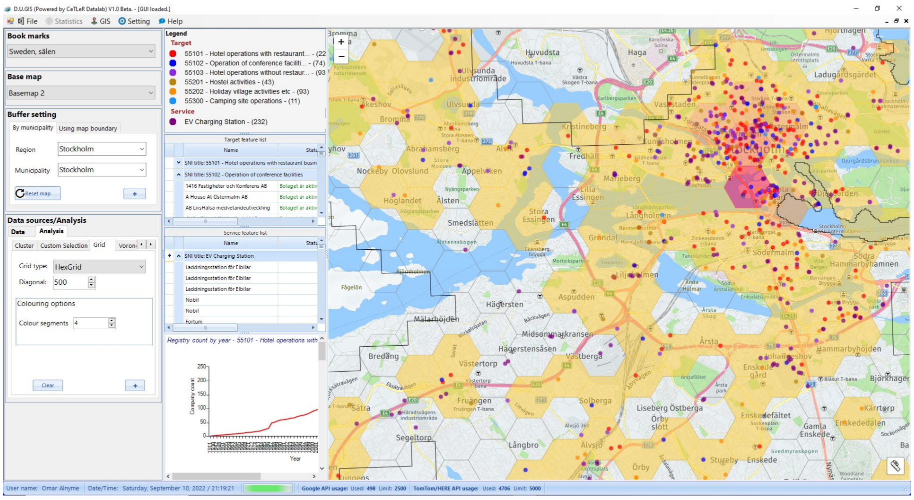


Figure 21. Hexagonal grid analysis with 500m diagonal and 4 color segments

7.9.1.5 Voronoi analysis

Under development.

7.9.2 Submodule 2

The module aggregates the weekly/monthly economics values by integrating data from both the tourism volume module and the research survey data. The results are shown in Figure 22.

The module displays economic effects on yearly bases, weekly bases, and for a custom selected period.

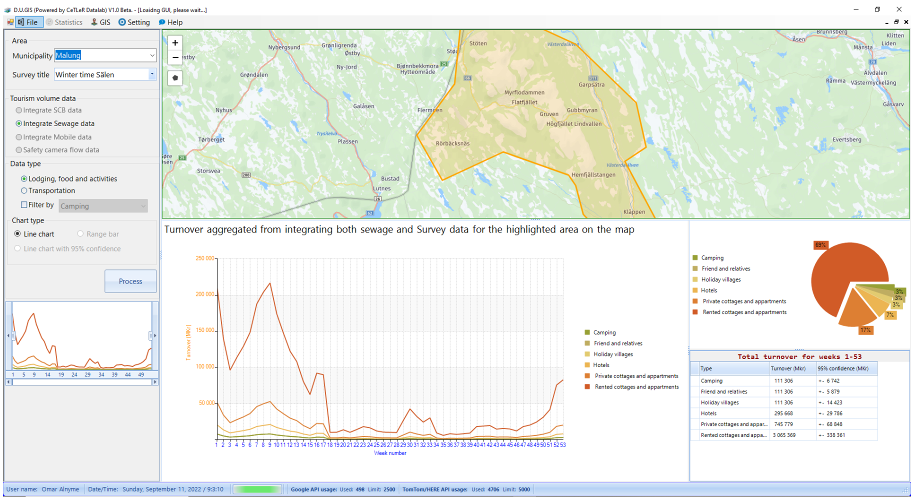


Figure 22. An economic analysis by integrating survey data with population data from the tourism volume module

7.10 Survey tool

The Survey tool is a traditional survey tool that integrates the PPGIS component; the outcome is a tool that provides communication bridges between municipalities and its population. With this survey tool you can engage the population in participating in fundamental decisions that will affect residents’ daily lives, like transportation, health services, etc.

The tool has already been engaged in two research projects:

- Study for citizens of Idre
- Study for citizens of Malung-Sälen

The purpose of the studies was to understand the usage of the different transport modes and to collect feedback regarding the transportation infrastructure.

Questions such as “Mark places that you feel there are in need of improvements connected to mobility and transport” can be answered by the study area citizens by dropping a pin on the map that is attached to the survey question. Figure 23 is the collected data results as a heatmap analysis.

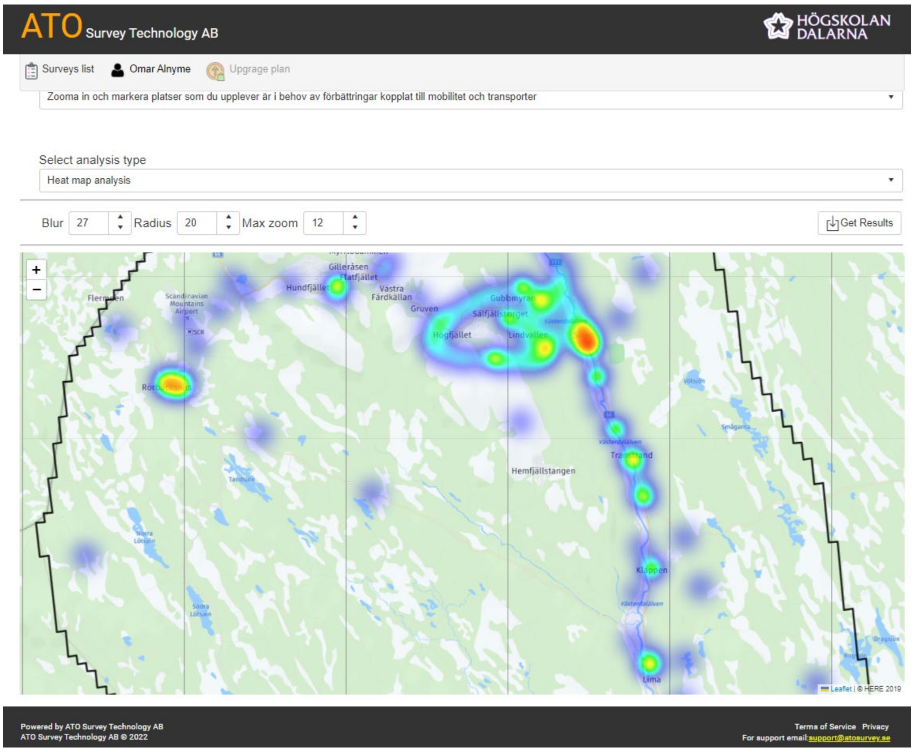
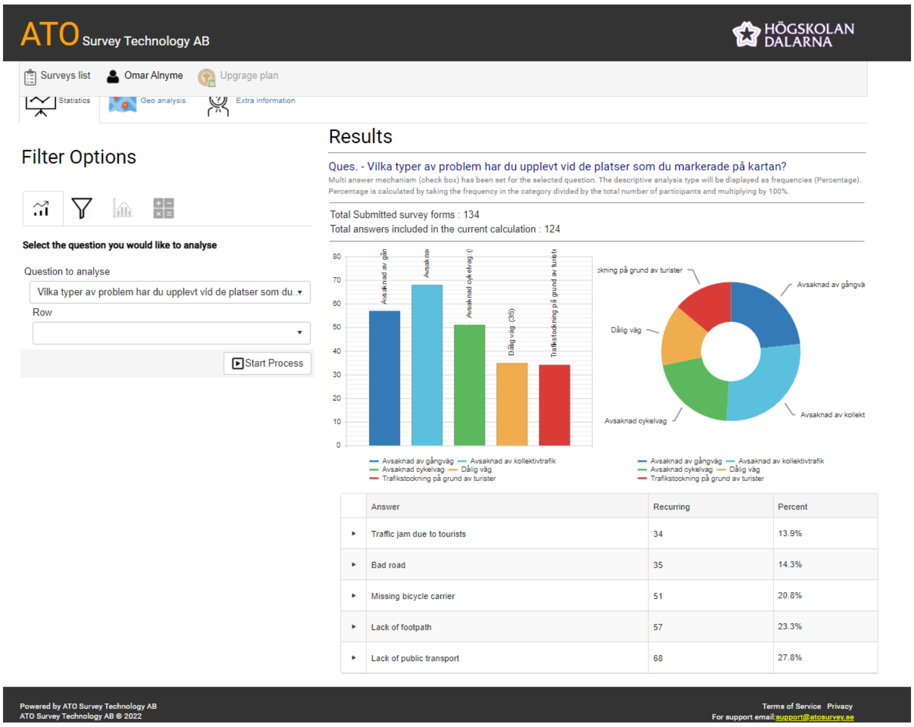


Figure 23. Heat map analysis

The type of problems that the study area citizens have specified is shown in Figure 24.



Answer	Recurring	Percent
Traffic jam due to tourists	34	13.9%
Bad road	35	14.3%
Missing bicycle carrier	51	20.8%
Lack of footpath	57	23.3%
Lack of public transport	68	27.8%

Figure 24. Type of mobility issues within the study area

8 Conclusions

This report has provided a brief explanation of the MIRANDA tool and its links to the D.U.GIS platform. The different sections of the report have explained the system structure, its data sources, coding languages and the Class libraries. Moreover, it has been reported on the type of data used, the necessary links to APIs, as well as on the system model.

This final section concludes by stating that MIRANDA-tool is at the 1.0 -stage. Development is needed in order for the MIRANDA-tool to reach its full potential as a tool for planning for tourism and infrastructure development.

CeTLeR

Centre for Tourism and Leisure Research

Kontakt: cetler@du.se

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