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SABRINA
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Deliverable D.T3.3.4
SCRT User manual

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Authors per project partner (if more than one per PP, provide them together):	Marunica, Ljubotina (FPZ), CADCOM (External)
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Revision Log

Version	Date	Reason	Name and Project Partner
0.8	03.10.2022	Draft for PP review	Marunica, Ljubotina (FPZ), CADCOM (External)

Abbreviation List

Abbreviation	Full name
SCRT	Safe Cycling Routes Toolkit
WPT	Work Package
iRAP	International Road Assessment Programme
ECS	European Certification Standard
ECF	European Cyclists' Federation
SCIIP	Safer Cycling Infrastructure Investment Plan
GIS	Geographic Information System
AADT	Average Annual Daily Traffic
FSI	Fatal and Serious Injury
VRU	Vulnerable Road Users
OSM	OpenStreetMap
GDP	Gross Domestic Product
BCR	Benefit-cost Ratio

1. Introduction

The Safe Cycling Routes Toolkit (SCRT) is a part of the Interreg Danube-SABRINA[1] project. SABRINA project focuses on road infrastructure safety for cyclists as one of the most vulnerable road users. It tackles cycling infrastructure safety issues on existing, planned, and missing cycling corridors crossing nine countries in the Danube region. Its goal is to improve conditions for road bicycle infrastructure safety in the region by raising the capacities of all relevant national, regional, and local stakeholders to build and improve bicycle infrastructure in a safe and sustainable way. The priority of the SABRINA project is a better connected and energy responsible Danube region, with the specific objective being to support environmentally friendly and safe transport systems and balanced accessibility of urban and rural areas.

The goal of SABRINA's Work Package WPT3 (Strategic decision-making toolkit) is to provide users (cycling infrastructure and road safety authorities and stakeholders) with a unified set of procedures, know-how, recommendations based on Inspection and Safety Ratings of the Danube Bicycle Routes (WPT1) as well as best practice analysis and case studies (WPT2) for improving and developing cycling routes which are focused on road safety and safe travels. SCRT toolkit has been created in order to enable this process for various stakeholders. SCRT will be tested in WPT4 (Pilots and Trainings) on selected cycle routes in each project partner country. The creation of the user manual (this document) is a part of the deliverable D.T3.3.4: SCRT user manual and documentation.

SCRT is based on three road safety and cycling route assessment methodologies, as well as available research on the impact of infrastructure on cyclist's safety. The analysed data was utilised to create parameters and processes which are then used to assess and give recommendations for improvements of cycle routes. In the toolkit, the user can access documents regarding all aspects of infrastructure impact on cyclist's safety, assess the planned route (or compare two routes) from the road safety perspective, or convert csv. files from iRAP to ECS format, and vice versa. In addition to available documentation which can be accessed by the user in order to gain insight about the principles, know-how and case studies of good and bad practices regarding road safety of cyclists, various route assessment modules can be used to dynamically assess planned or existing cycle routes. The user can obtain information regarding the price and safety ratings of typical cross sections or their own route. User route is assigned typical cross sections which are then assessed and rated in CycleRAP and iRAP methodology, and it can be compared to other routes which the user has created in order to facilitate strategic level decisions. SCRT offers the user a possibility to receive recommendations on how to improve the route according to the available funding. It also offers an investment plan and an outline of benefits of upgrading the infrastructure.

This guide is organised in the following way: first, all modules of SCRT are introduced and explained. Later, the Assessment Modules are thoroughly and individually explained in a step-by-step manner. Within the Annex 1, an overview of data sources used for calculation algorithms are given.

[1] https://www.interreg-danube.eu/approved-projects/SABRINA

2. Safe Cycling Routes Toolkit – What is it?

The Safe Cycling Routes Toolkit (SCRT) is a cycling safety assessment toolkit. SCRT allows users to select an infrastructure layout on selected parts of the observed route and assess them for safety. Based on the defined cross-section information, best practices and available research, traffic flows and safety ratings from existing S0methodologies, the platform guides the user through cycling infrastructure comparison, recommended upgrade strategies and/or road safety infrastructure countermeasures on critical locations. The toolkit makes recommendations based on the algorithm that will take into account cycling user risks from ECS, iRAP and CycleRAP methodologies, cycling infrastructure reduction potential and infrastructure costs considering also the restraints that might apply in different common scenarios.

The toolkit is organised in 4 sections: Getting started section, Document repository, Assessment modules and Conversion tool. Each of the sections are explained in this chapter, with the Assessment modules section being explained in greater detail within Chapter 3.

Since its practicality and benefits should be available to everyone, the SCRT toolkit is free to use. The platform can be accessed at https://sabrina-scrt.eu/scrt/, while password/username access can be obtained by contacting scrttool@gmail.com or using the registration feature of the tool.

2.1. Assessment methodologies utilised within the toolkit.

The three methodologies: ECS, iRAP and CycleRAP, are the base of the toolkit. Each of them is shortly elaborated within this sub-chapter.

European Certification Standard (ECS)[2] is a cycling route assessment methodology developed by European Cyclists' Federation (ECF). The main goal of ECS is to improve the quality of EuroVelo, the European cycle route network, as well as to provide quality control to motivate different target groups with varying levels of experience to use the certified trans-national routes. The methodology can be used in different stages of route development: planning of the route, route survey, action plan, certification of the route, certified route. During these stages, ECS plays various roles.

The primary objective of iRAP is the reduction of fatal and serious injury accidents, using proposed infrastructure-related countermeasures. There are four RAP protocols: Crash Risk Mapping, Star Rating, Performance Tracking, and Investment Plans. The most important protocol for this toolkit is the **iRAP Star Rating**[3]. It focuses on road elements that have been associated with crash risk. Star Rating methodology can assess roads while considering the safety needs of different road user, e.g., cyclists, motorized vehicles, motorcyclists, and pedestrians, since one road may have a different ranking for different road user types.

The overall aim of **CycleRAP**[4] is to reduce the risk of road crashes for cyclists and users of other light mobility vehicles. This methodology aims to provide a way to objectively measure and benchmark safety for cyclists and other users. It also aims to evaluate the existing network's capacity to cater for rapidly increasing demand or increase in new vehicle types, as well as to prioritise funding and investment into bicycling and light mobility infrastructure. It uses crash initiation factors, crash triggers, and severity determinants to calculate the CycleRAP scoring. This methodology focuses on conflicts with vehicles, conflicts between bicycles and/or light mobility vehicles, conflicts with pedestrians and crashes which do not involve other road users.

[2] https://eurovelo.com/download/document/ECS-Manual-2021_online.pdf
[3] https://irap.org/3-star-or-better/
[4] https://irap.org/cyclerap/

2.2. Getting started section

The Getting started section offers the user multiple options, as it can be seen in Figure 1. On the right-hand side, the following options exist:

- Video tutorials – YouTube videos with thorough explanation on how to use the platform
- Manuals – pdf files with thorough explanations on how to use the platform
- Frequently Asked Questions – section where all frequent questions which the users might have are addressed

The left-hand side features the following options:

- Register or Log in – explained below
- Back to home – this button returns the user to the home screen

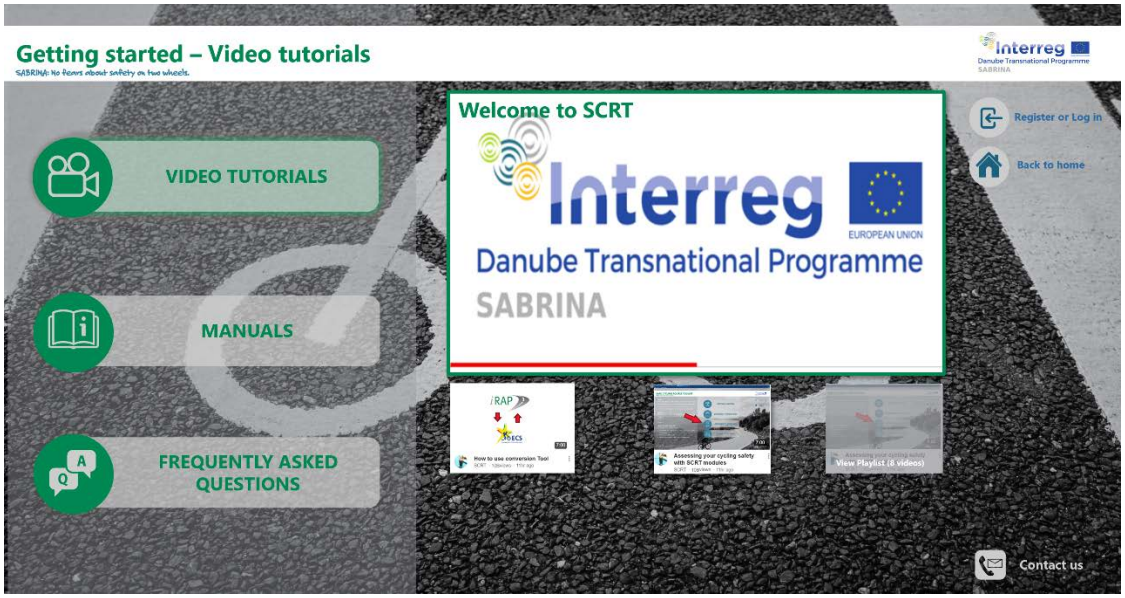


Figure 1 – Getting started section

Figure 2 and Figure 3 present the Register and Log in menus. The Log in menu also offers the user a possibility to reset the password and to register. The register menu also offers the user the option to log in or contact the support for help.

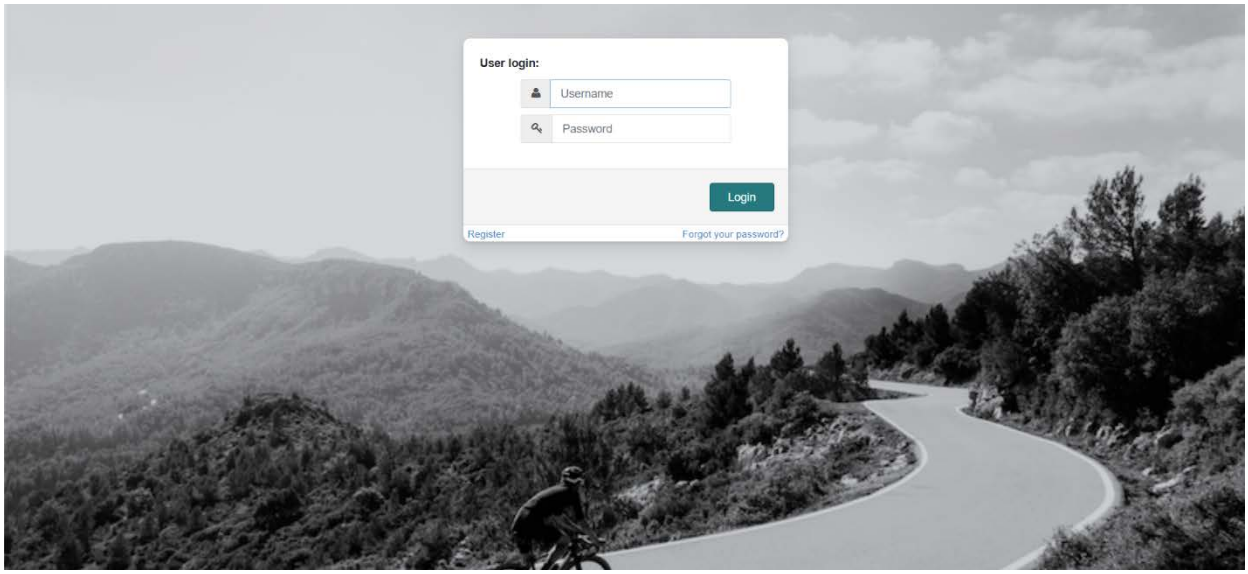


Figure 2 – Log in menu

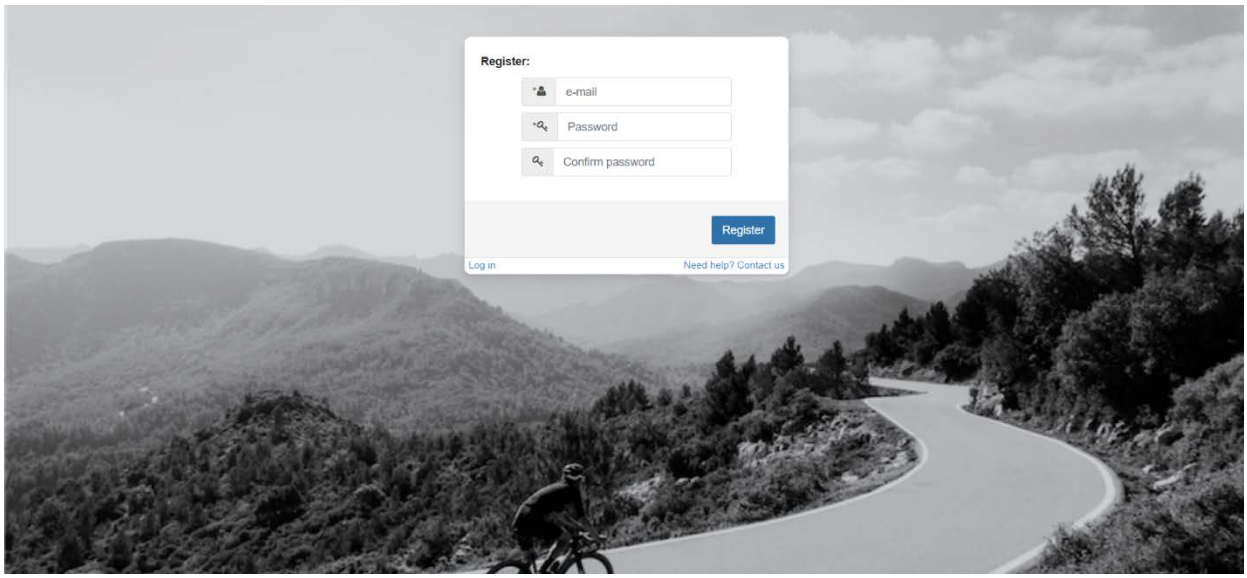


Figure 3 – Registration menu

After the registration process is completed by entering your e-mail and desired password, you will receive a confirmation e-mail. SCRT administrator will need to approve your request and assign you with a username. If this does not happen in a short amount of time (within one or two working days), contact SCRT support regarding this issue.

2.3. Document repository

The document repository can be accessed by clicking on the *Document repository* icon on the homepage, either on the left-hand side, or on the right-hand side, as presented in Figure 4.

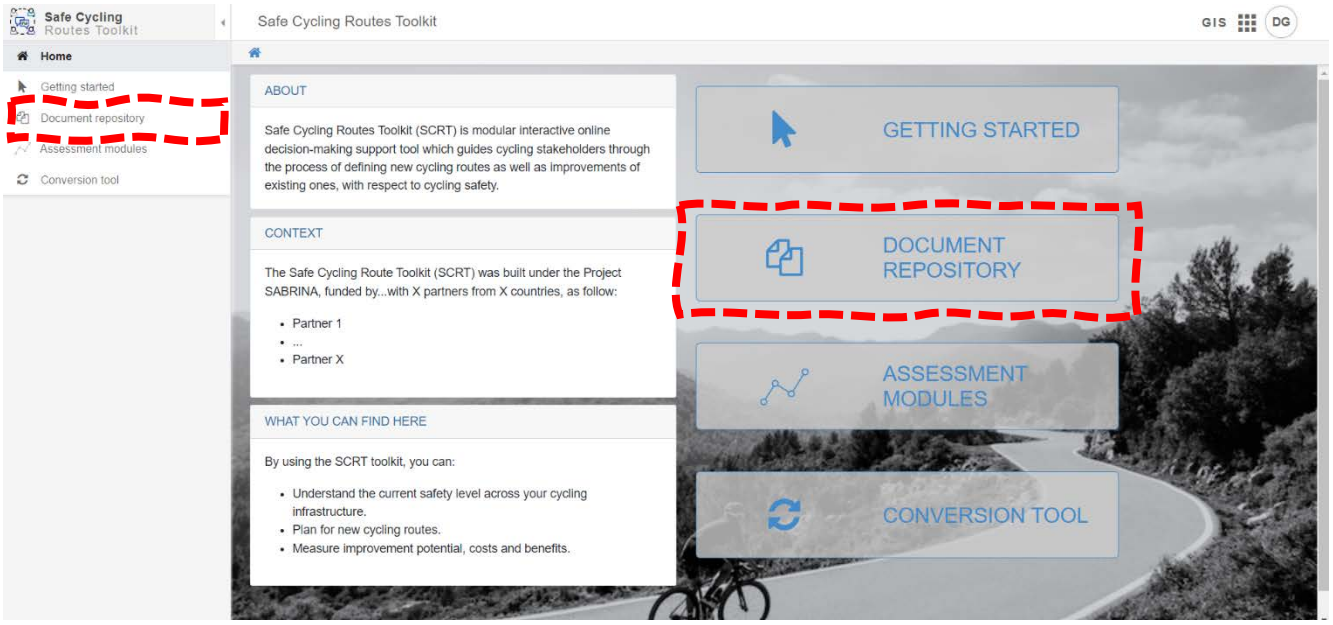


Figure 4 – Accessing the document repository

It contains sections regarding:

- SABRINA project deliverables from Work Packages 1 and 2
- Cycling factsheets + Best Practices report
- SCRT tool guidelines
- Pilot project summaries (to be delivered)

Administrator level users have special allowances on the interface to create additional or update existing sections/folders. A possibility to download documents as well as view them on-screen is available for all users. The portal can store documents in different file formats, such as .ppt, .doc and .pdf formats. Unregistered users are able to view and download the files while administrator level users are able to upload, name and sort the documents per relevant sections. Figure 5 shows the start page of the Document repository.

Figure 5 – Document repository homepage

After clicking on any of the folders, the user is presented with a menu of additional folders and files regarding cycling safety (Created within SABRINA project). Figure 6 presents the extended view of available folders and files.

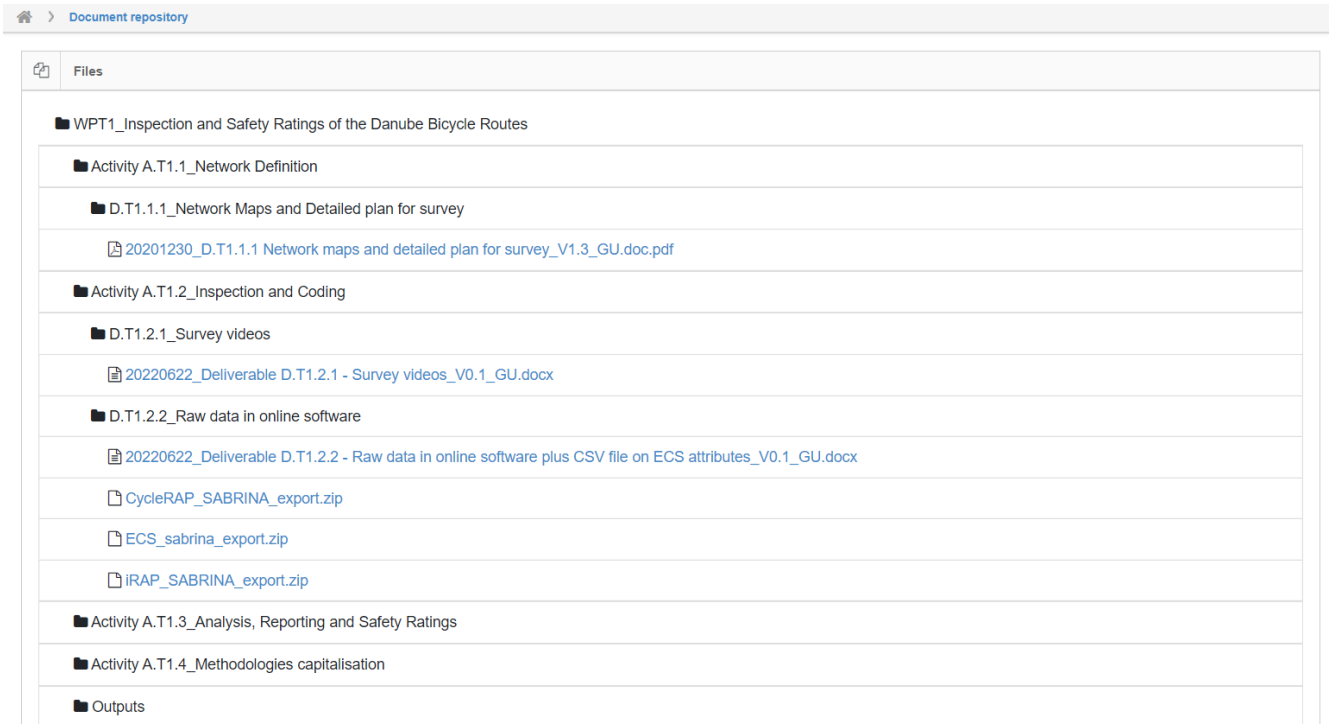


Figure 6 – Document repository extended view

2.4. Assessment modules

The Assessment modules section features 5 modules: Cycling Cross sections, Route rating/comparison module, Countermeasure module, Safer Cycling Infrastructure Investment Plan (SCIIP) and GIS module. To enter the modules menu, the user should first access Assessment modules by clicking the Assessment modules button on the home screen, as shown in Figure 7.

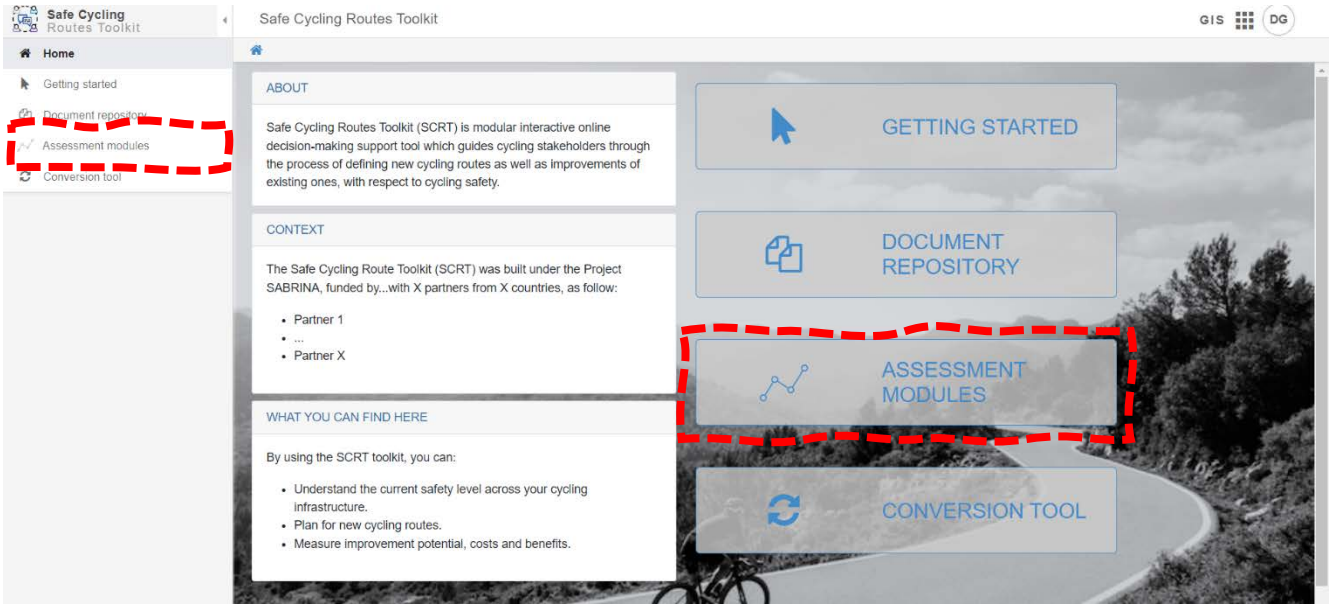


Figure 7 – Accessing assessment modules

The Cycling Cross sections module enables users to inspect all cross-sections which were entered within the SCRT database. To enter this module, the user should click on the Go to button next to the Cycling Cross sections label in the Assessment modules menu, as shown in Figure 8.

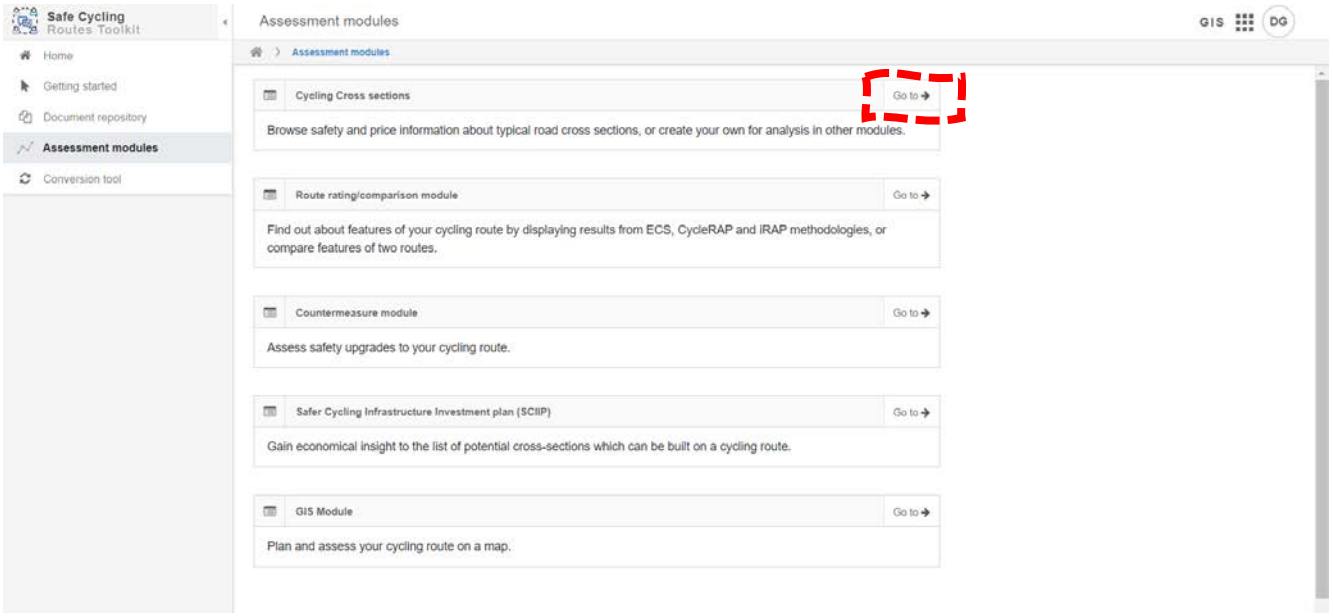


Figure 8 – Accessing Cycling Cross sections

Cross sections are enabled by selecting cycling infrastructure type of the cross-section, and then selecting ranges (from high to low) for Pedestrian flow, AADT, Vehicle speeds and Cycling flow. Selecting a certain cross section from the user data input interface presents that cross section to the user, displaying all the relevant information regarding the shown cross-section's name, description, image, cost in € per 100m, accident reduction potential, iRAP Star Rating, CycleRAP risk score, Safety score, Speed limit and relevant traffic flow information.

The Countermeasure module offers feasible upgrade suggestions to the current road with regards to safety. To enter this module, the user should press the Go to button next to the Countermeasure module label, as shown in Figure 9.

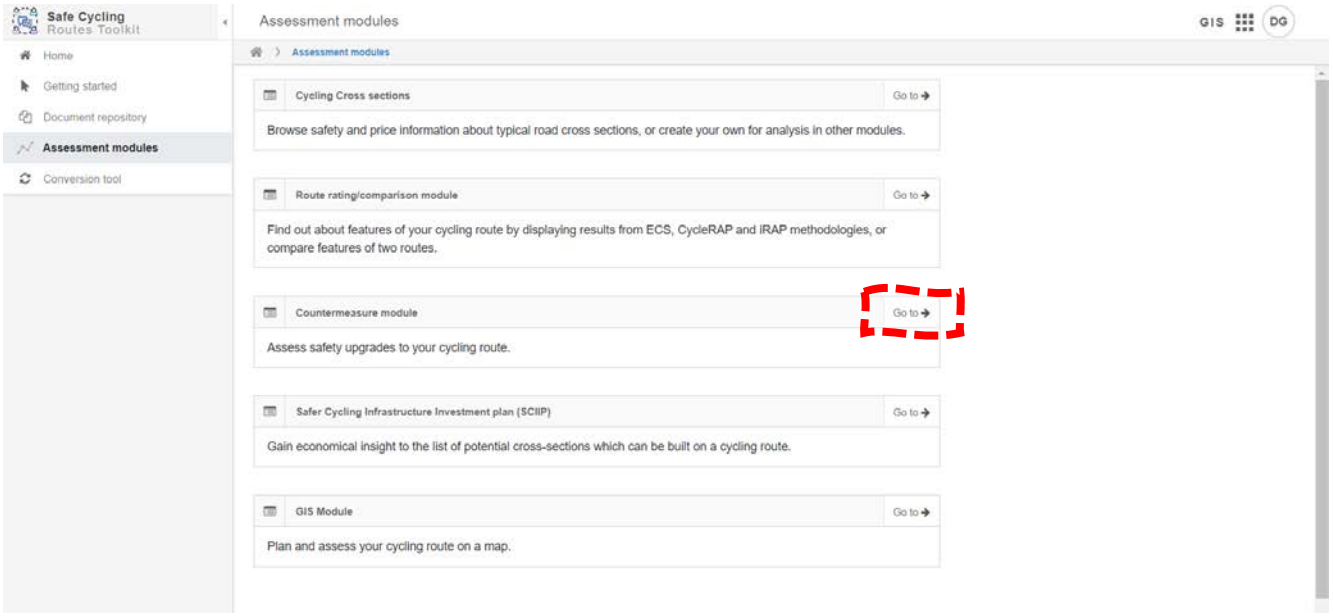


Figure 9 – Accessing the Countermeasure module

Module is an extension of the route rating/comparison module. Users can load a previously saved route and select the desired scope of investment (Investment in € per 100m). Users can exclude/include certain cross-sections from the assessment by clicking on include/hide next to desired cross section in a separate menu. Countermeasure module presents optimal upgrades of the baseline (existing) cross-section to the user. Suggested improvements are listed in a tabular form per baseline cross section, they indicate the price of investment, and also indicate on how many kilometres of defined cross sections the upgrade should be applied.

Safer Cycling Infrastructure Investment Plan (**SCIIP**) cost and benefit module is envisioned as an extension to the Countermeasure module for users who wish to assess the most favourable cost-benefit countermeasure out of those cross-sections which are selected as feasible by the countermeasure module. To access this module, the user should press the Go to button next to the Safer Cycling Infrastructure Investment Plan (SCIIP) label, as shown in Figure 10.

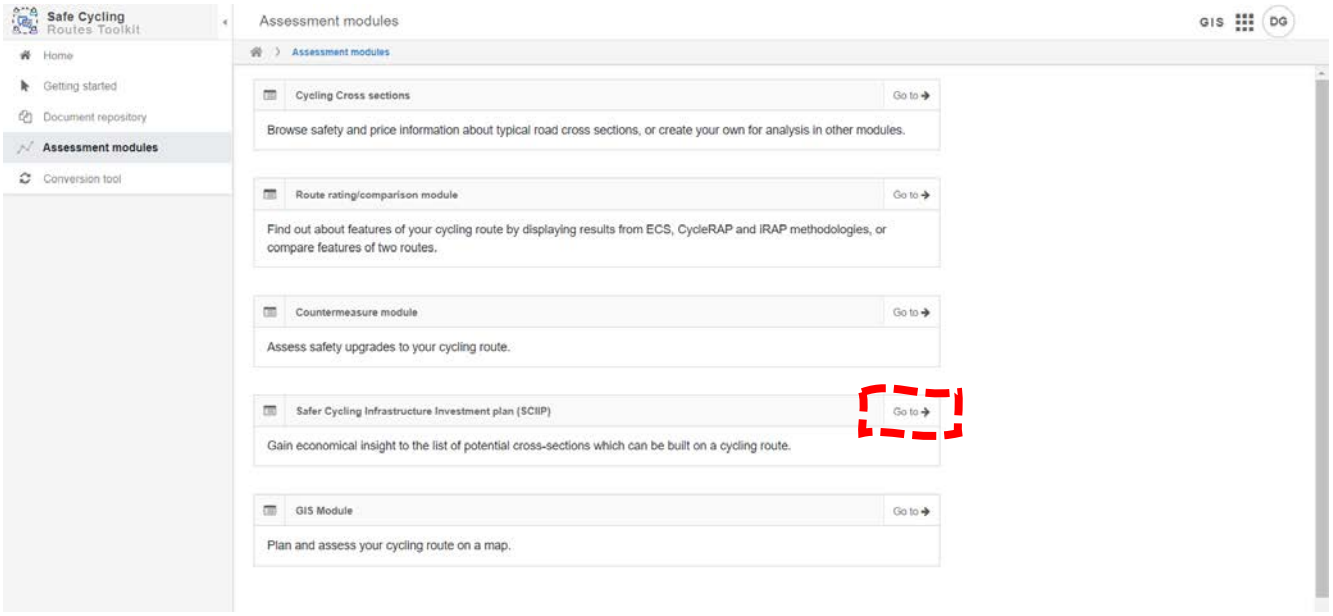


Figure 10 – Accessing SCIIP module

An additional set of accident (Cycling deaths within respective period, fatality underreporting factor, fatal to serious injury ratio) and economic (GDP per capita in €, discount rate, value of life and serious injury multipliers, as well as analysis period) data is required by the user in order to perform the SCIIP assessment. SCIIP module, once the user selects desired upgrades for each cross-section, presents the user with results regarding total fatal and serious cyclist injuries (FSI) which can be prevented, safety benefits, estimated costs, benefit to cost ratio, safety score upgrade and cost per FSI saved in a tabular form. Total route estimation is followed by an individual cross-section assessment.

Within the **Route rating/comparison module**, users can attribute cross sections, flows and speed limit attributes to a route which were defined in a GIS module. To access this module, the user should press the Go to button, next to the Route rating/comparison module label, as shown in Figure 11.

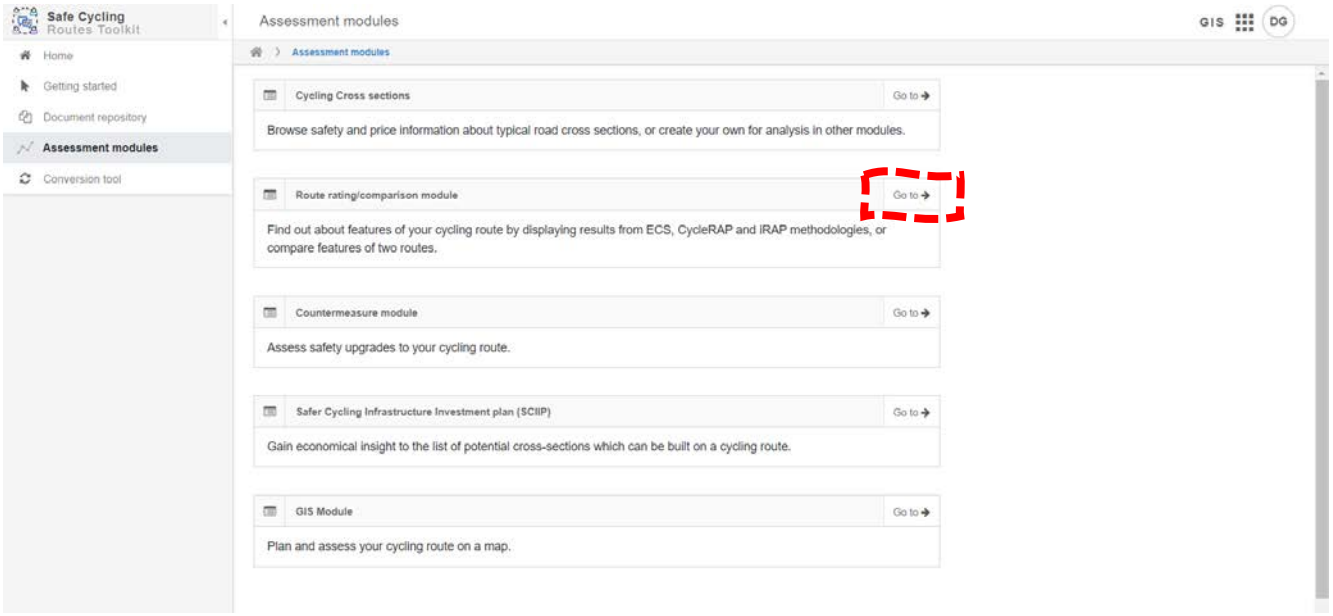


Figure 11 – Accessing the Route rating/comparison module

Once the entire length of the route has its cross-sections attributed, users will have the option to save the route and/or view results. For each route, route rating/comparison module will provide results in tabular form regarding CycleRAP, iRAP, speed and flow information. Additionally, ECS attributes which were previously added within the GIS module on the route will also be assessed and presented.

Within the **GIS module**, users can select map layers, define route geometry on the map either by drawing/editing centrelines manually or by importing outside vector layer into the GIS module. To access the module, the user should click on the Go to button, next to the GIS module label, as shown in Figure 12.

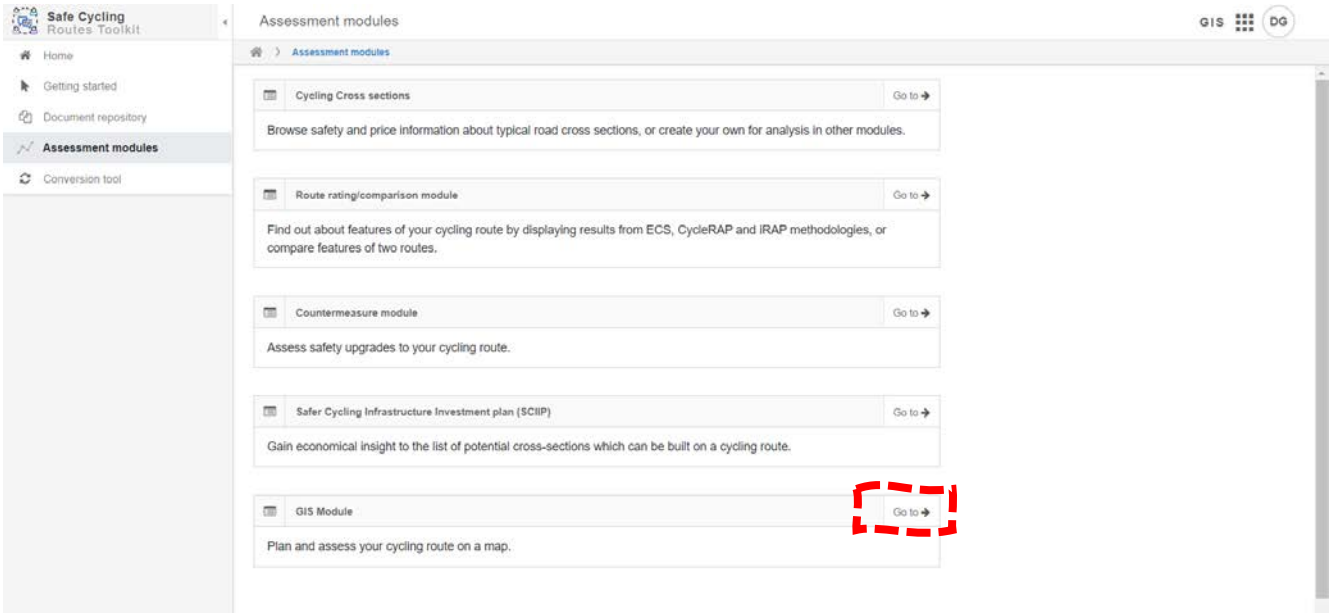


Figure 12 – Accessing GIS module

For each route, users are prompted to split the route where cross section layouts change, and they can also enter relevant ECS point attributes. Users can then save the route in order to do a full route assessment in other modules.

2.5. Conversion tool

SCRT includes a tool that is able to convert collected compatible georeferenced infrastructure feature data in .csv format (common attributes) between iRAP and ECS methodologies.

Figure 13 shows the way to access the conversion tool.

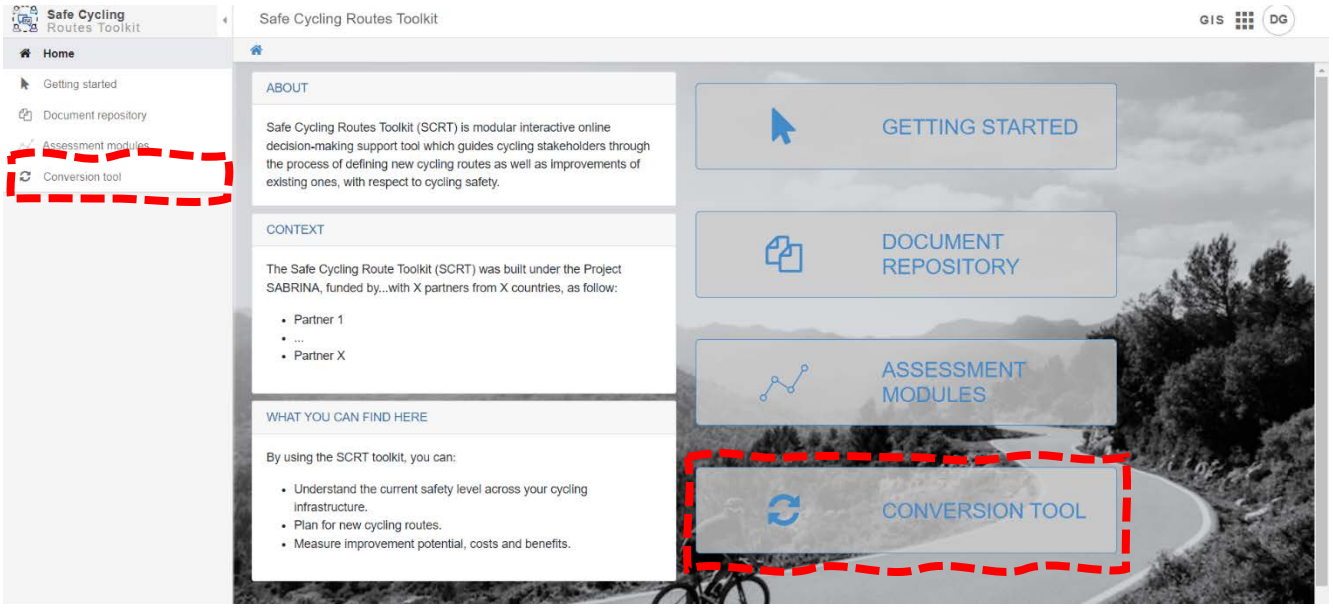


Figure 13 – Accessing the conversion tool

In order to convert the file, it is necessary to upload it in the appropriate iRAP or ECS upload file format. Examples of iRAP and ECS .csv files (opened in Microsoft Excel), are shown in Figure 14 and Figure 15.

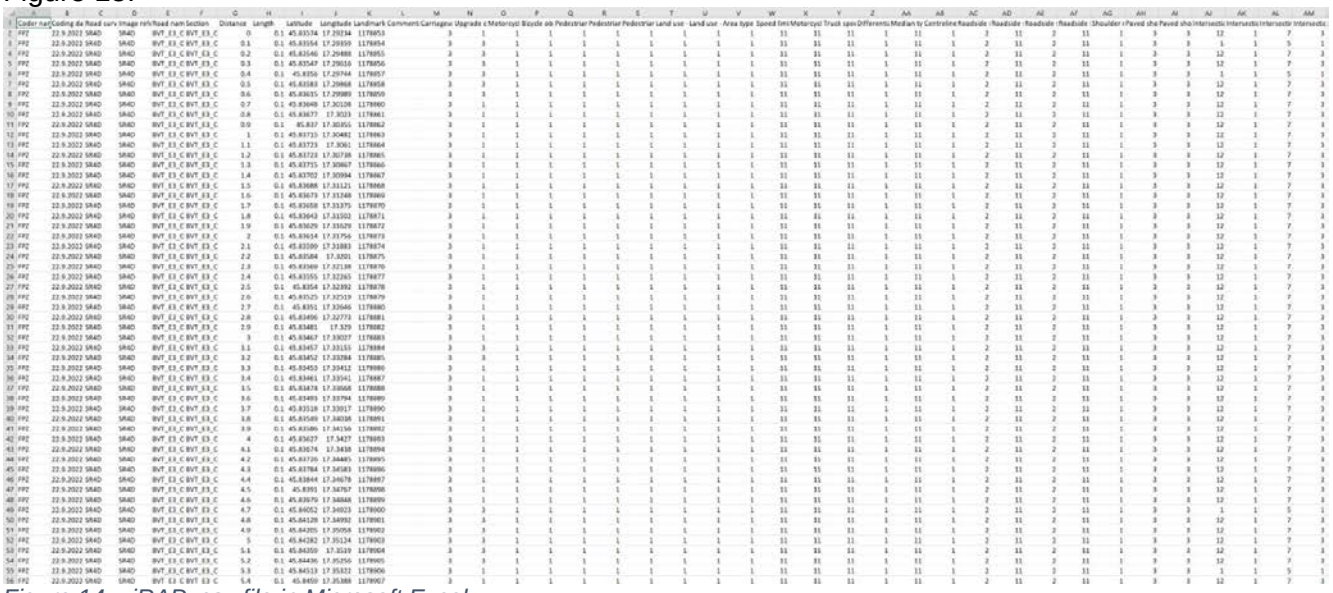


Figure 14 – iRAP .csv file in Microsoft Excel

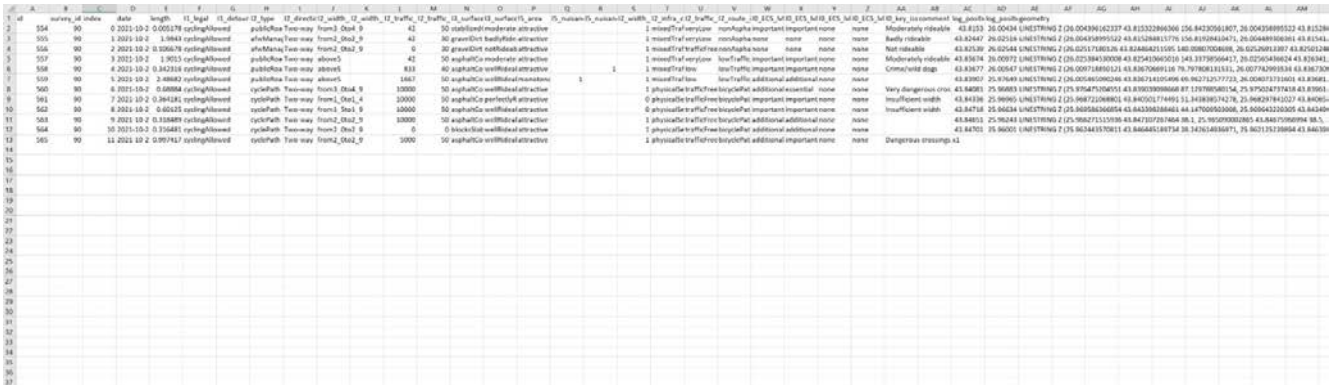


Figure 15 – ECS .csv file in Microsoft Excel

After selecting the appropriate file type, the user should click the Choose File button, as shown in Figure 16.

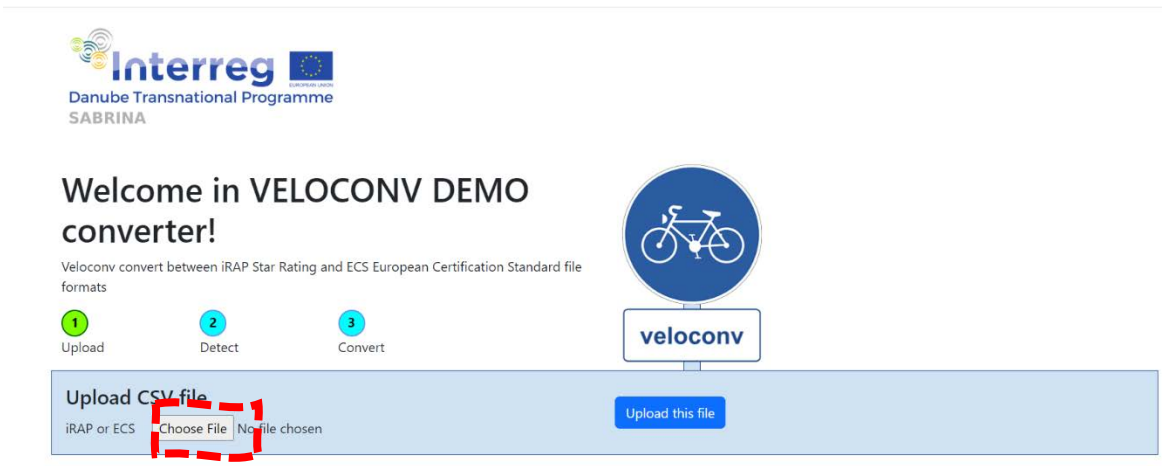


Figure 16 – Conversion tool start page – choosing a file

After the file has been chosen, the next step is to click the Upload this file button (shown in Figure 17), in order to upload the file.

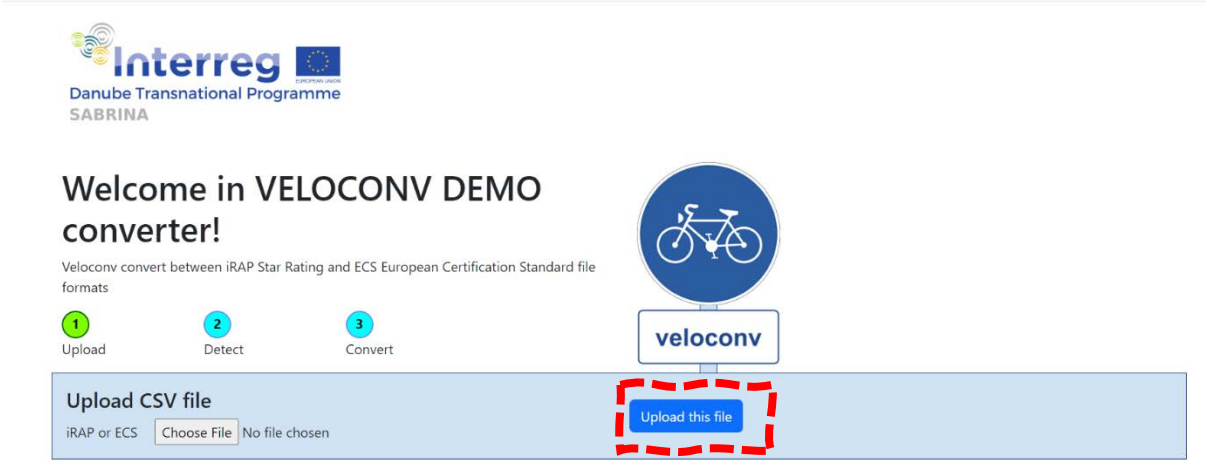


Figure 17 – Conversion tool start page - uploading a file

After pressing the Upload this file button, the File received notification will show up, as presented in Figure 18. The user should then press the Next button.

Figure 18 – Conversion tool after receiving file

Figure 19 presents the screen after the platform detects the file. The user then has the option to press the Next button or the New upload button, which takes the user back to the start screen of the module.

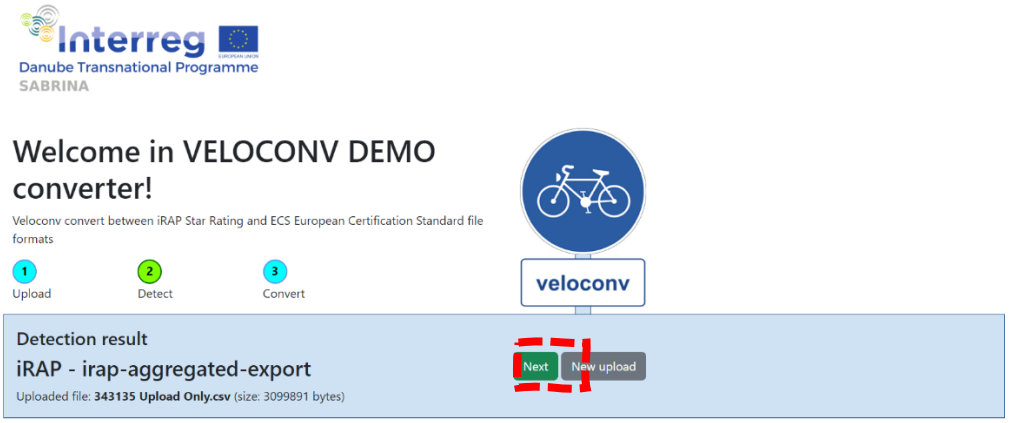


Figure 19 – File detected in conversion tool

Figure 20 shows the results of the conversion. The user has the option to download the converted files by pressing the Download button, or upload new files, using the New upload button. The minor_sections-test.dsv conversion output file, opened in Microsoft Excel, is presented in Figure 21.

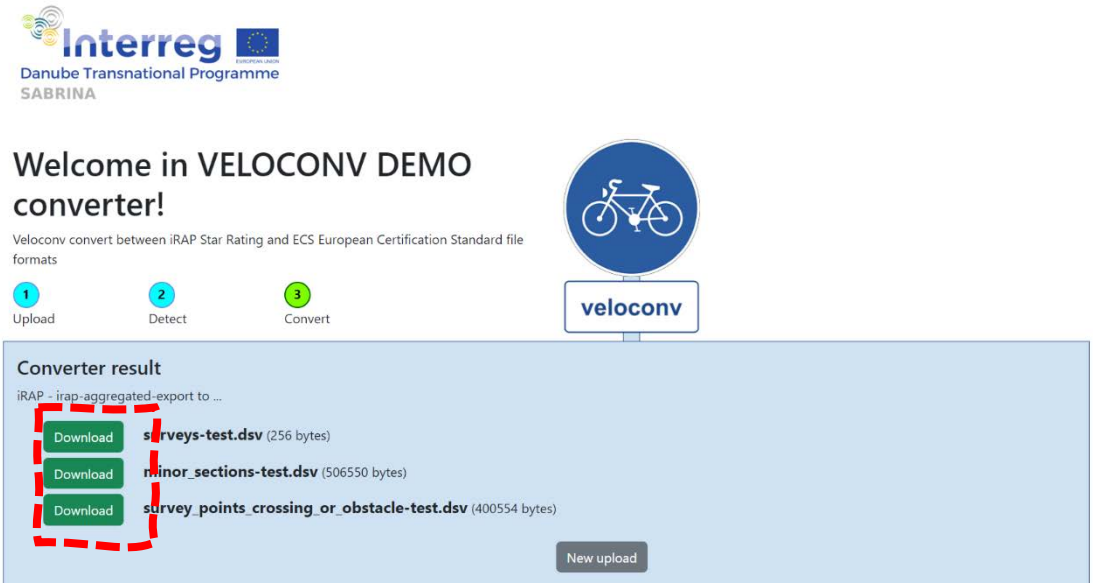
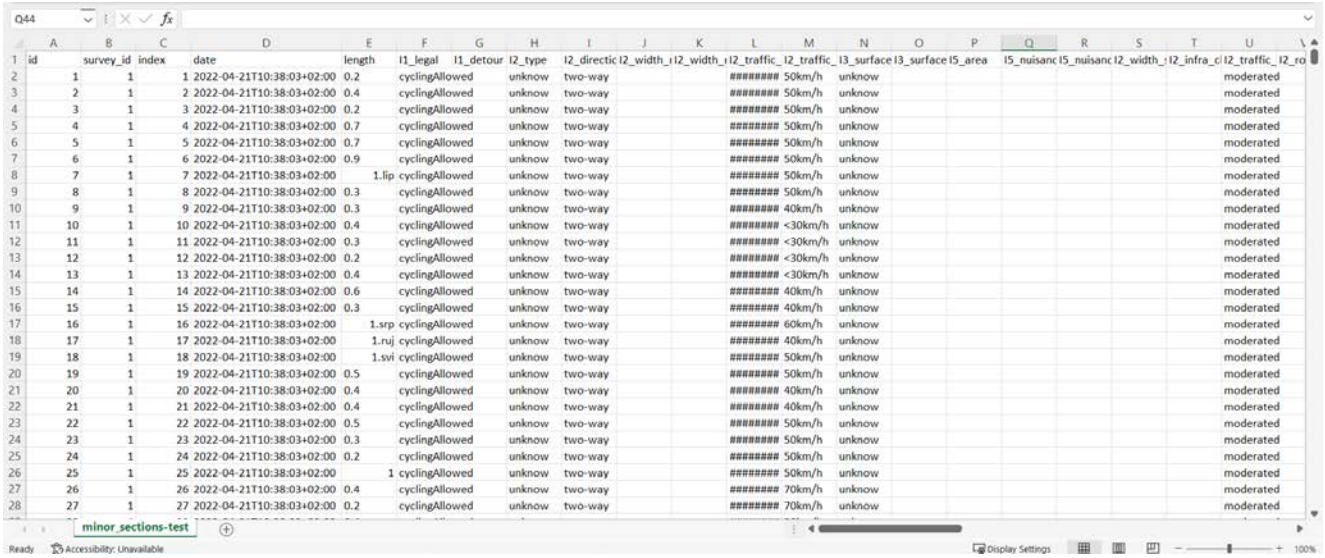


Figure 20 – Results of the conversion



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27	1	27	2022-04-21T10:38:03+02:00	0.2	cyclingAllowed		unknow	two-way			########	70km/h	unknow							moderated	

3. Assessing your cycling route with SCRT

This section is a step-by step guide per module, which will enable the users to assess their cycling route with emphasis on cycling safety. Through its five modules, the user can obtain all relevant information about the iRAP and CycelRAP rating of the current state of cycling infrastructure, as well as various information about potential improvements, their cost and impact.

3.1. Cycling cross-section module – browsing safety and price information

This module presents the user with the option to choose between various infrastructure layouts, while taking into account the traffic situation (flow of pedestrians, vehicles, and cyclists, as well as vehicle speed). The result of this input is a set of safety scores, costs per 100m, service life of infrastructure, and other information which are explained below.

Figure 22 presents the start screen of this module.

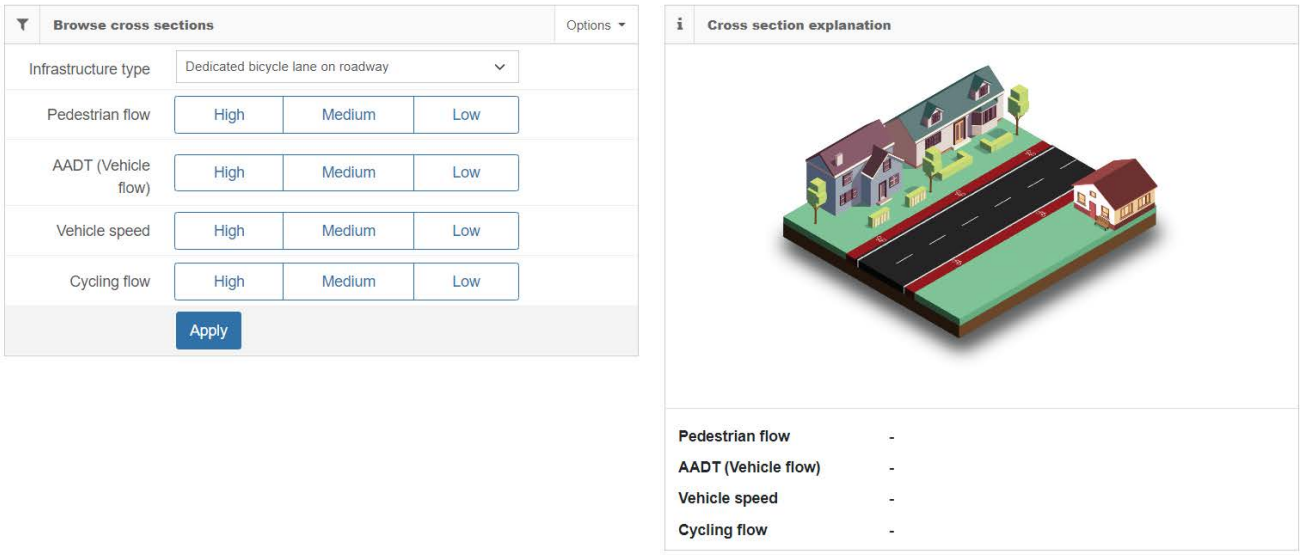
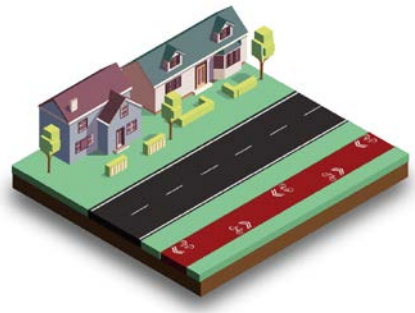
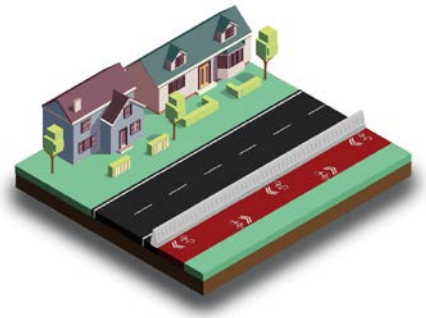
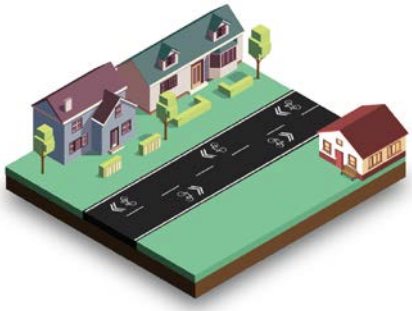


Figure 22 – Cross section module start page

The user is presented with a set of choices. Firstly, the user should choose the appropriate infrastructure type from the drop-down menu. Table 1 displays infrastructure types which are available for selection.

Table 1 – Infrastructure types in SCRT

Name	Image	Description
Dedicated bicycle lane on roadway		An on-street lane intended for use by bicycles/light vehicles, which is out of the main path of large, motorised vehicles and marked accordingly.
No VRU infrastructure		Bicyclists/light vehicles use the same street space/path as large, motorised vehicles.
Segregated bicycle path		An off-street path which is intended for use by bicycles/light vehicles only.
Barrier protected bike lane		A dedicated bicycle path separated from traffic by a physical barrier. A physical barrier must be sufficient to restrain a vehicle from entering the bicycle facility at the posted speed limit.

Shared roadway (Sharrow)		Shared Lane Markings (SLMs), or "sharrows," are road markings used to indicate a shared lane environment for bicycles and automobiles. Among other benefits shared lane markings reinforce the legitimacy of bicycle traffic on the street, recommend proper bicyclist positioning, and may be configured to offer directional and wayfinding guidance.
Shared use path (Pedestrian/Cyclist)		An off-street path which is intended for use by bicycles/light vehicles and pedestrians. Multiuse paths are generally wider with signage indicating it as such.
Sidewalk		An off-street path intended for pedestrian use. Cyclists often utilise this space if no adequate cycling infrastructure is provided.
Wide road shoulder		Space on the street (but out of the direct path of large, motorised vehicles) used by bicyclists/light vehicles. May be unmarked.

Clicking on any of the infrastructure types presents the user with a graphical representation of the type, on the right-hand side of the screen.

Afterwards, the user chooses parameters which describe the traffic situation at the cross section. All parameters are rated as low, medium, and high. The four parameters for which ranges will need to be selected are: pedestrian flow, AADT (vehicle flow), vehicle speed, and cycling flow. Table 2 presents the values used to rate each parameter.

Table 2 – Values for the calculation of parameters

Infrastructure type	[Select one of infrastructure types from the slider]		
Pedestrian flow	High = Above 300 pedestrians per hour	Medium = From 26 to 300 pedestrians per hour	Low = Below 26 pedestrians per hour
Vehicle flow	High = Above 10000 vehicles per day	Medium = From 5000 to 10000 vehicles per day	Low = Below 5000 vehicles per day
Vehicle speeds	High = Above 61km/h	Medium = Between 31km/h and 60km/h	Low = 30km/h per hour or lower
Cycling flows	High = Above 300 cyclists per hour	Medium = From 26 to 300 pedestrians per hour	Low = Below 26 cyclists per hour

Once the user clicks on the adequate value of each parameter, they are presented dynamically, in a tabular form, as shown in Figure 23.

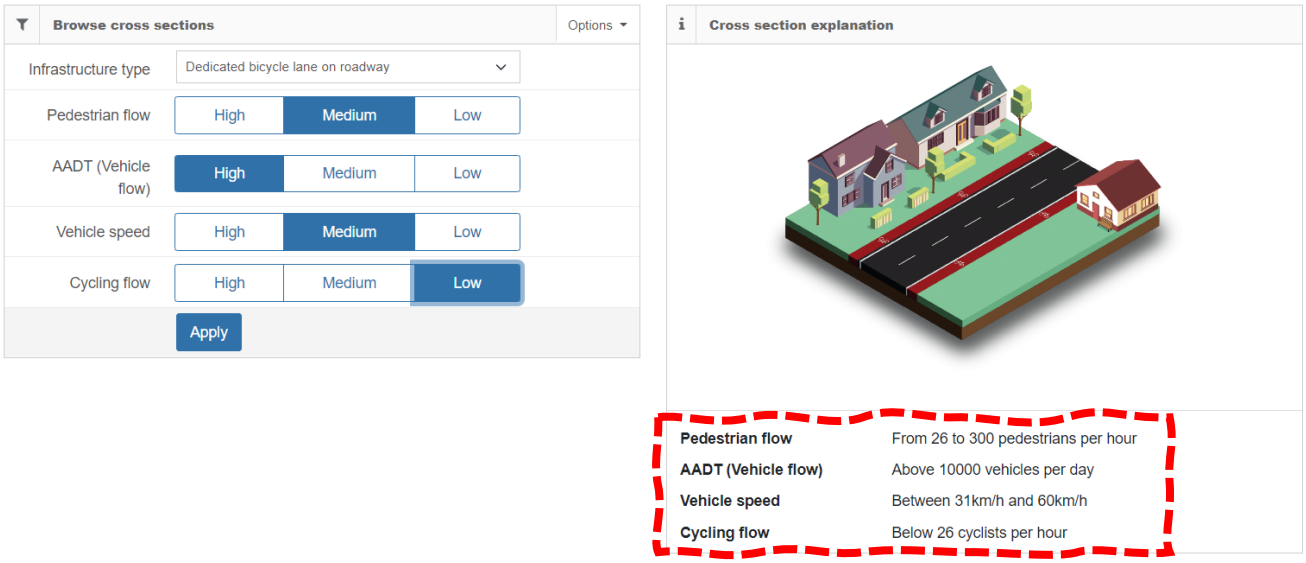


Figure 23 – Values of traffic parameters in the platform

Clicking the apply button provides the user with the iRAP Star Rating score and the CycleRAP risk level, as well as a textual description of the complete situation at the cross-section, as presented in Figure 24.

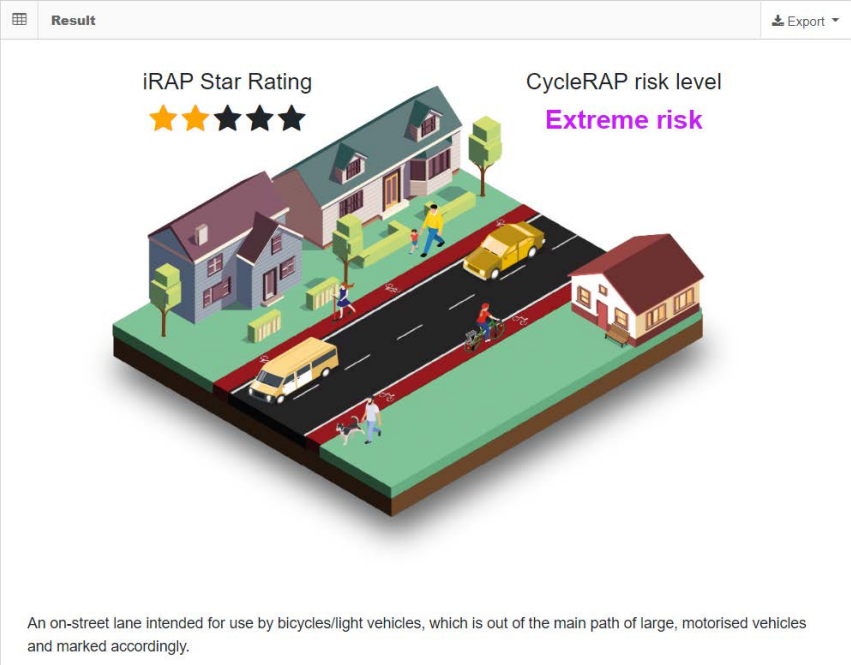


Figure 24 – Results of assessing the cross section

The platform offers the possibility of exporting files as iRAP, CycleRAP and ECS files for a given 100m segment, as shown in Figure 25.

Figure 25 – Exporting cross section results

The second, lower, part of the result screen, presents the user with additional information about the cross-section in a tabular form, as presented in Figure 26.

Cross section ID:	284
Cross section name:	Dedicated bicycle lane on roadway
Cost in € (100m):	1227
Reduction potential:	0.5
Vehicle flow:	Medium (5001 to 10000 AADT)
Safety Score:	41.8
iRAP Score:	2 stars
CycleRAP score:	Extreme risk
Pedestrian flow:	Medium pedestrian volume (From 26 to 300 per hour)
Cycling flow:	Medium cycling volume (From 26 to 300 per hour)
Service life (Years):	6
Speed (Km/h):	Medium (Between 30km/h and 60 km/h)

Figure 26 Additional information about the cross-section

The attributes included are:

- Cross section ID
- Cross section name – same as the infrastructure type in the input menu
- Cost in € (100m) – Cost per 100m of building the infrastructure.
- Reduction potential – Reduction potential factor which describes the reduction in likelihood and severity of an accident (for example, reduction potential of 0.25 means that the likelihood of an accident with severe consequences or death is reduced by 25% when compared with no dedicated cycling infrastructure)
- Vehicle flow – same as vehicle flow in the input menu. The vehicle flow in this case represents the AADT (Average Annual Daily Traffic), which represents the amount of average traffic (for one day), on a yearly basis. This parameter shows how busy one road is.
- Safety score – Sum score of 4 different accident types from iRAP and CycleRAP (Bicycle to vehicle, single bicycle, bicycle to bicycle, bicycle to pedestrian) methodologies. Lower score means that the cross-section is safer.
- iRAP score – presented in the top part of the screen. The Star Rating score given by iRAP represents an objective measure of the level of safety of a road. It ranges from 1 to 5 stars, with 1 being very unsafe and 5 being very safe.
- CycleRAP – presented in the top part of the screen. CycleRAP is based on risk levels, ranging from Extreme risk to Low risk. Extreme risk presents a very low safety level for cyclists, while Low risk presents the highest safety level for cyclists. Other risk levels are High risk and Medium risk.
- Pedestrian flow – same as pedestrian flow in the input menu. The pedestrian flow in question is the one measured during the peak hour of the day.
- Cycling flow – same as cycling flow in the input menu. The cycling flow in question is the one measured during the peak hour of the day.
- Service life (Years) – number of years after which the object (marking or important infrastructure elements) should be renewed

- Speed (km/h) – same as vehicle speed in the input menu. While the speed noted is the legal speed limit, users can instead consider operating speeds when selecting this as well.

Results of the cross sections module help the users get an estimate of cyclist safety in various traffic situations, and the module can be used as a quick on-glance safety assessment of a certain type of infrastructure under given flow and speed criteria.

Within the module, it is also possible to define your own cross-section. Custom defined cross-sections **can be used in other modules and be applied on any route**. If an user wishes to create their own custom cross-section, they can do so by clicking on + New cross section icon within the Browse cross sections window, as presented within the Figure 27.

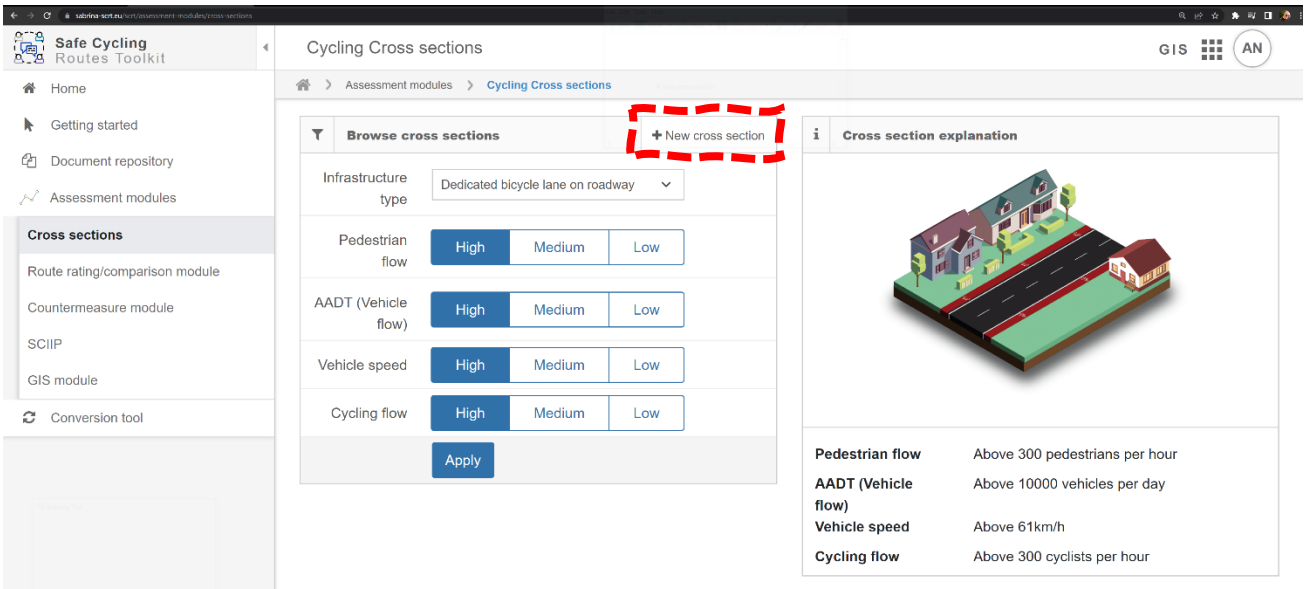


Figure 27 – Accessing new cross-section feature

Following window will be presented (Figure 28), where the user can input their data for the section.

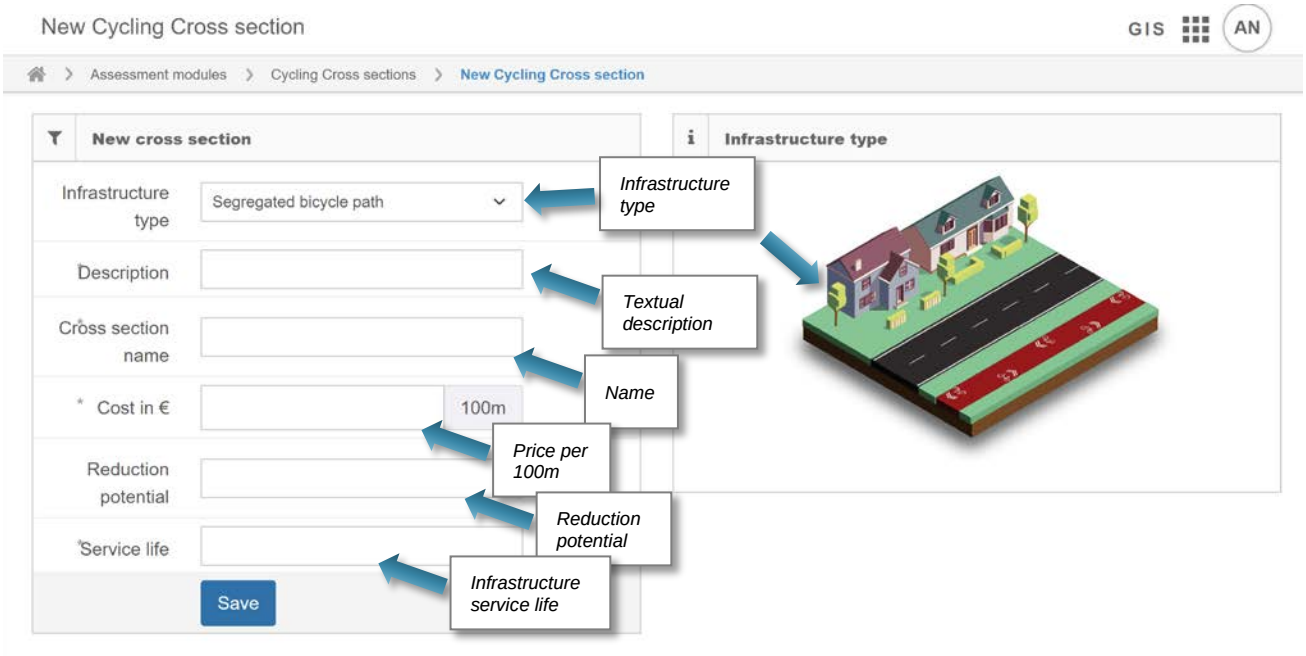


Figure 28 – Custom cross-section entry data requirements

Once assigned, this cross-section can be used within all modules for route assessment or can be browsed if selected under “infrastructure type”. Custom cross sections will have [CUSTOM] before the name, as seen within the Figure 29.

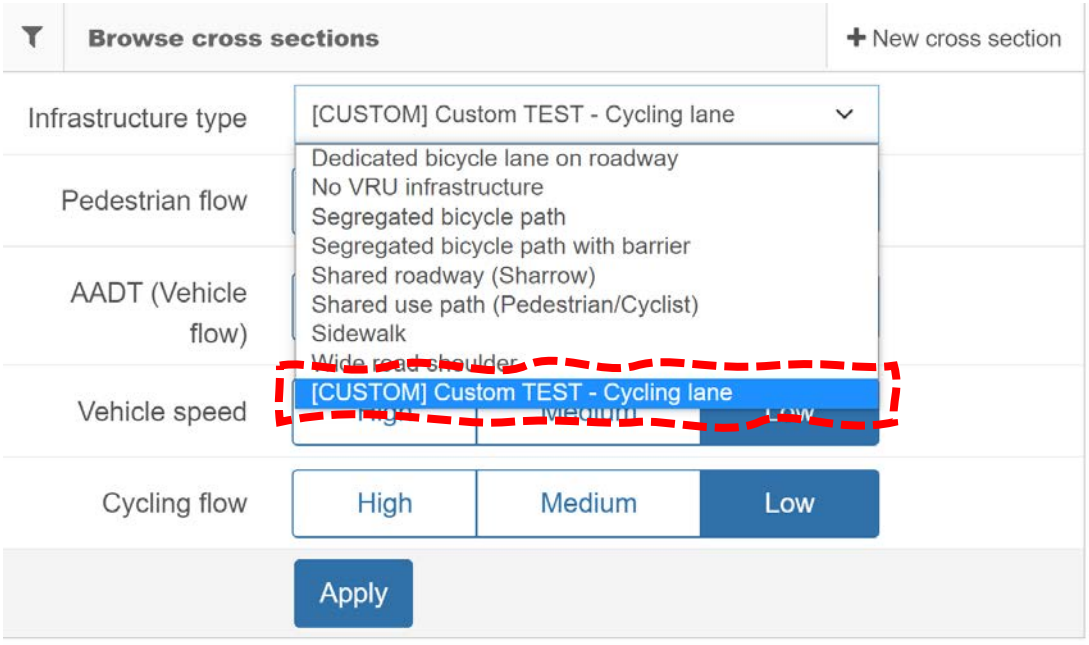


Figure 29 – Custom cross section selection option

3.2. GIS module - defining the route

3.2.1. Basic GIS system interfaces and options

The GIS module user interface (Figure 30) can display different Geographic Information System (GIS) map and data layers. The Base layer provides a background for contextualizing the working layers. A number of different mapping services are supported including Google Maps and OpenStreet Map. Overlays are working layers used for additional relevant information.

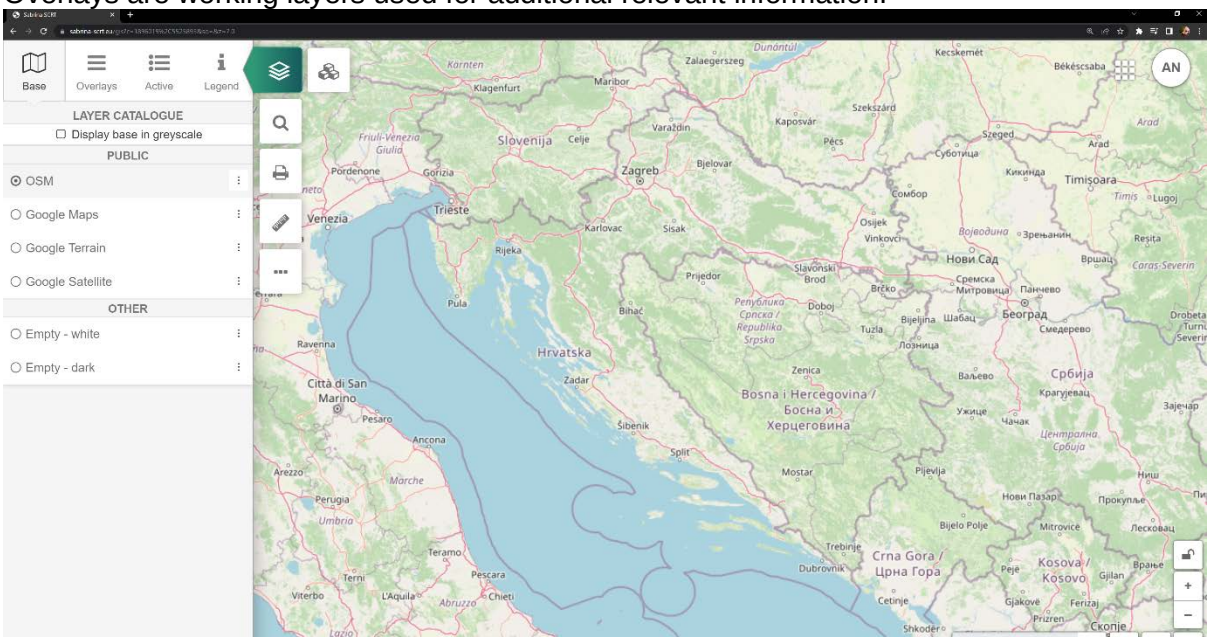


Figure 30 – GIS module User Interface

The interface consists of 6 main options:

1. Layers option
2. Find option
3. Print option
4. Tools option
5. Other option
6. Data option

Each of the main options of the GIS module can be seen on the figure below (Figure 31).

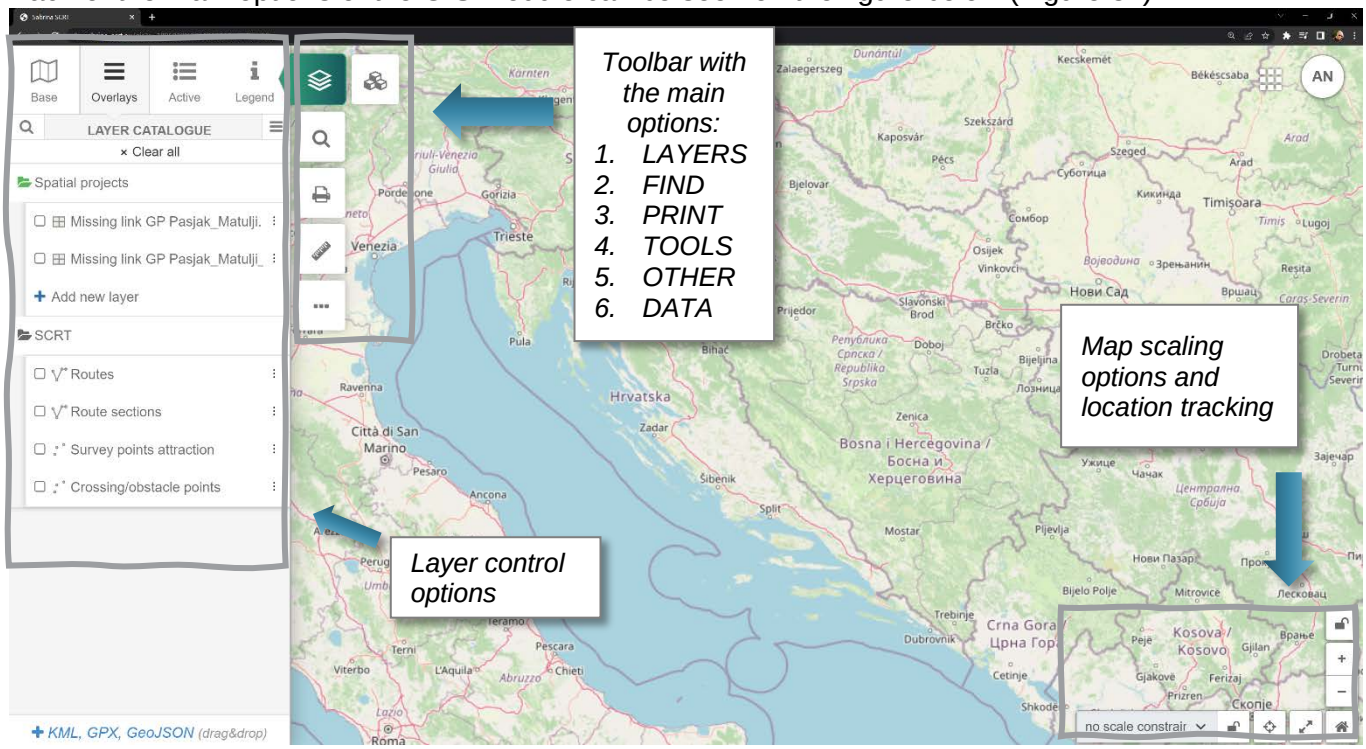


Figure 31 – GIS module system interface commands

"*Layers*" option contains four different tabs: Base layers, data layers (Overlays), Active layers, and the Legend. Base tab contains the default public base layers that are used as a background (map) layer: Open Street Map, Google Maps, and Google Satellite (Figure 32). Other base layers include the plain white and plain black background. All base layers can be also displayed in grayscale.

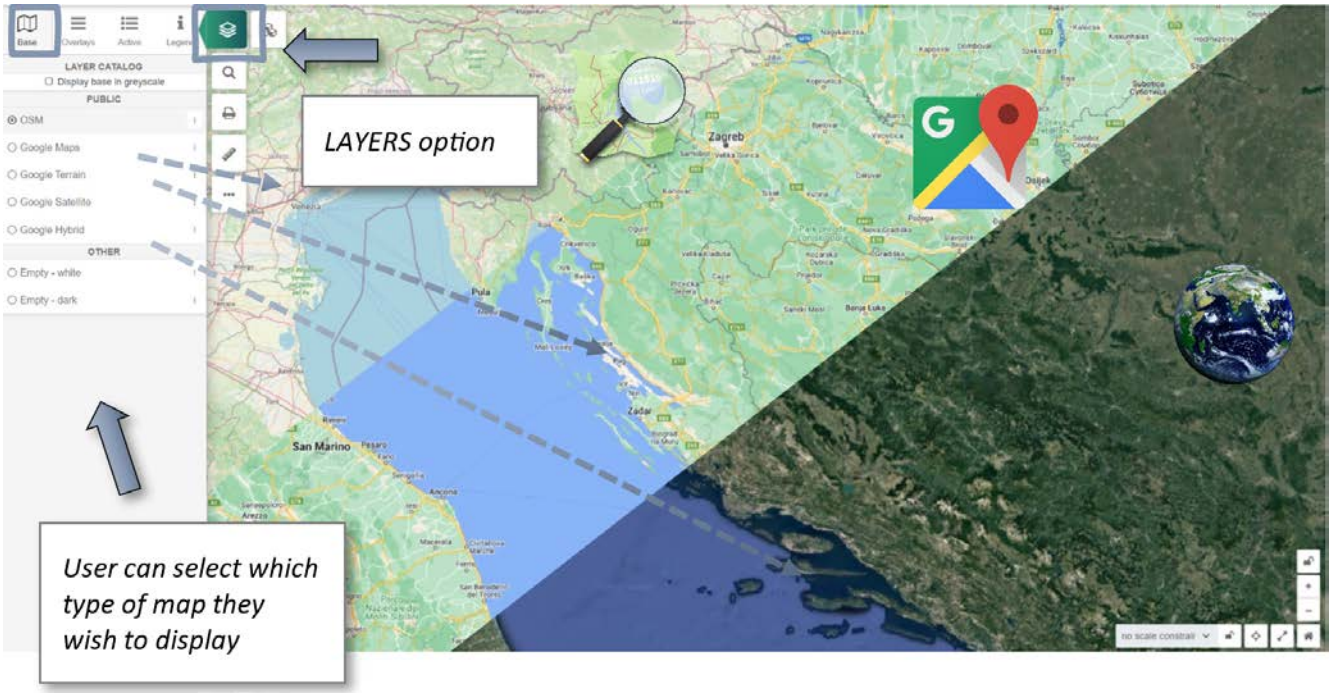


Figure 32 – Layer options - Base layer (OSM, Google Maps, Google Satellite)

Overlays tab includes 2 different “folders”, each one containing different data layers (Figure 33). “Spatial project” folder contains uploaded geometry data layers, and “SCRT” folder contains layers which include cycling routes (“Routes”), separated sections of the route (“Route sections”), and various ECS point attribute groups.

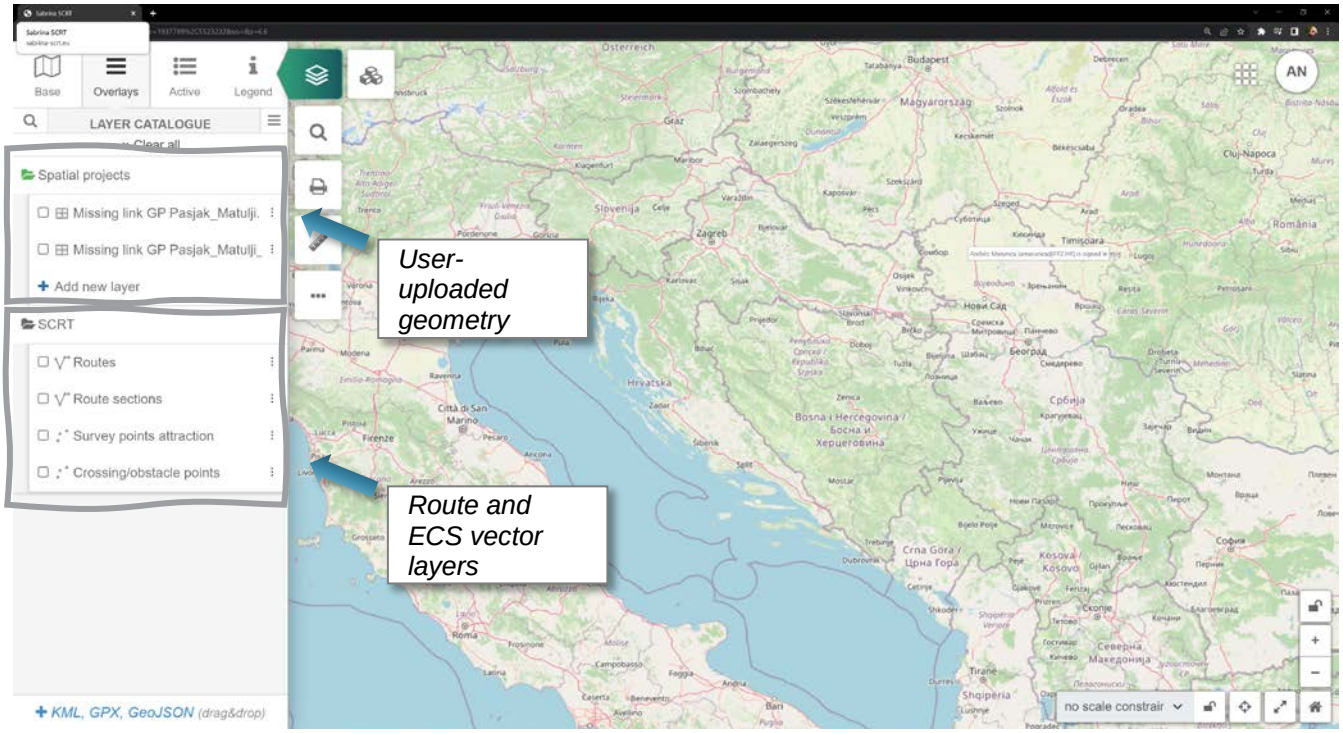


Figure 33 – LAYERS option - Overlays tab

Active tab shows current active layers that are shown on the map view. These layers can be hidden or removed from the current map view.

Find option is used to list and find all of the available data within the GIS module system (Figure 34). The list is presented in the form of a table with the individual items in rows. Clicking on an item pans the map and zooms to the selected item, opening the item options and attributes window. The attributes of individual items in the table are presented in columns. The magnifying glass icon ( ) opens an additional window where data can be filtered. The ( ) icon is used to show the desired data present inside of existing polygons by clicking on the “Select on the map” option, or to list the data inside of a new polygon that can be created manually by clicking on the “Draw a polygon” option. “Show results on map” option can be selected so that only the data currently listed in the table is displayed on the map.

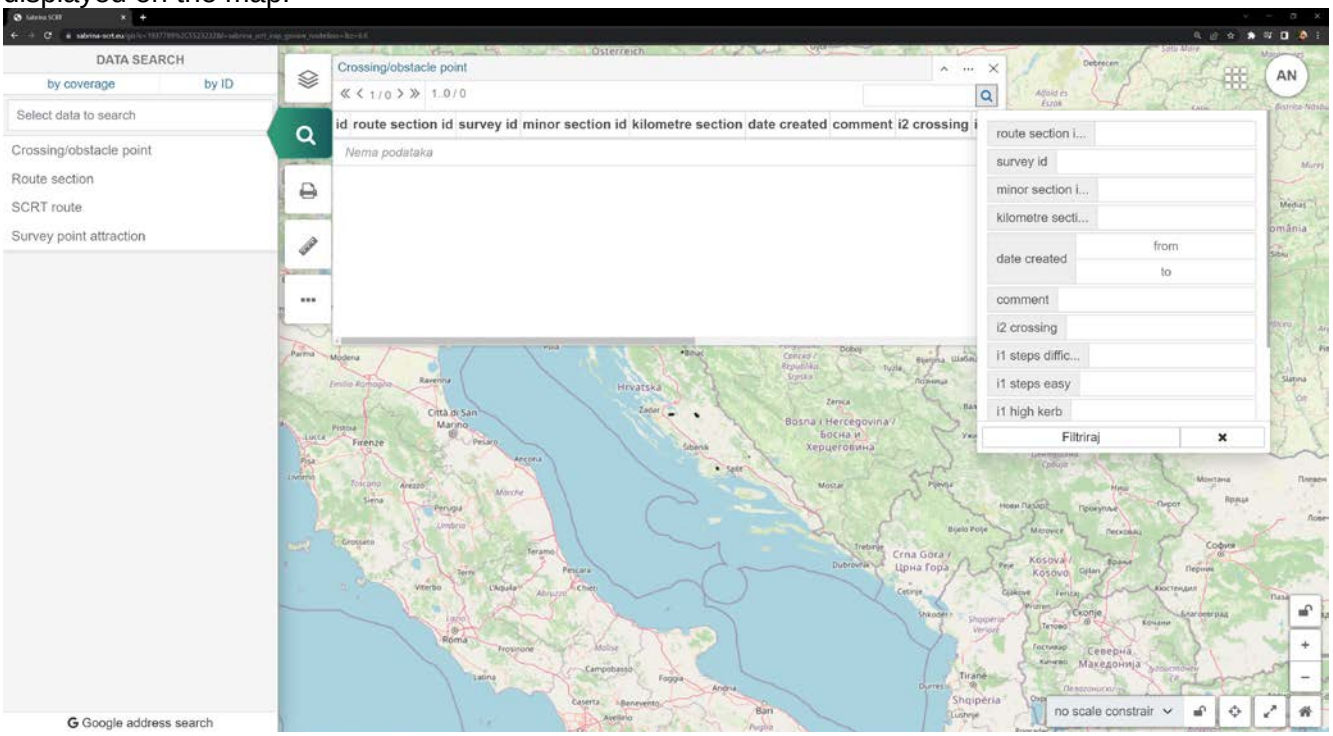


Figure 34 – FIND option

Figure 35 shows the print option. Selecting the print option opens the resizable window and printing options which include the paper size, orientation, scaling and other options. Clicking on the “Print” button exports a .PDF file with the map and the displayed data inside of the smaller rectangle of the resizable print area window.

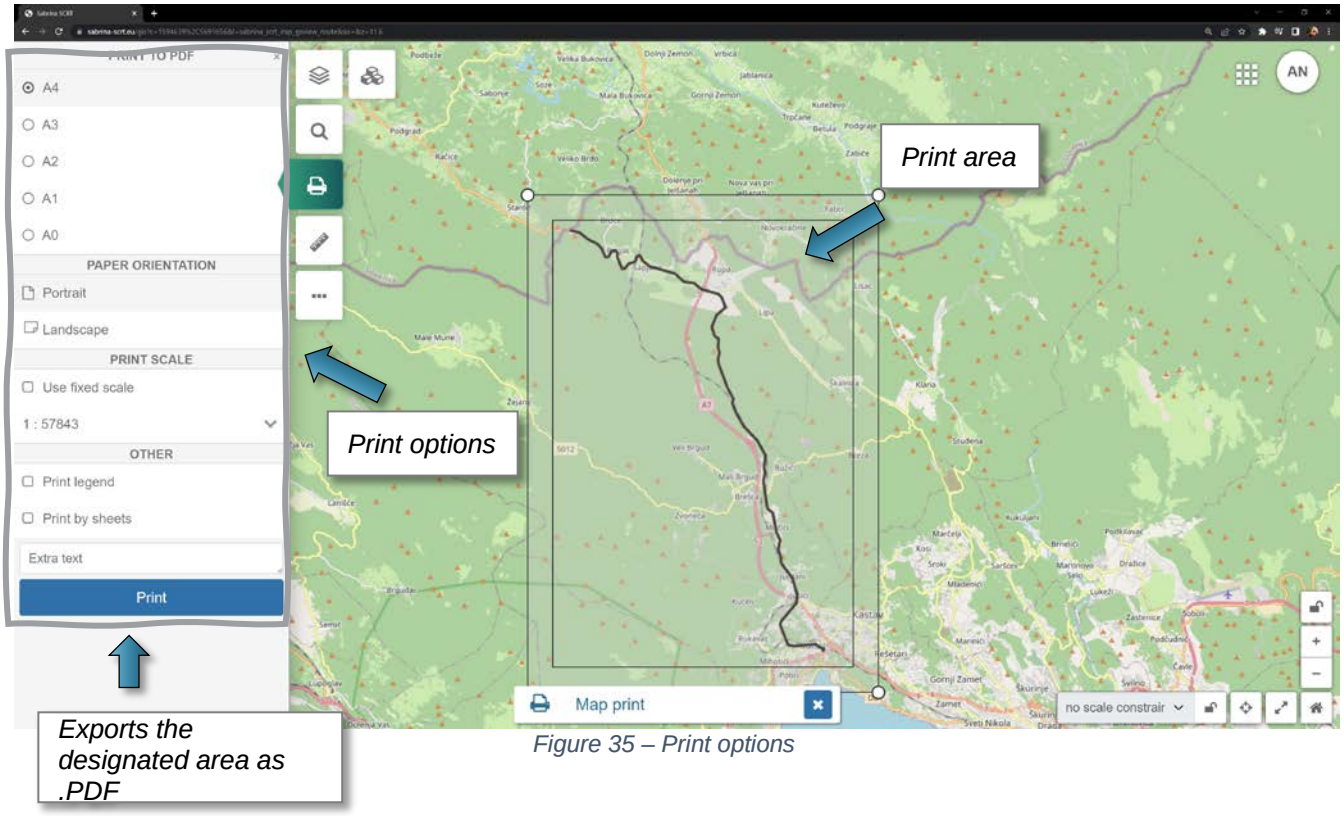


Figure 35 – Print options

Measurement Tools allows performing 4 different types of measurements on raster images: measuring length, area, radius, and capturing location coordinates. Figure 36 shows the "Length" measurement feature. Any length can be measured on a raster satellite image or any vector layer (e.g. lane width or distance to an specific objects along the road).

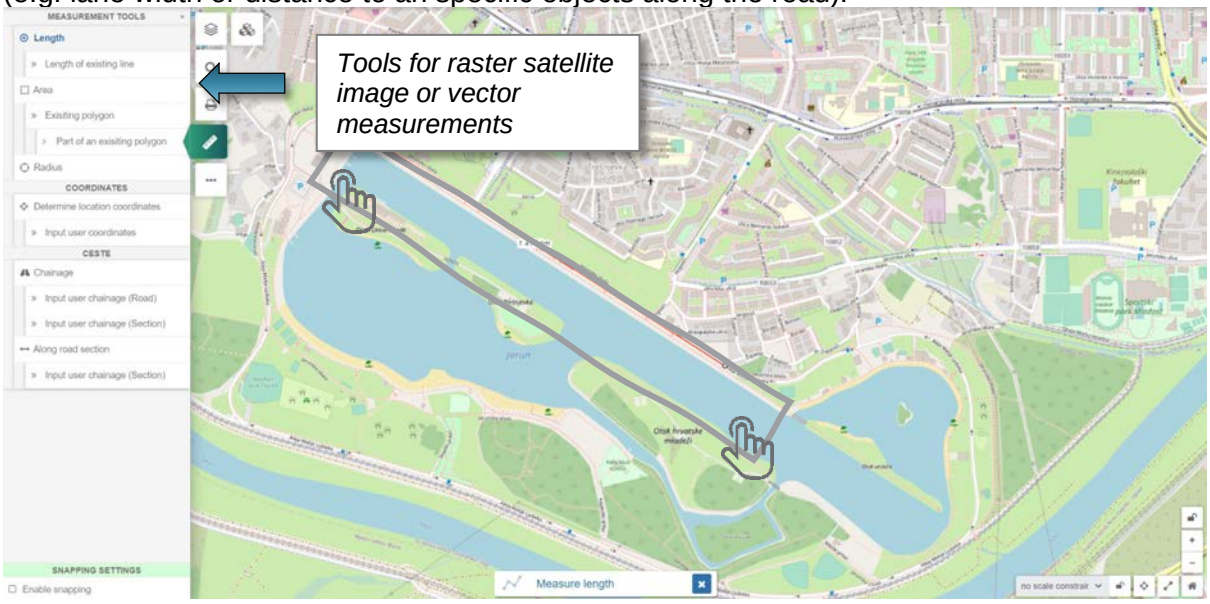


Figure 36 – TOOLS option – Length

Figure 37 –TOOLS option – Area

Figure 37 shows the “Area” measurement option. After drawing a polygon, around a observed area, the surface for this area is automatically measured and displayed. Figure 38 shows the “Radius” measurement tool. By using this tool, a circle of different radius can be constructed based on three points selected on the map. The radius of created circle is automatically measured and shown on the map.

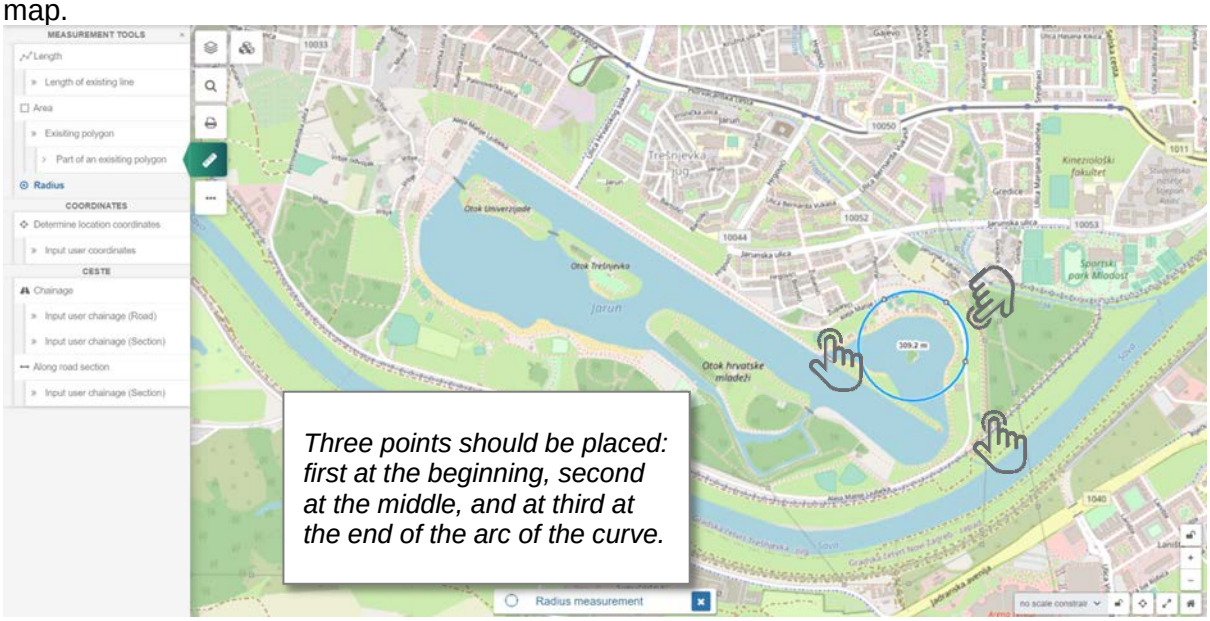


Figure 38 – TOOLS option – Radius

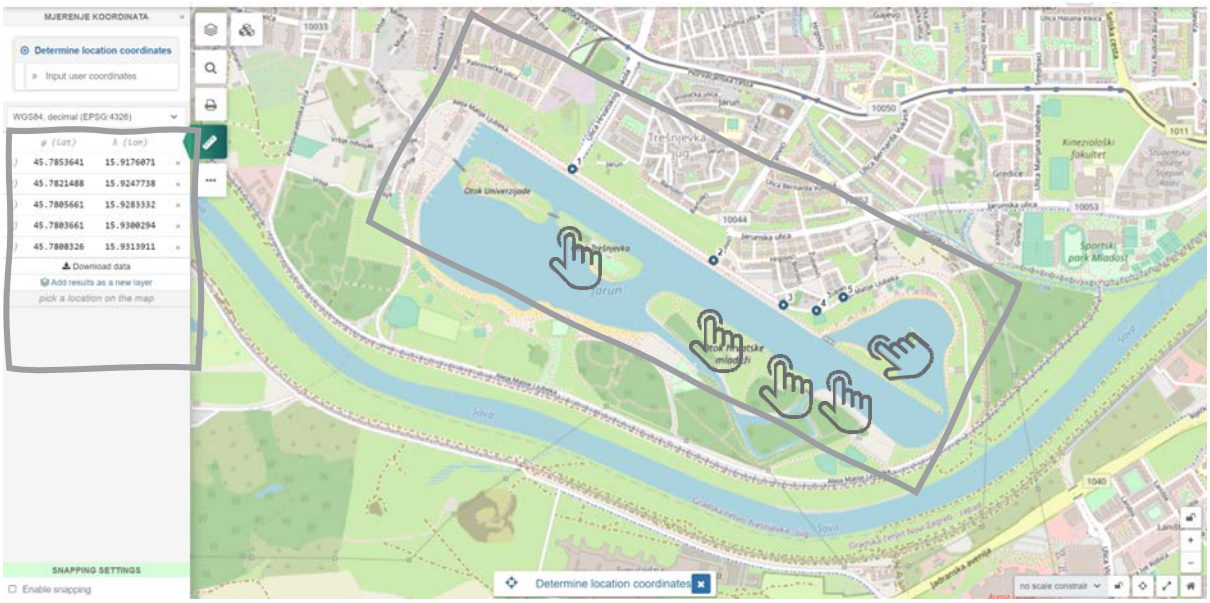


Figure 39 – TOOLS option – Location coordinate

3.2.2. Defining your cycling route in GIS module – Step by step guide

The main purpose of GIS module is defining the geometry of the route and its basic characteristics. When opened, it presents the users with an OpenStreetMap (OSM) map, with the possibility to choose different viewing options (Google Maps, Google Terrain, and Google Satellite) in the Base tab, as presented in Figure 40.

To use the map, the user can use the mouse wheel to zoom in/out of where their mouse pointer is. By holding the mouse wheel or the left click-button, the user can move throughout the map. This is important to keep in mind when drawing the route.

Figure 40 – Base tab of the GIS module

Once the user has its desired map layer background and has selected a location to begin drawing the route, the user should select the Overlays tab and then click on an empty checkmark next to “Routes”, as shown in Figure 41.

Figure 41 – Routes option activated in GIS module

When “Routes” is “checkmarked”, the user should click on the three dots to the right side of the “Routes text”, and then click on “Edit geometry” (Figure 42). This will open edit mode where the route can be drawn.

Figure 42 – Using the Edit geometry option

In the edit mode, the user can now begin drawing the route by clicking on ”add line” icon. Clicking the first point on the map defines the starting point of the route. Each next click presents the next point

of the route, with segments between them being straight lines. Clicking the mouse wheel enables the user to move around the map in all directions, while also adding new points on the route (Figure 43). It is also possible to zoom in and out during the creation of the route.

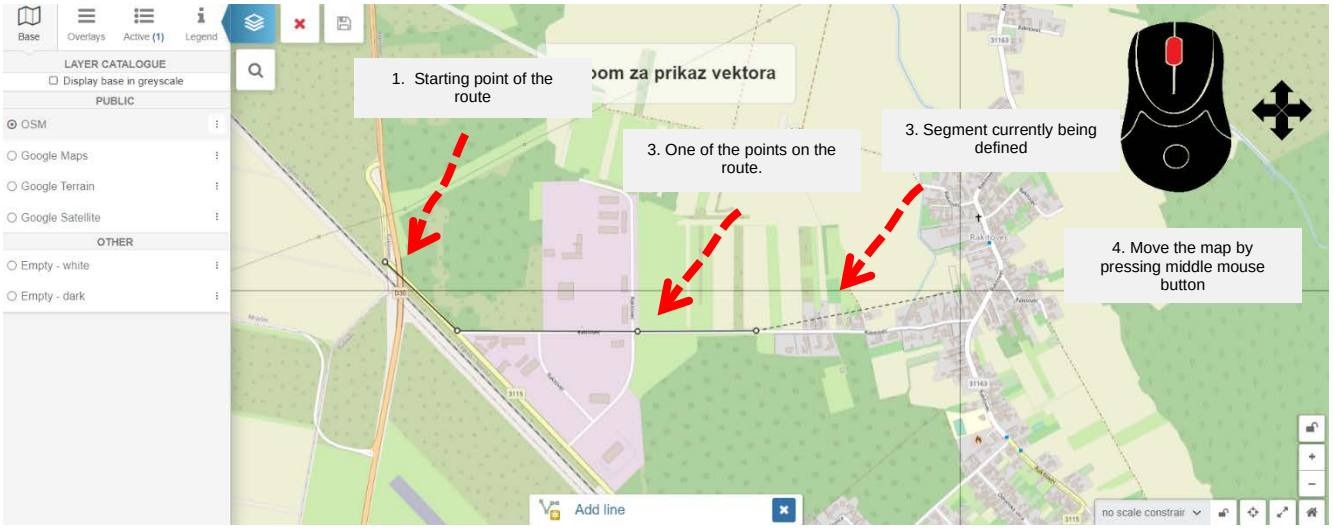


Figure 43 – Creating a route

Once the user is done with the final point, that point should be double clicked to finish the route. One other button to keep in mind is the edit geometry button, which can be used to edit the centreline of the route. Once the route is drawn, the Save icon should be clicked.

Figure 44 – Using Edit geometry and Save button

If the user is satisfied with the layout of the route (or does not wish to save), the red X icon next to the save icon should be clicked to leave edit mode.

Once the user leaves edit geometry mode either by cancelling or saving the route, they should click on the route centreline which was created for the route (if there are multiple checkmarks enabled within overlays, the user will be prompted to select one of the layers in some cases. If this happens, the user should click on “Routes”). Once the route is selected, a special window in the right upper

corner of the screen will open, where the route can be assigned a name. After naming the route, the user should click save (two clicks on a save button are required, be mindful of a popup message which confirms that the name of the route was saved), and then click on the “Add cross-section” button (Figure 45). Clicking on “x” in the upper right corner of this new window deselects the route.

Figure 45 – Creating, naming, and saving the route; Adding cross sections

Once the previous step is completed, the user should uncheck the checkmark next to “Routes” and click the checkmark next to “Route sections” (Figure 46). Then, the user should click on three dots on “Route sections” and when a new window appears, click “Edit geometry”. Edit geometry mode will turn on again, where the route can be selected, and cross sections can be split.

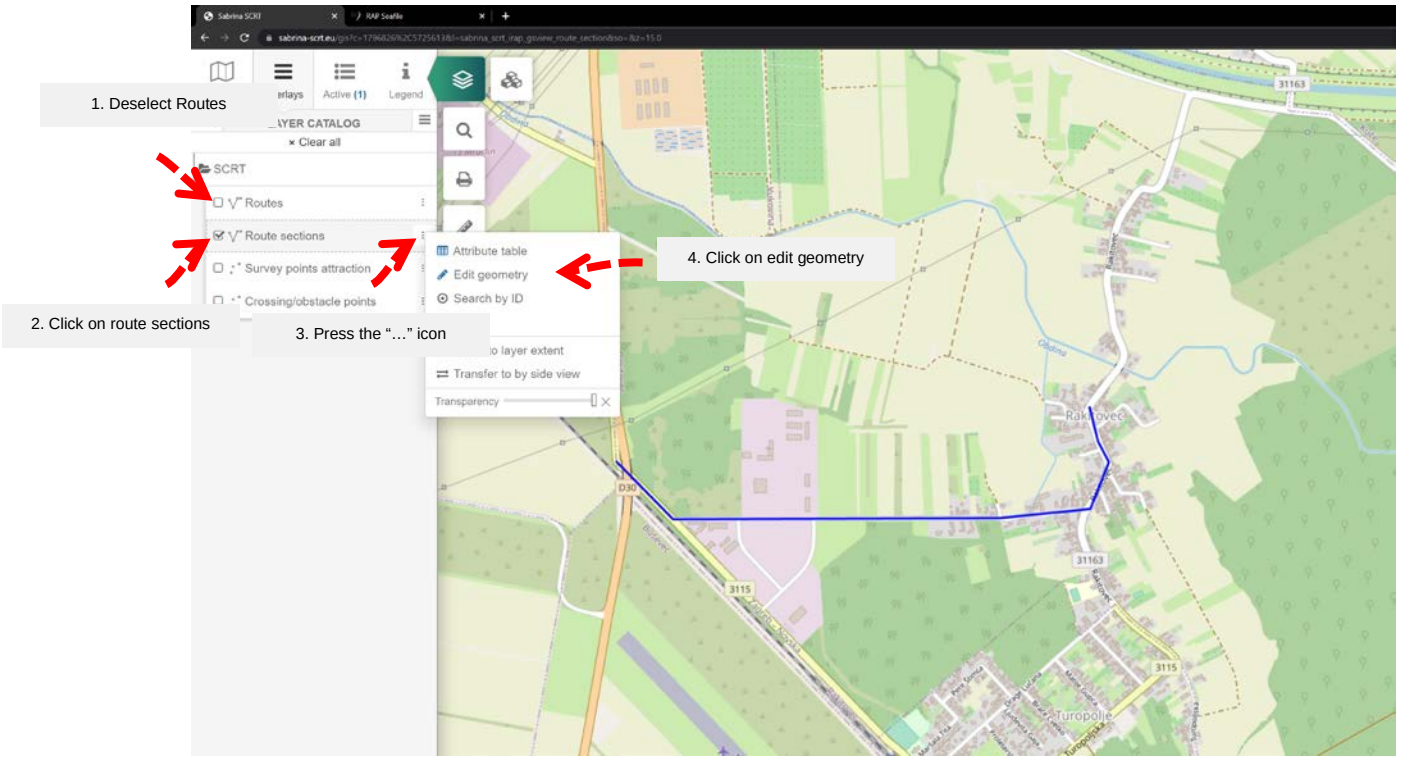


Figure 46 – First step in creating Route sections

Once edit mode is accessed, the user should click on the route centerline. If the route cannot be clicked on, the user should zoom in or click on “Zoom za prikaz vektora” (English translation will be updated soon) which has appeared on the screen. The “Split objects” icon is used to split the route into multiple sections, where the user will attribute various cross-sections for this route by making a line which will cut/intersect the route. Double clicking the final point on the line completes the split process, as presented in Figure 47.

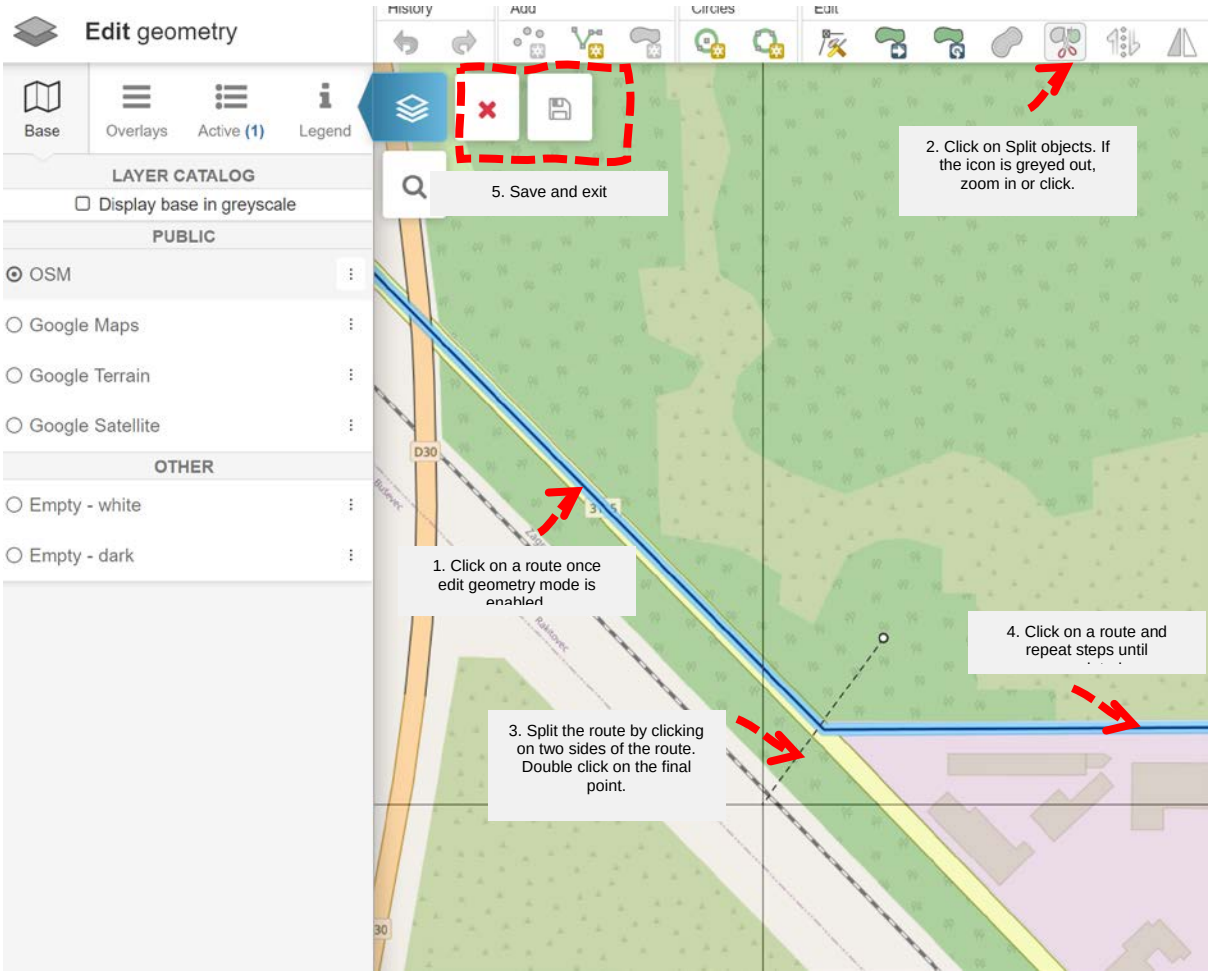


Figure 47 – Second step in creating Route sections

This process should be repeated until the route is adequately split. If is greyed out, the user should click on the route or zoom in. Once the process is complete, the user s**hould click on save** and then on red “x” next to save.

The route is now completed and is ready to be assessed in the **route rating module**.

3.2.3. Adding ECS point attributes within the GIS module

Also, it is possible to add ECS point attributes in the GIS module. However, this is **not a mandatory action** since the route can be assessed in other modules without any ECS point attributes. A single point can represent multiple services, obstacles, or attractions. For example, a point located on the main crossing of a small town can represent all the different categories of accommodation and food services available in the town. Another point can include evaluation of safety hazard (dangerous crossing), physical obstacle (high kerb) and legal continuity (obligation to dismount).

Following types of points are defined:

- Crossing/obstacles
- Attraction
- Signing
- Public transport
- Accommodation/food
- Information
- Bike service
- Rest place
- Other

The platform takes the point attributes into account and presents ECS results in the output of route rating module. The following section explains how to add ECS attributes.

First step involves clicking on checkmarks next to “Routes” and “Survey point attractions” (Figure 48).

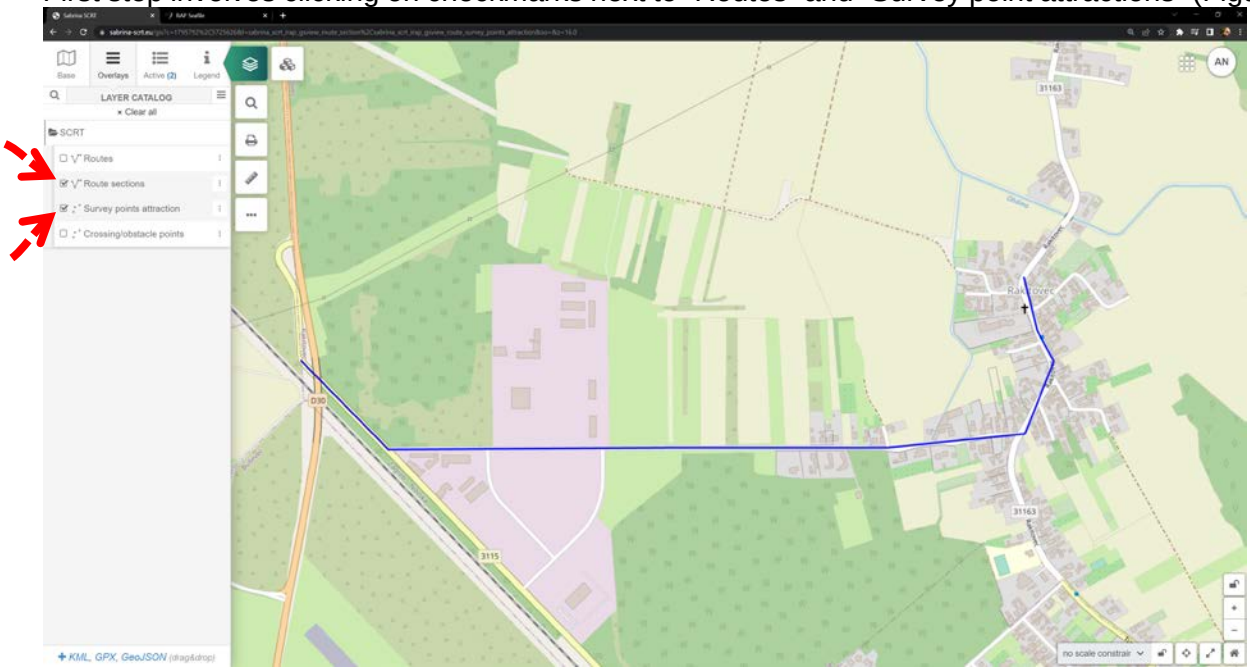


Figure 48 – First step: clicking Routes and Survey point attractions

To see present crossings more clearly the map background should be changed to Google Satellite in the Base layer tab. If the user has visibility issues, the “display layer in grayscale” option should be activated (Figure 49).

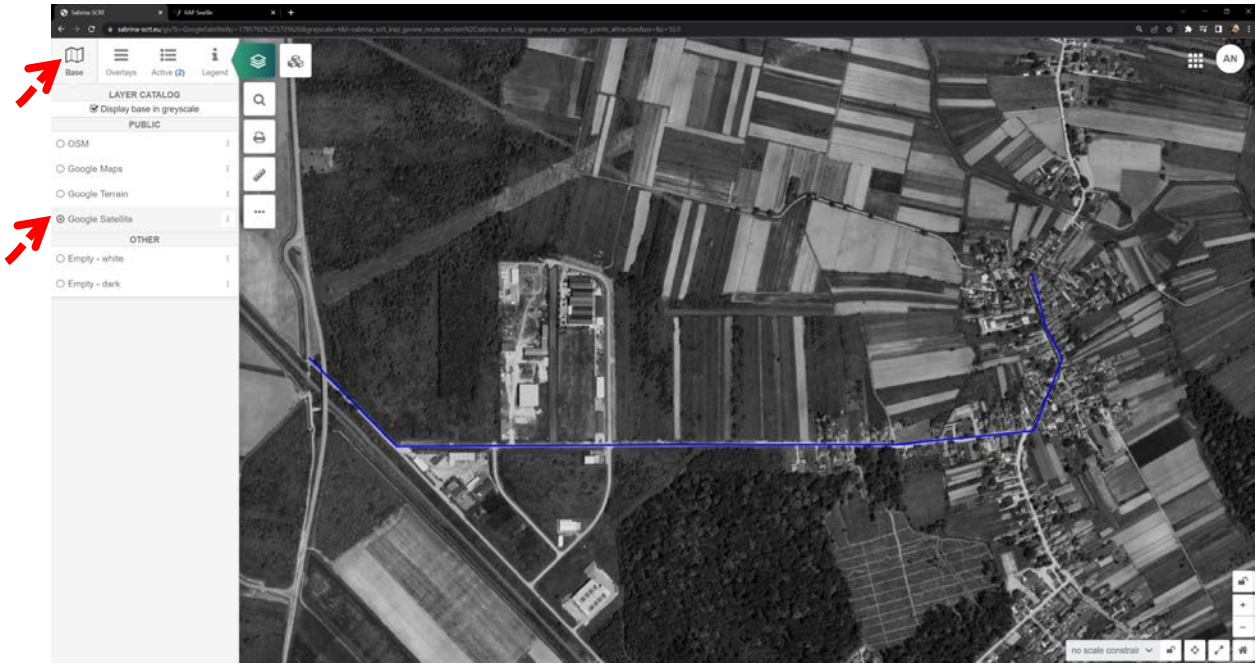


Figure 49 – Enabling Google Satellite and Grayscale option

The user should then return to the Overlays tab and click on three dots to the right side of "Survey points attraction" and later click Edit geometry to open edit mode (Figure 50).

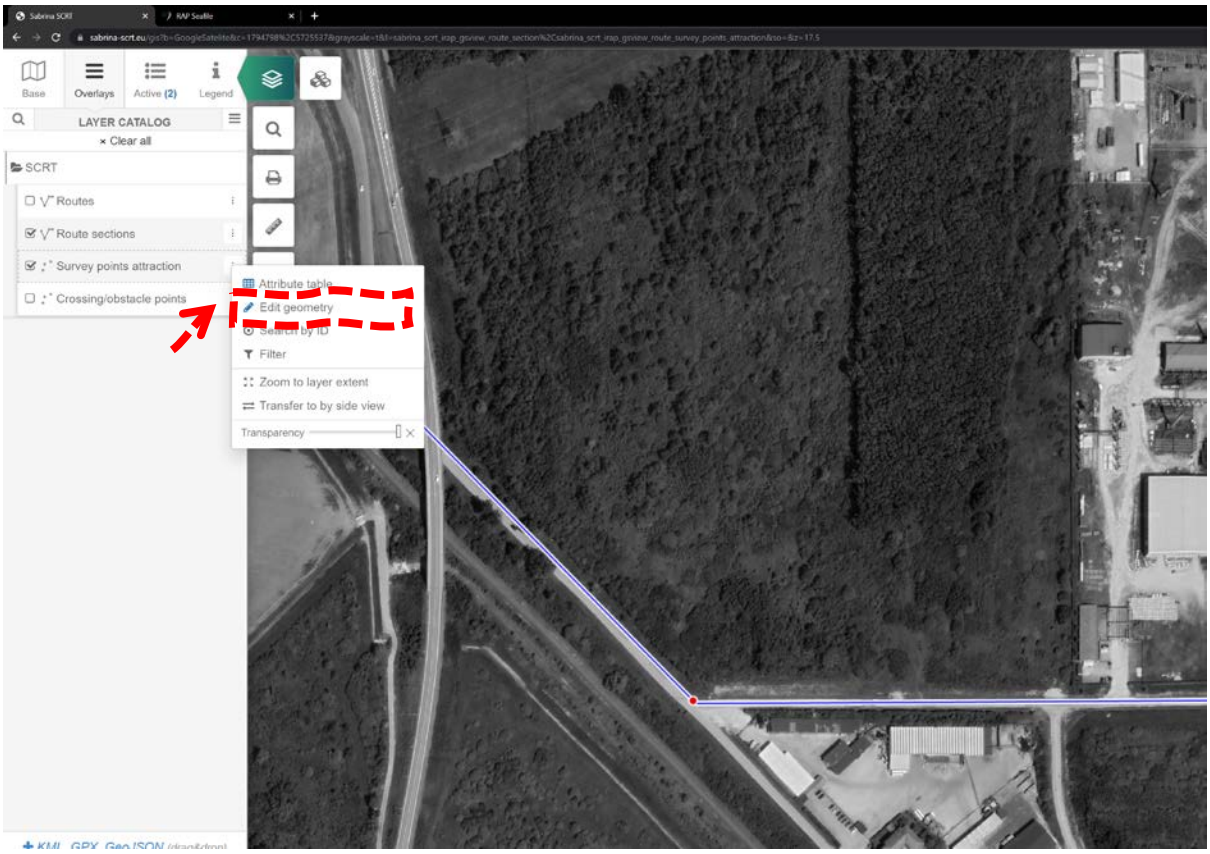


Figure 50 – Accessing the Edit geometry option

Within the edit mode, the user should click on "add-point" icon and add any point which can be defined as an attraction according to the ECS manual. It should be made sure that the **point is**

located on the route line (Line intersects the point). The process should be continued until all desired locations are added (Figure 51).

Figure 51 – Adding new points to the route

The process should be continued until all desired locations are added. Once it is completed, the user should click on Save and exit the edit mode (Figure 52).

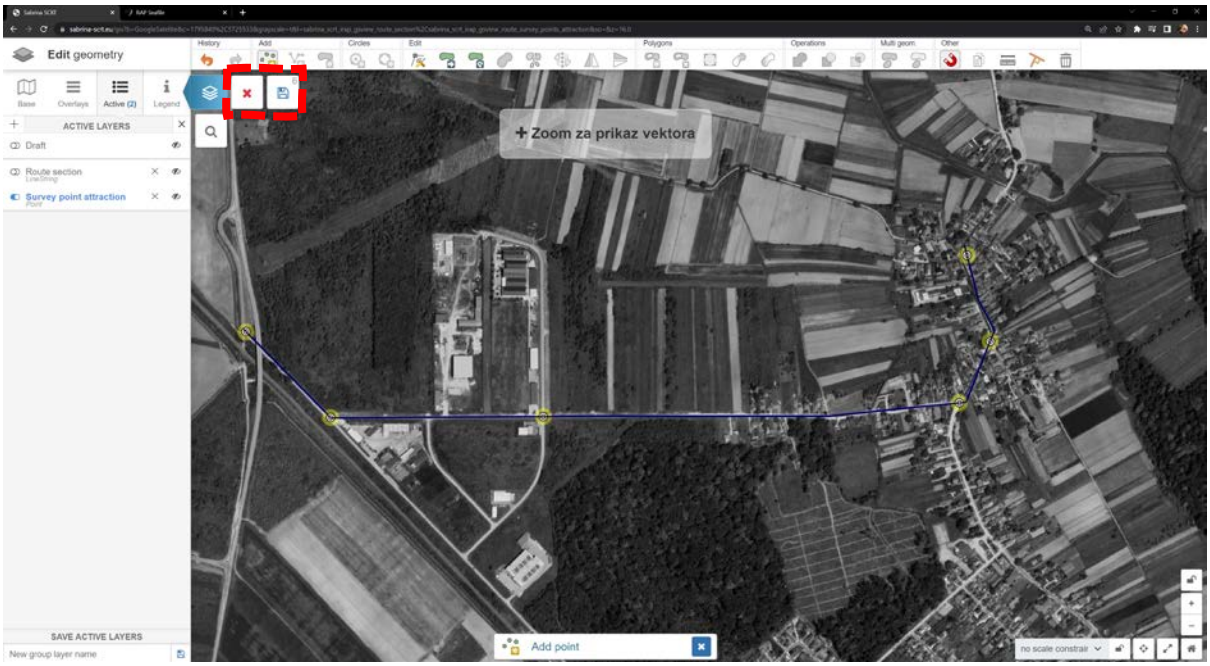


Figure 52 – Saving and exiting edit mode

When the user leaves edit mode, the three dots next to “Survey points attraction” should be clicked, and afterwards, the attribute table button (Figure 53).

Figure 53 – Accessing the attribute table

All ECS attraction attributes can be seen within the attribute table (Even from the other routes), so they can be filtered for this route by clicking on „draw a polygon“ (Figure 54), after which the rough poligon around the route can be drawn, which will then select only new attributes. Once the polygon is defined, accept should be pressed when window prompts the user to search within selected area to select only ECS attributes for the route (Figure 55).

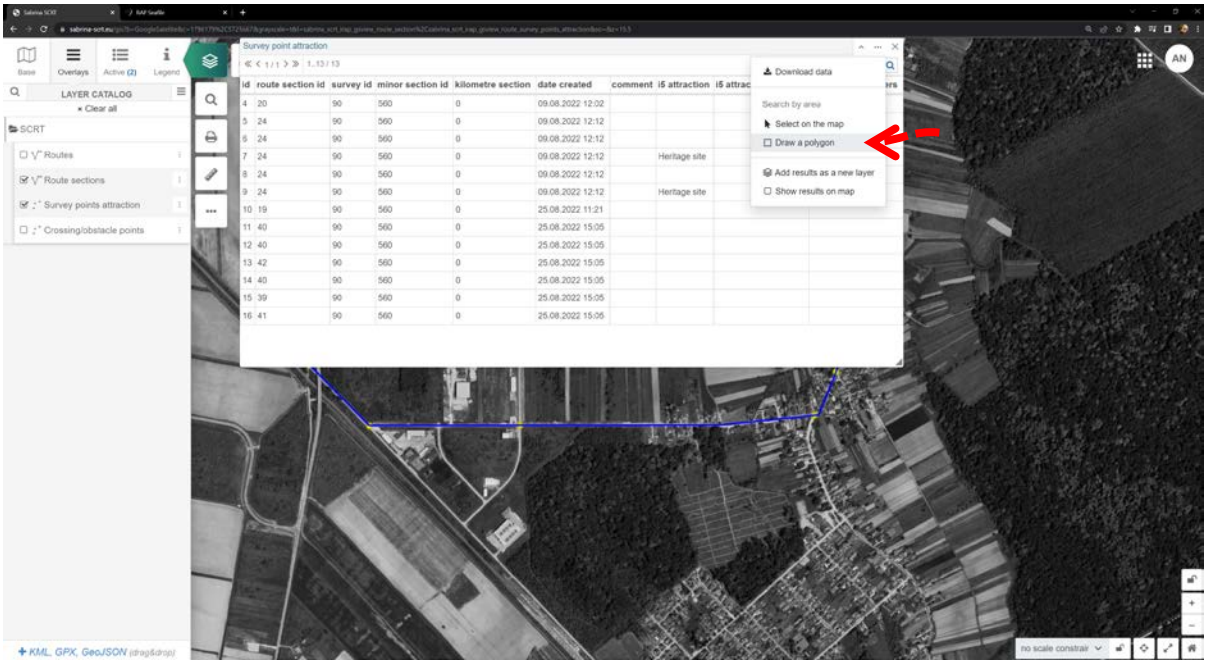


Figure 54 – Accessing the Draw a polygon option

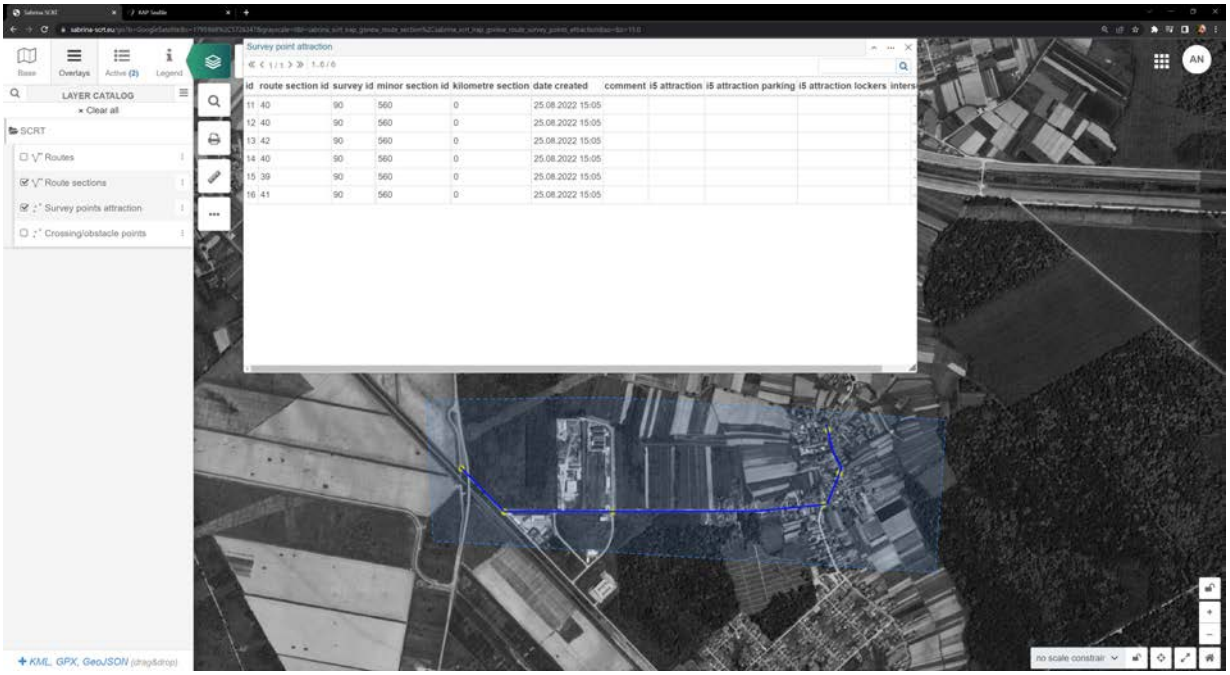


Figure 55 – Window with drawn polygon and a list of attributes inside it

The user should click on each of the points and name them (Clicking on the point in the attribute table selects it and zooms in on point's location). "Cultural heritage" will be used for all the attractions in this example. The save button should be clicked once the ECS survey point is named (Figure 56). The process should be repeated until all the points have been named appropriately. ECS manuals from ECF should be consulted regarding appropriate naming and attribute groups.

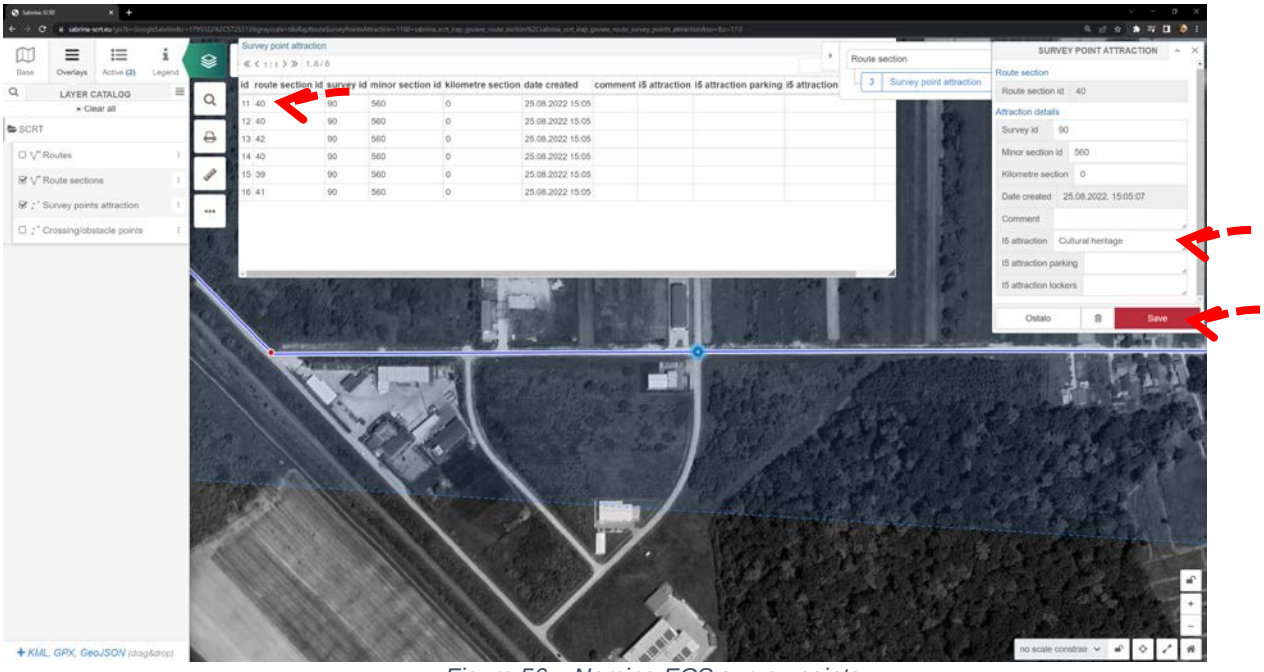


Figure 56 – Naming ECS survey points

Now all the ECS attractions on the route have been recorded and can be seen within route rating module once they load and assess the route within that module. They are presented in a list in Figure 57.

Survey point attraction

1..6 / 6

id	route section id	survey id	minor section id	kilometre section	date created	comment	i5 attraction	i5 attraction parking	i5 attraction lockers	i
11	40	90	560	0	25.08.2022 15:05		Cultural heritage			
12	40	90	560	0	25.08.2022 15:05		Cultural heritage			
13	42	90	560	0	25.08.2022 15:05		Cultural heritage			
14	40	90	560	0	25.08.2022 15:05		Cultural heritage			
15	39	90	560	0	25.08.2022 15:05		Cultural heritage			
16	41	90	560	0	25.08.2022 15:05		Cultural heritage			

Figure 57 – Survey point attraction list

3.3. Route rating/comparison module

This module enables the user to, according to the infrastructure type and traffic situation, rate the entire route combination, give additional data about the route combination, and compare the route combination to other route combinations and other routes. The results which can be obtained using this module are described below.

Once entering this module, the user is presented with the following options, as presented in Figure 58.

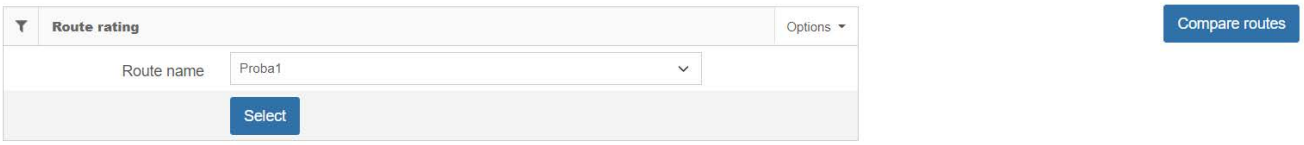


Figure 58 – Route rating start screen

If the user wishes to rate the previously saved route (Routes are defined in the GIS module, please refer to GIS module chapter in order to gain insight on how to do the route definition), this can be done by selecting it from the drop-down menu. If the user wishes to compare two routes instead, the Compare routes button should be used. Routes comparison will be presented later on.

After selecting the route, the user is presented with a series of available options, similar to the cross sections module. Figure 59 presents the two important input areas: combination name and section information (labelled below).

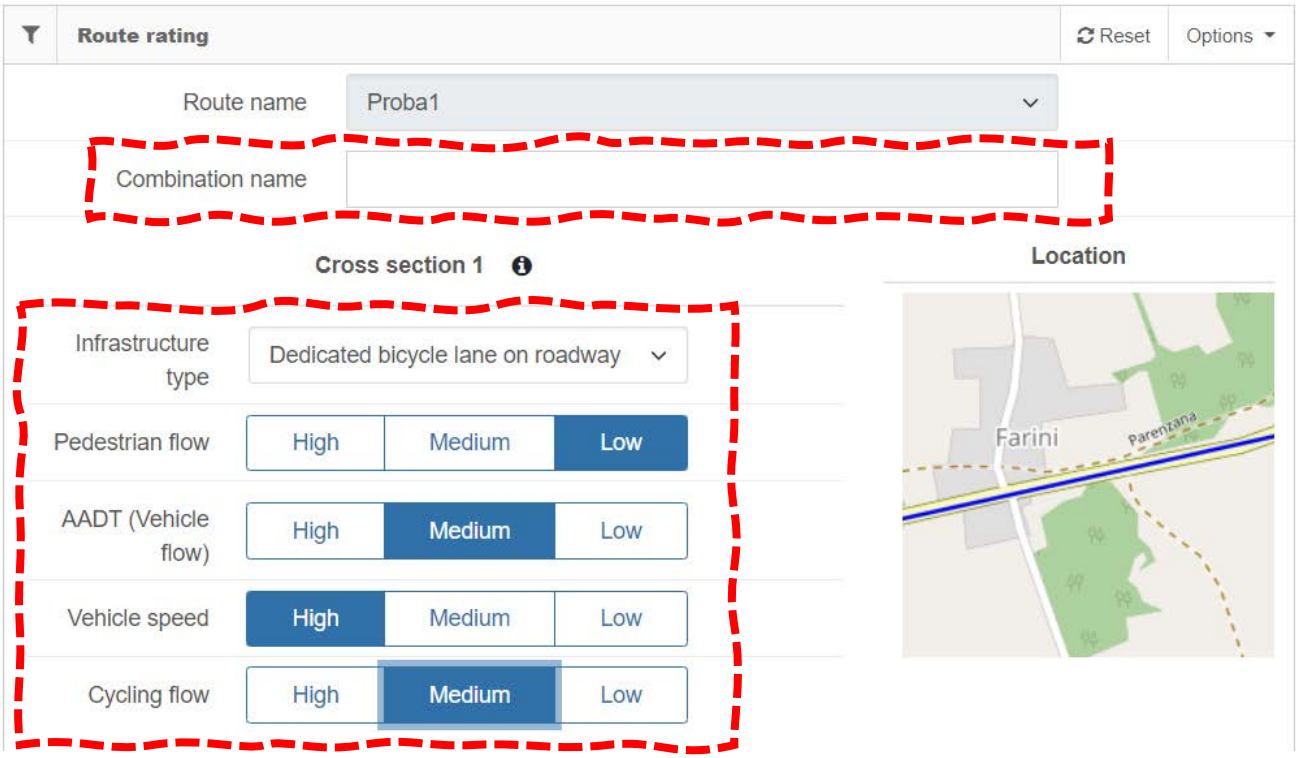


Figure 59 – Two input areas: Combination name and Section information

Firstly, the user should add a name of the combination that is being created. Entering the combination name is vital if the user wishes to save the given parameters. Then, the user should choose the appropriate infrastructure type from the drop-down menu. The following infrastructure types are available:

- Dedicated bicycle lane on roadway
- No VRU infrastructure
- Segregated bicycle path
- Barrier protected bike lane
- Shared roadway (Sharrow)
- Shared use path (Pedestrian/Cyclist)
- Sidewalk
- Wide road shoulder

Afterwards, the user chooses parameters which describe the traffic situation at the cross section. All parameters are rated as low, medium, and high. The four parameters for which ranges will need to be selected are: pedestrian flow, AADT (vehicle flow), vehicle speed, and cycling flow. Table 3 presents the values used to rate each parameter.

Table 3 – Values for the calculation of parameters

Infrastructure type	[Select one of infrastructure types from the slider]		
Pedestrian flow	High = Above 300 pedestrians per hour	Medium = From 26 to 300 pedestrians per hour	Low = Below 26 pedestrians per hour
Vehicle flow	High = Above 10000 vehicles per day	Medium = From 5000 to 10000 vehicles per day	Low = Below 5000 vehicles per day
Vehicle speeds	High = Above 61km/h	Medium = Between 31km/h and 60km/h	Low = 30km/h per hour or lower
Cycling flows	High = Above 300 cyclists per hour	Medium = From 26 to 300 pedestrians per hour	Low = Below 26 cyclists per hour

The map in the route rating module can be used to view the location of the cross section. The left mouse button can be used to move around the map, while the mouse wheel can be used to zoom in or out. Figure 60 shows the position of the map. It can be noted that the route is zoomed out compared to Figure 59, to showcase its ability to move and zoom in/out in the map.

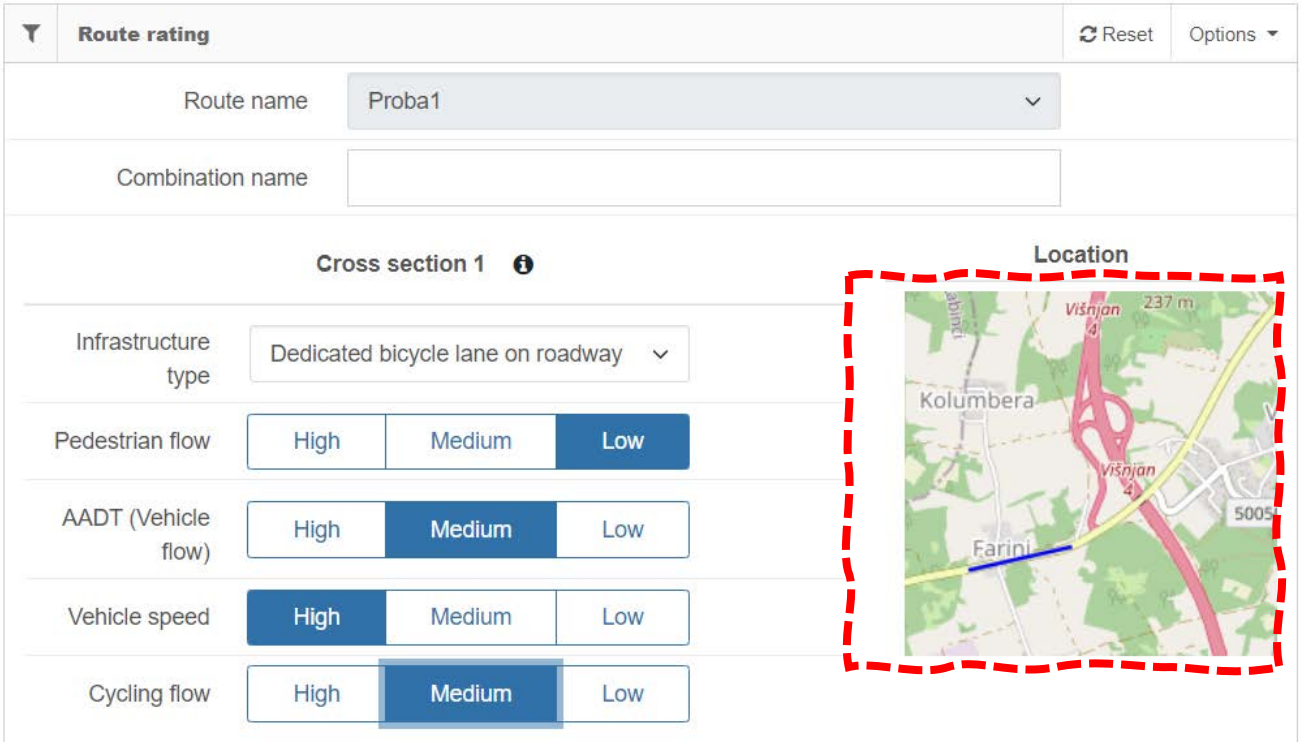


Figure 60 – Route section map

More options are available to the user: to load a saved route and view its results, and to define new route in GIS, as presented in Figure 61. Also, the user can reset parameters by clicking the Reset button, next to Options.

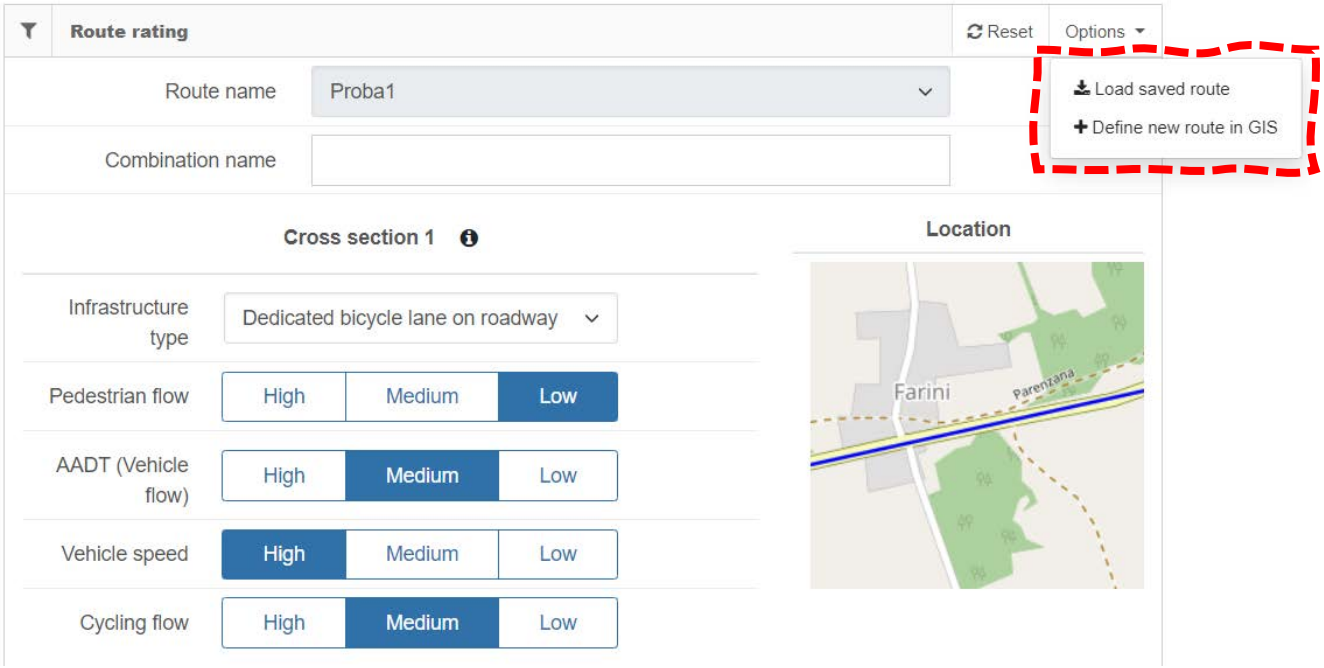


Figure 61 – Additional options in route rating module

Also, the user is offered two options: to apply the parameters and save them, or to apply the parameters and view them without saving. This function is presented in Figure 62.

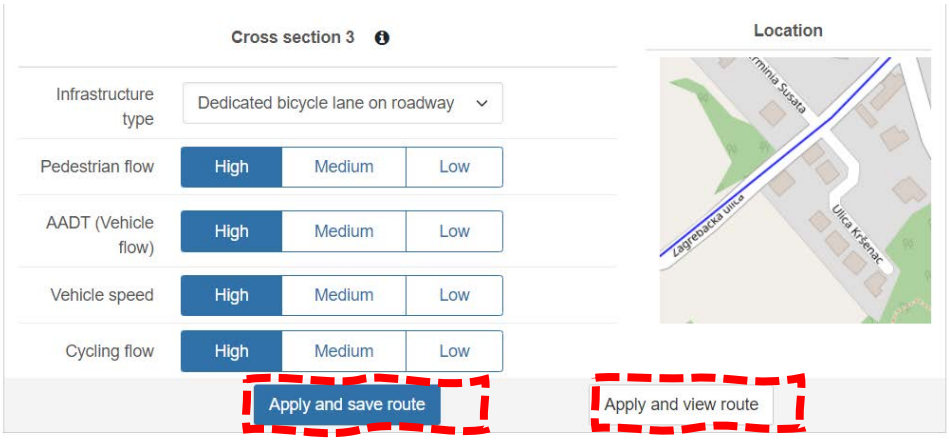


Figure 62 – Applying and saving or viewing the route

By applying the given parameters, the following results are presented (Figure 63).

Result

Total cost		14.724,00 €	
iRAP score average		66.7091 SRS	
	1 star	66 %	0.8 km
	2 stars	33 %	0.4 km
	3 stars	0 %	0 km
	4 stars	0 %	0 km
	5 stars	0 %	0 km
CycleRAP score average			
	Extreme	99 %	1.2 km
	High	0 %	0 km
	Medium	0 %	0 km
	Low	0 %	0 km
Vehicle flow (AADT)			
	High	99 %	1.2 km
	Medium	0 %	0 km
	Low	0 %	0 km
Pedestrian flow			
	High	33 %	0.4 km
	Medium	0 %	0 km
	Low	66 %	0.8 km
Cycling flow			
	High	99 %	1.2 km
	Medium	0 %	0 km
	Low	0 %	0 km
Speeds			
	High	66 %	0.8 km
	Medium	33 %	0.4 km
	Low	0 %	0 km
Route attractiveness			
Route crossing or obstacles			
Total number of 100 m sections		12	
Dedicated bicycle lane on roadway		33 %	0.4 km
Dedicated bicycle lane on roadway		33 %	0.4 km
Dedicated bicycle lane on roadway		33 %	0.4 km
	Total	100 %	1.2 km

Figure 63 – Route rating output

The user can view the total cost and the share of the following aspects throughout the route: Star Rating, CycleRAP score average, Vehicle flow (AADT), Pedestrian flow, Cycling flow and Speeds. If ECS parameters have been added, Route attractiveness and Route crossing or obstacles will also be calculated and presented. Also, the total number of 100 m sections, as well as the share of each type of infrastructure, are presented.

The comparison tool enables users to compare two routes or two route combinations (for example, current state combination and planned state combination). The routes or route combinations are chosen using the drop-down menu, presented in Figure 64.

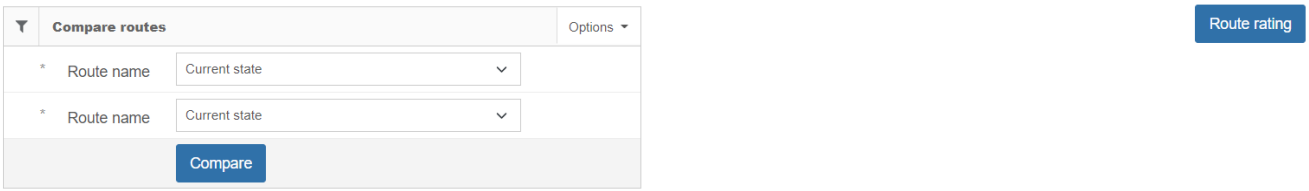


Figure 64 – Compare routes start screen

After choosing two different routes or route combinations to compare, the user will, after clicking the Compare button, be able to see the results of the comparison, presented in Figure 65.

Result

Difference			Route 2	Route 1
Cost difference		1650 %	257.692,00	14.724,00
Safety improvement (SRS)		-57 %	28.6712	66.7091
	1 star difference	-33 %	33	66
	2 stars difference	-33 %	0	33
	3 stars difference	0 %	0	0
	4 stars difference	0 %	0	0
	5 stars difference	66 %	66	0
CycleRAP score average				
	Extreme risk difference	-65 %	33	99
	High risk difference	0 %	0	0
	Medium risk difference	0 %	0	0
	Low risk difference	66 %	66	0
Vehicle flow (AADT)				
	High	0 %	99	99
	Medium	0 %	0	0
	Low	0 %	0	0
Pedestrian flow				
	High	0 %	33	33
	Medium	0 %	0	0
	Low	0 %	66	66
Cycling flow				
	High	0 %	99	99
	Medium	0 %	0	0
	Low	0 %	0	0
Speeds				
	High	0 %	66	66
	Medium	0 %	33	33
	Low	0 %	0	0
Route attractiveness				
Route crossing or obstacles				
	Difference in number of sections	0	12	12

Figure 65 – Compare routes output

The comparison list presents the user with several differences (presented in %), in the aspect of: Cost, Safety improvement (SRS), CycleRAP score average, Vehicle flow (AADT), Pedestrian flow, Cycling flow, Speeds and in number of sections. The comparison of Route attractiveness and Route crossing or obstacles are available if the user inputs ECS parameters. Also, all parameters for both routes are presented next to the data about the route differences.

3.4. Countermeasure module

The countermeasure module offers the user ability to select a route or route combination and an acceptable price for 100m (in euros). After entering this information, the module will offer options which are affordable for the user, and which will improve the Safety Score. The input menu can be seen in Figure 66.

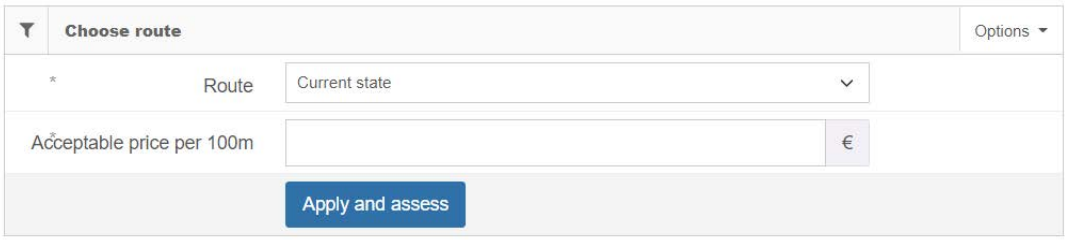


Figure 66 – Countermeasure module start screen

Also, the user can, as in previous modules, access the following options: Load saved route and Define new route in GIS, as presented in Figure 67.

Figure 67 – Countermeasure module additional options

After clicking Apply and assess, the user will be presented with the following information, with an example provided in Figure 68.

Result

Upgrade from	Upgrade to	On	Safety score Before	Safety score After
Cross section 1				
No VRU infrastructure	Shared roadway (Sharrow)	0.4 km for 2.132,00 €	151.0	143.9
No VRU infrastructure	Dedicated bicycle lane on roadway	0.4 km for 4.908,00 €	151.0	94.3
Cross section 2				
No VRU infrastructure	Shared roadway (Sharrow)	0.4 km for 2.132,00 €	151.0	143.9
No VRU infrastructure	Dedicated bicycle lane on roadway	0.4 km for 4.908,00 €	151.0	94.3
Cross section 3				
Shared roadway (Sharrow)	Dedicated bicycle lane on roadway	0.4 km for 4.908,00 €	59.4	41.8

Figure 68 – Countermeasure module output

For each Cross Section, individual row presents one viable option for the route, which can be considered. The first column presents the current infrastructure facilities, while the second presents the potential upgrades which are affordable for the user. The third column presents the price of the upgrade, while the last two columns present the Safety Score, before and after the upgrade. This module can help the user make an appropriate strategic decision regarding the network upgrade.

3.5. Safer Cycling Infrastructure Investment plan (SCIIP) modules

The Safer Cycling Infrastructure Investment plan (SCIIP) module enables users to calculate the safety benefits and costs and plan for investment. This is done by choosing a route and inputting the data presented in Figure 69, and explained below.

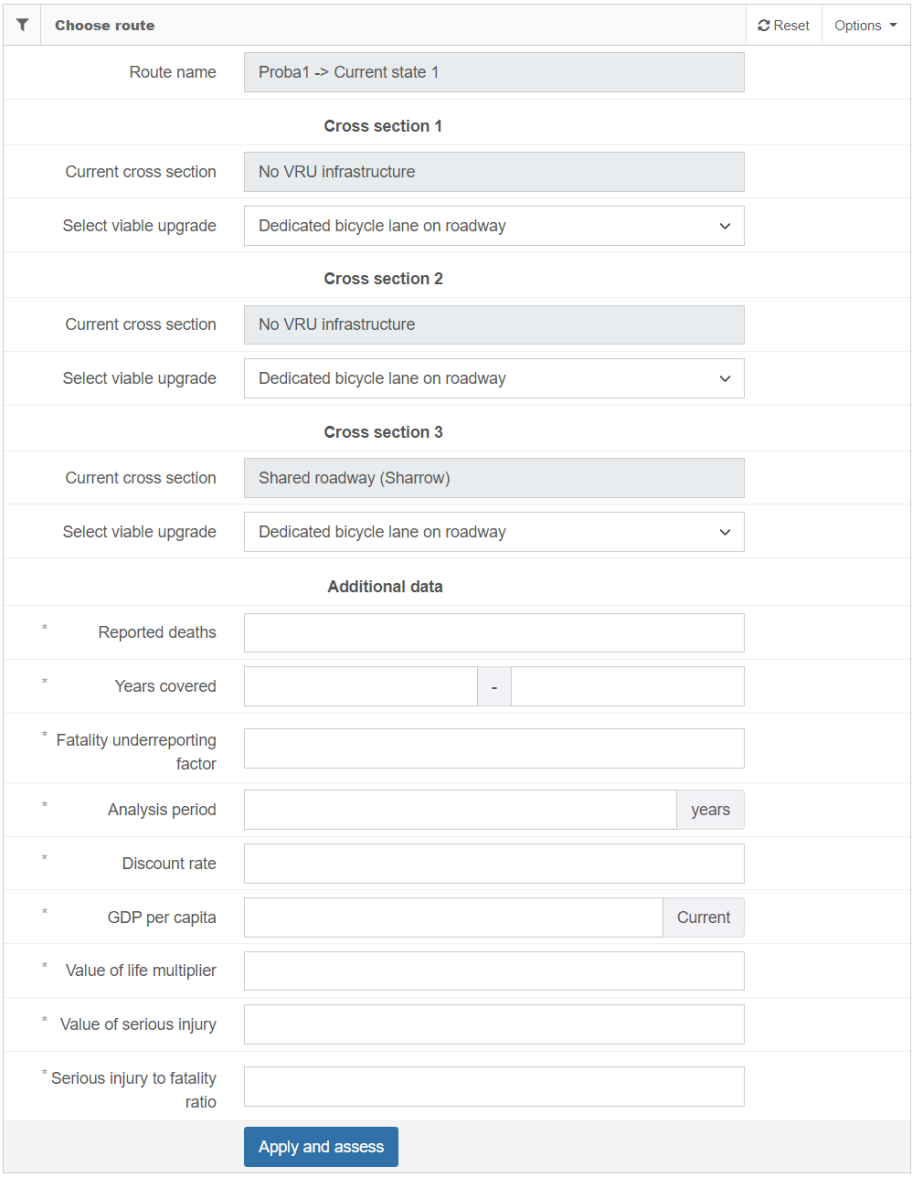


Figure 69 – SCIIP module input menu

After selecting the chosen route, the user should select viable upgrades for all cross sections. Additional data is required:

- Reported deaths – cycling deaths which were recorded on the observed network
- Years covered – the period which is analysed
- Fatality underreporting factor – represents the percentage of underreporting fatal accidents. If the percentage is 10%, 1.1 is written. Underreported fatalities are those which have occurred, but have not been recorded
- Analysis period – number of years which determine the end of the analysis period (20 is recommended)
- Discount rate – it is used to estimate net present values. iRAP recommended value is 4% but this can be adjusted depending on the usual practice in each country
- GDP per capita – Gross Domestic Product, expressed in Euros, current prices
- Value of life multiplier – iRAP recommends the value of 70
- Value of serious injury – percentage expressed value of serious injury compared to Value of life
- Serious injury to fatality ratio – ratio of serious injury accidents compared with fatal accidents

After inputting this data, the user should click the Apply and assess button, presented in Figure 70. This way, the platform calculates the relevant output data. Also, the Options button at the top of the screen provides the user with two options: Load saved route and Assess new route in GIS. The input data can also be reset.

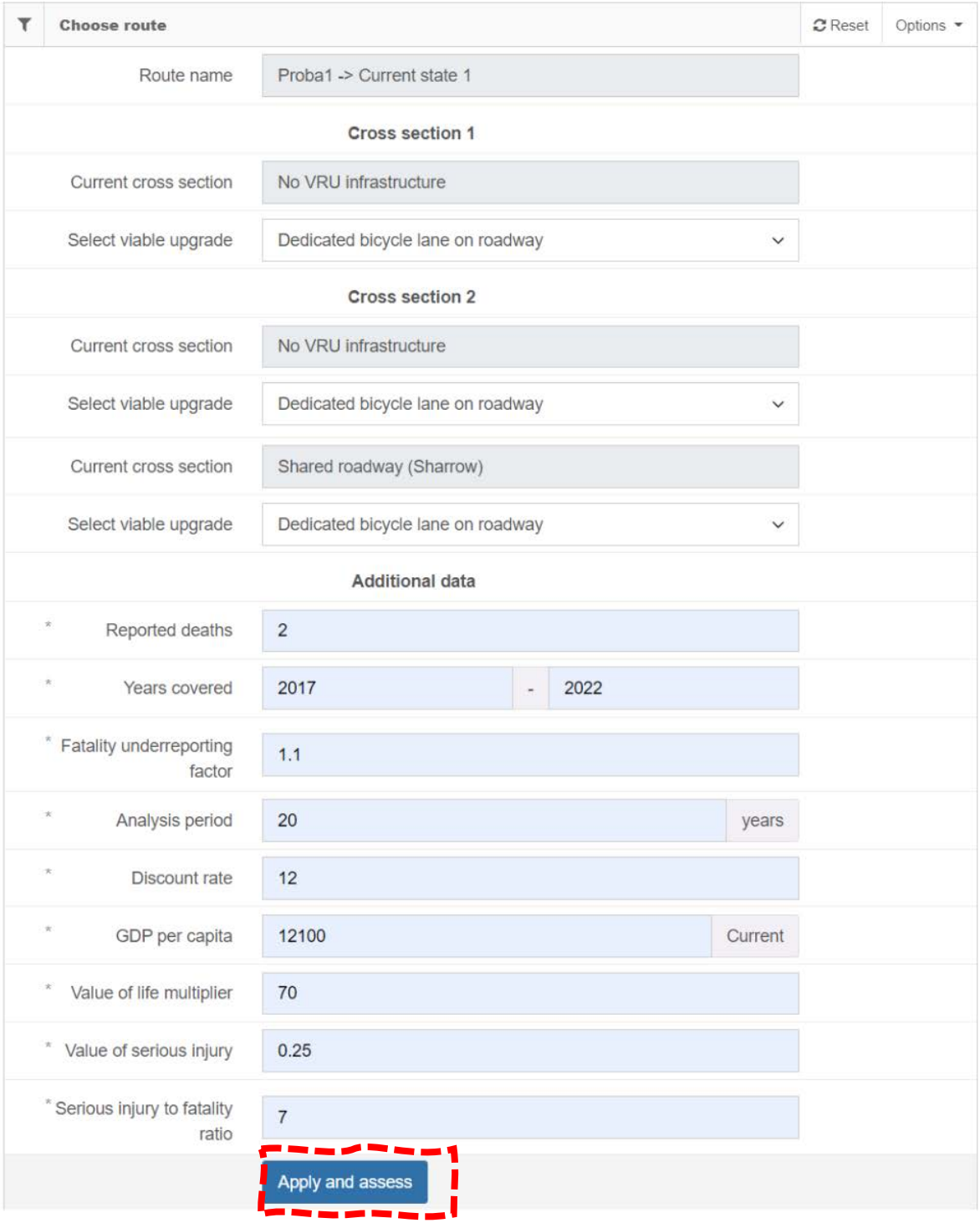


Figure 70 – Applying the input data in SCIIP module

Figure 71 presents the output data calculated by the platform.

Result

SCIIP

Total FSIs Saved	Total PV of Safety Benefits	Estimated Cost	Cost per FSI saved	Program BCR	Network length
67.2	7.520.054,02 EUR	44.172,00 EUR	657,32 EUR	170.2	1.2

Countermeasure	Length (KM)	FSIs saved	PV of safety benefit	Estimated Cost	Cost per FSI saved	Program BCR
Dedicated bicycle lane on roadway (Cross section 1)	0.4	22.4	2.506.684,67 EUR	14.724,00 EUR	657,32 EUR	170
Dedicated bicycle lane on roadway (Cross section 2)	0.4	22.4	2.506.684,67 EUR	14.724,00 EUR	657,32 EUR	170
Dedicated bicycle lane on roadway (Cross section 3)	0.4	22.4	2.506.684,67 EUR	14.724,00 EUR	657,32 EUR	170

Figure 71 – SCIIP module output

The output presents the safety benefits and costs of infrastructural upgrades, the Fatal and Serious Injuries (FSIs) saved for defined analysis period, cost per FSI saved, as well as the program Benefit-cost ratio (BCR) for defined analysis period.

4. Annex 1 - Data sources

The data used in the research was obtained from various sources, and they are presented in this Annex. At the moment, there is a lack of adequate scientific data on the impact of cycling infrastructure on accidents where cyclists have been involved. This is why the SCRT tool, besides the default values for each infrastructure type, has an option for the user to define their own values in order to update the data as they see fit (once more research becomes available). Furthermore, this option will enable the user to assess the safety of their cycling routes with data which is closer to their national standards.

Table 4 presents the costs, reduction potential and service life of each infrastructure type.

Table 4 – Costs, reduction potential and service life of infrastructure types

Nr	Infrastructure type	Cost in € (100m)	Reduction potential	Service life (Years)
1	No VRU infrastructure	0	0	0
2	Shared roadway (Sharrow)	533	0,19	5
3	Wide road shoulder	18 993	0,71	25
4	Dedicated bicycle lane on roadway	12 27	0,5	6
5	Shared use path (Pedestrian/Cyclist)	131 774	0,6	20
6	Sidewalk	10 910	0,41	40
7	Segregated bicycle path	31 598	0,842	20
8	Barrier protected bike lane	20 932	0,52	20

The No VRU infrastructure type is described as: Bicyclists/light vehicles use the same street space/path as large, motorised vehicles (International Road Assessment Programme (iRAP), 2022). The cost, reduction potential and service life are 0, as the infrastructure already exists and there is no safety improvement.

Shared roadways (Sharrow) are defined as road markings used to indicate a shared lane environment for bicycles and automobiles. Among other benefits shared lane markings reinforce the legitimacy of bicycle traffic (National Association of City Transportation Officials (NACTO), n.d.). The price for 100m was obtained from (City of Bellingham, 2014), the reduction potential was obtained from (Crash Modification Factors Clearinghouse, 2012) and the service life was also obtained from (City of Bellingham, 2014).

Wide road shoulder is defined as space on the street (but out of the direct path of large, motorised vehicles) used by bicyclists/light vehicles. May be unmarked (International Road Assessment Programme (iRAP), 2022). The cost per 100m was obtained from (Benni, Macaraig, Malmo-Laycock, Smith Lea, & Tomalty, 2019), the reduction potential from (Federal Highway Administration, 2013), and the service life from (Wisconsin Department of Transportation, 2019).

Dedicated bicycle lane on roadway is defined as an on-street lane intended for use by bicycles/light vehicles, which is out of the main path of large, motorised vehicles and marked accordingly (International Road Assessment Programme (iRAP), 2022). The cost per 100m was obtained from (City of Bellingham, 2014), the reduction potential from (Schmitt, Study Finds Protected Bike Lanes Increase Traffic Safety for Everyone-Including Drivers, n.d.), and the service life from (City of Bellingham, 2014).

Shared use path (Pedestrian/Cyclist) is an off-street path which is intended for use by bicycles/light vehicles and pedestrians. Multiuse paths are generally wider with signage indicating it as such (International Road Assessment Programme (iRAP), 2022). The cost per 100m was obtained from (Bushell, Poole, Zegeer, & Rodriguez, 2013), the reduction potential from (Schmitt, Study Finds Protected Bike Lanes Increase Traffic Safety for Everyone-Including Drivers, n.d.), and the service life from (Luecke & Loughran, 2019).

A sidewalk is defined as an off-street path intended for pedestrian use. Cyclists often utilize this space if no adequate cycling infrastructure is provided (International Road Assessment Programme (iRAP), 2022). The cost per 100m is obtained from (Purnell, 2022), the reduction potential from (Crash Modification Factors Clearinghouse, n.d.), and the service life from (Czarencki & Poon, 2017).

A segregated bicycle path is defined as an off-street path which is intended for use by bicycles/light vehicles only (International Road Assessment Programme (iRAP), 2022). The cost per 100m is obtained from (Luecke & Loughran, 2019), the reduction potential from (Crash Modification Factors Clearinghouse, n.d.), and the service life from (International Road Assessment Programme (iRAP), 2022).

A barrier protected bike lane is defined as a dedicated bicycle path separated from traffic by a physical barrier. A physical barrier must be sufficient to restrain a vehicle from entering the bicycle facility at the posted speed limit (International Road Assessment Programme (iRAP), 2020). The cost per 100m was obtained from (Wilson, 2020), the reduction potential from (Pasadena Complete Streets Coalition, n.d.), and the service life from (Luecke & Loughran, 2019).

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