User Manual

The MerlinRoads Team

V1.0, April 2025

Contents

Chapter 1

General Infomation

MerlinRoads is a traffic incident visualization dashboard. It provides users with the tools to explore, filter, and visualize traffic incidents on a road network, as well as run traffic simulations to assess the impact of road closures and other events. It consists of two main components:

- Incident Dashboard: Allows users to search, filter, and visualize traffic incidents using various parameters like date, time, location, and type.
- SUMO Simulation Interface: Enables users to simulate traffic flow on the road network, modify road conditions (e.g., close roads), and visualize simulation statistics.

This manual serves as a guide to using the application effectively. It explains how to navigate the interface, filter and view incident data, and run simulations using the integrated SUMO traffic simulator. It also covers visualization settings and customization options.

Chapter 2

Location Search

This section features all relevant information for finding incidents. It covers the general steps for searching incidents in a specific location, along with advanced filter options to refine results by date, day or time. Moreover, it covers how to interact with the map.

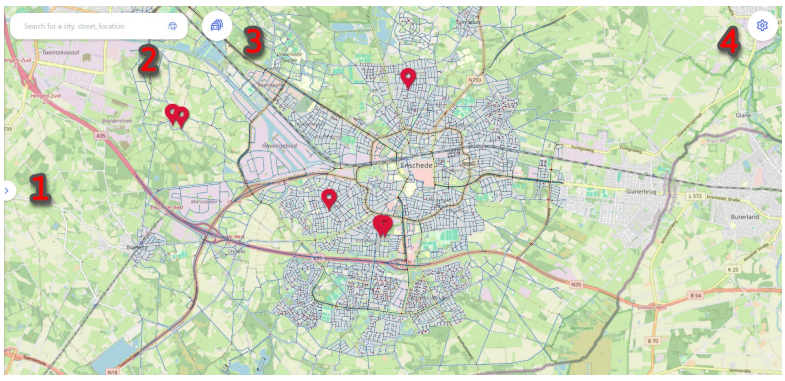

Figure 2.1: The homepage of MerlinRoads with buttons to open the search menu (1-2), SUMO (3) and the settings (4).

2.1 Finding Incidents

To be able to search for a specific location, you will first open the search menu. Do this by clicking on the input field in the top left (2.1.2) or the button on the left (2.1.1) of the home screen. Both will open the menu shown in figure 2.2. In order to search for incidents in a specific location, use the input field (2.2.1). While typing, a list of suggestions will appear. Click on one of them to autocomplete your search. Alternatively, you can

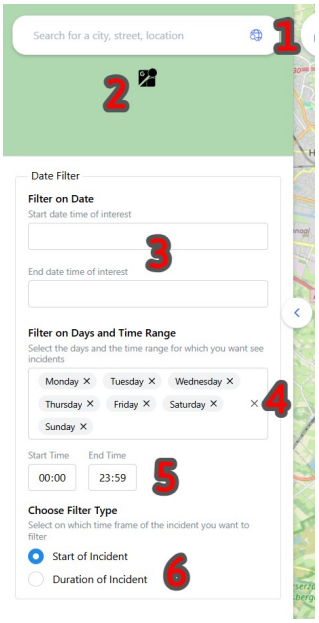

Figure 2.2: The searchbar to filter on specific locations (1-2), dates (3), days (4), times (5) and types (6).

enter the full location name manually and press enter or the search button to complete the search.

Once submitted, the dashboard will display the entire road network along with all incidents within the specified range, as defined in the settings (see section 4.1). If the location is invalid, an error message will appear and no updates will be made.

To visually inspect the searched location, click the green square (2.2.2). This will open a street view of the location.

2.2 Date/Time Filtering

To filter incidents by specific dates, days, or times, you can use the options available in the Date Filter section. You can apply all the described filters simultaneously, and the results will reflect the combination of your selected criteria. To apply all changes in this section, you need to search for the location again. Once you do, the changes will be applied and the incidents will be filtered based on your selected criteria. The following filters can be applied:

- **Date Filtering:** To filter by a specific date range, use the date input fields (2.2.3) to select a start and end date. When you click the input

field, a date picker will appear (fig 2.3). You can select a date by clicking on the desired day. All incidents within the selected date range (inclusive) will be displayed on the map.

- **Day filtering:** To filter by specific days, use the dropdown menu that appears after clicking the day input field (2.2.4). Select days by clicking on them, or remove them by clicking again or by clicking the cross next to them. Additionally, you can remove all selected days at once by clicking the cross on the right side of the dropdown menu. All incidents that occurred on the selected days will be displayed on the map.

- **Time filtering:** To filter by specific times, use the time input fields (2.2.5). Enter the start and end time, where the first two digits represent the hours and the last two represent the minutes. All incidents that occurred within the selected time range (inclusive) will be displayed on the map.

- **Filter types:** Our application allows you to filter incidents based on two different kind of time frames. You can select one of these options by clicking the corresponding radio button (2.2.6).

  - **Start of Incident:** This option allows you to filter by the incident's start date, which is useful if you need an overview of when each incident occurred.
  - **Duration of Incident:** This option allows you to filter by the incident's entire duration. It will display incidents for which any point within the range of the start and end dates overlaps with the specified filters. This is useful if you want an overview of all ongoing incidents.

2.3 Interactive Map Controls

The main map, shown in Figure 2.1, is interactive. You can use your mouse or touchpad to navigate and interact with it. The following actions are available:

- **Moving the map:** To explore different areas, click and hold the left mouse button (or press and hold on a touchpad), then drag the map in any direction to reposition it.

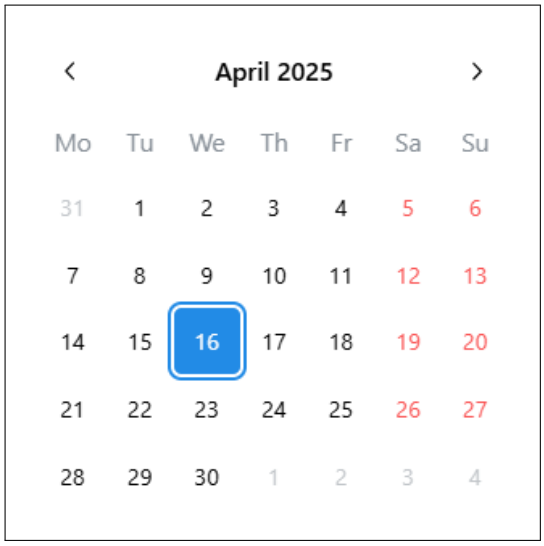

Figure 2.3: Date picker to filter on the start and end date

- **Zooming in and out:** To zoom in or out on the map, use the scroll wheel on your mouse or swipe up/down on a touchpad. Zooming allows you to view incidents in more detail or get a broader overview of the area.

Chapter 3

Incident Data and Statistics

This section provides all the relevant information to access incidents statistics. It includes information on how to view details about individual incidents, as well as how to find aggregated statistics for all incidents that occurred on a specific street.

3.1 Individual Incidents Data

To view data for a specific incident, hover over the markers on the main map. When you do, a pop-up like the one shown in Figure 3.1 will appear. This pop-up displays details about this specific incident. The contents of this pop-up may vary depending on the API or data source used, but it will at least include the incident type, description, severity, start time and end time.

3.2 Street Incident Statistics

To view statistics for all incidents on a specific street, click on this street on the roadmap. A pop-up will appear, displaying the name of the street at the top. Below this, you will find the incident statistics. If no incidents have occurred on that street, no information will be shown. Otherwise, the pop-up will display two graphs:

- **Pie Chart** The first, as shown in Figure 3.2, is a pie chart that visualizes the distribution of incident types on that street. You can hover over each segment of the chart to see the exact number of incidents of that type.

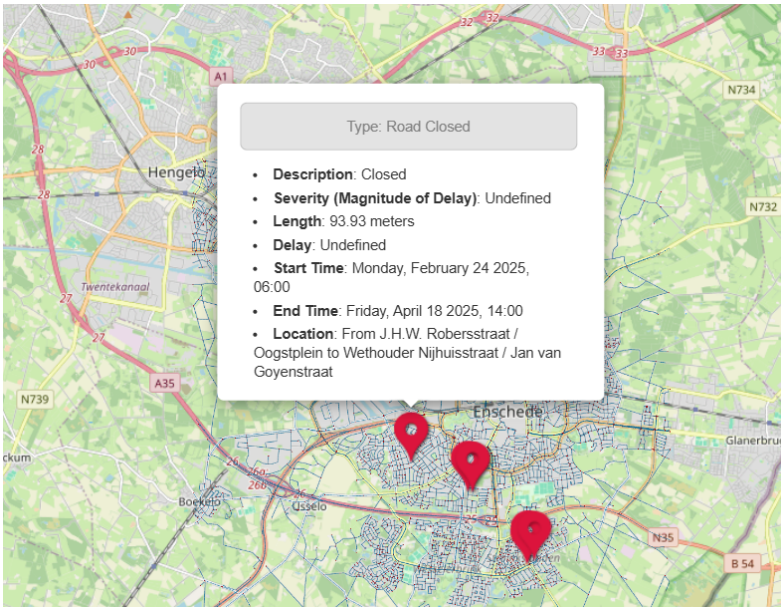

Figure 3.1: Incident information popup

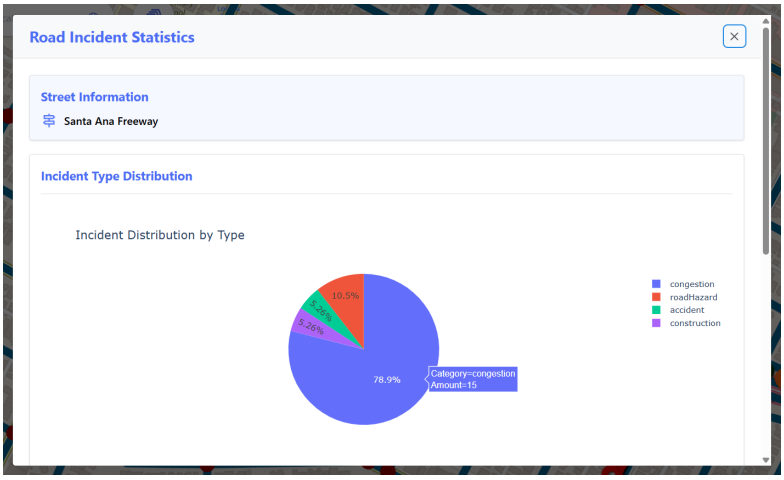

Figure 3.2: Street statistics - Pie chart

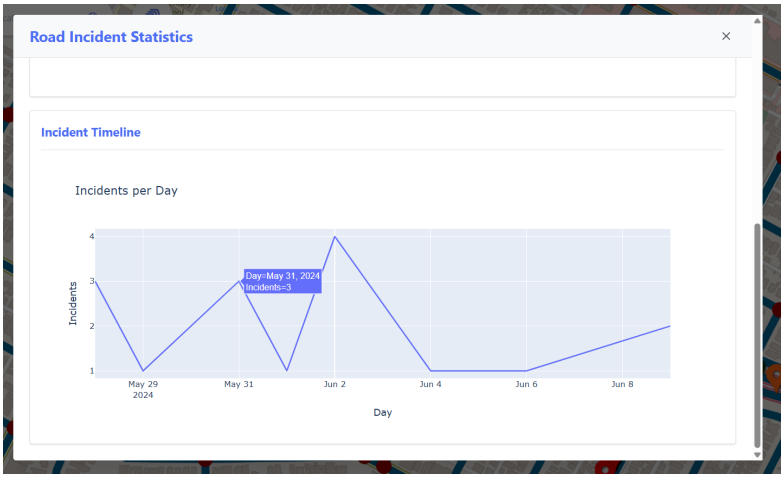

Figure 3.3: Street statistics - Line chart

- **Line Graph** The second graph, as shown in Figure 3.3, is a line chart that illustrates the distribution of incidents over time. It displays the number of incidents that occurred on each day. By hovering over any data point on the chart, you can view the exact number of incidents for that specific day.

Chapter 4

Customization Settings

This section covers the main settings of the application, allowing users to tailor various aspects such as default system behaviors, API configurations, map layer management, and appearance preferences.

4.1 Defaults

This section allows you to customize the default search ranges for map data and incident reporting. It is accessed by clicking the 'Defaults button' (4.1.1) in the Settings interface.

- **Default road map range (m)**: This control (4.1.1) sets the radius, in meters, used to query OpenStreetMap data around your selected location. It determines how far from your midpoint streets and intersections will be displayed.
- **Default API range (m)**: This setting (4.1.2) defines the radius for retrieving traffic incident data from the chosen API. It determines how far from your midpoint incident markers will be displayed

To activate the updated values, click the apply button (4.1.3) after adjusting the sliders above.

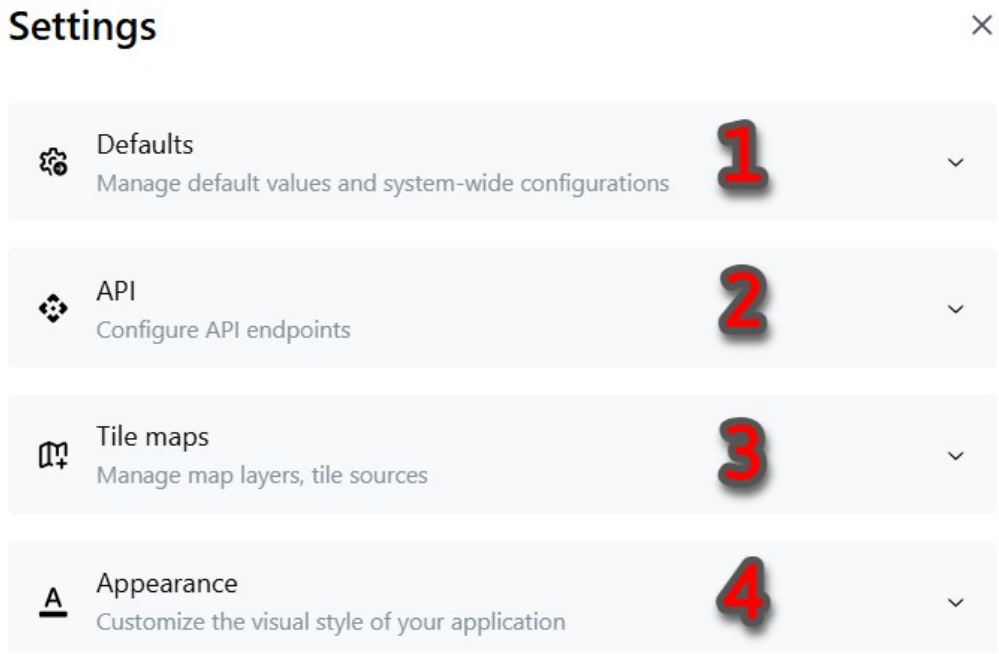

Figure 4.1: Settings interface with customizable categories: Defaults (1), API (2), Tile maps (3) and Appearance (4)

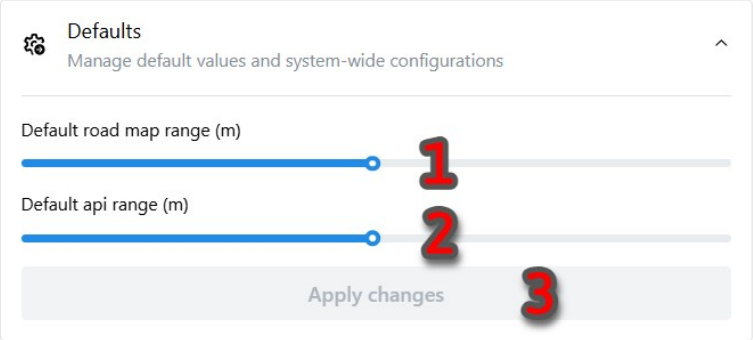

Figure 4.2: Default settings for map range (1), api range (2) and applying these changes (3).

4.2 API Configuration

Figure 4.3 shows the interface for selecting how incident data is sourced. It is accessed by clicking the API button (4.1.2) in the Settings interface.

- **Choose an API:** Users can select either the TomTom Traffic API (4.3.1) or the HERE Traffic API (4.3.2) as their data provider. Clicking on one of the options instantly switches the data source. Incident details may vary depending on the selected provider.
- **Upload Custom Dataset (.CSV):** Instead of using a live API, users can click the upload button (4.3.3) to provide a CSV file containing traffic incident data. Once uploaded, this dataset overrides any API-sourced information until a new provider is selected. For the expected CSV format, see Appendix A.

Note: Custom CSV uploads take precedence. To return to API data, simply reselect a provider.

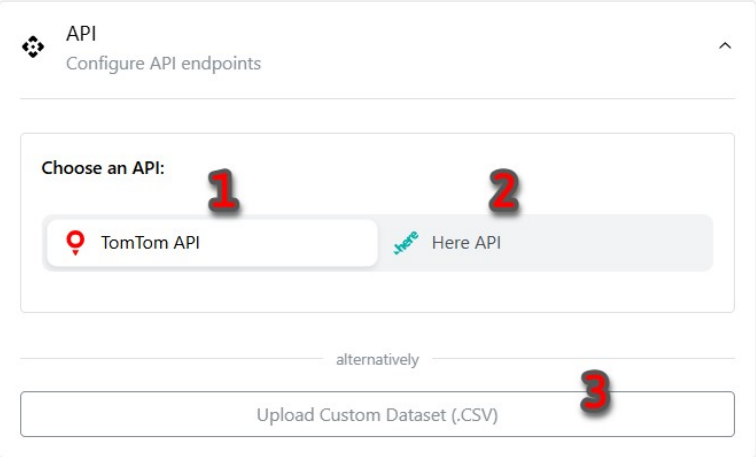

Figure 4.3: API configuration interface with selectable providers (1, 2) and CSV upload (3).

4.3 Tile Maps

Figure 4.4 shows the interface for selecting and customizing the base map layer. It is accessed by clicking the Tile maps button (4.1.3) in the Settings interface.

- Users can choose from three built-in tile map styles: OpenStreetMap (4.4.1), Carto Light (4.4.2), and OpenTopoMap (4.4.3). These options vary in detail and visual emphasis. Clicking a style immediately updates the map view.
- For more flexibility, the Custom option (4.4.4) allows loading a user-defined tile layer. When selected, additional input fields become active:
  - Custom Tilemap URL (4.4.5): A URL template with placeholders `{s}`, `{z}`, `{x}`, and `{y}` for tile coordinates.
  - Custom Tilemap Subdomains (4.4.6): Optional subdomains used by the tile service (e.g., `abc`).
  - Custom Tilemap Attribution (4.4.7): Attribution HTML for legal or licensing requirements.

Note: Tile map selection affects only visual styling and does not alter the incident data displayed.

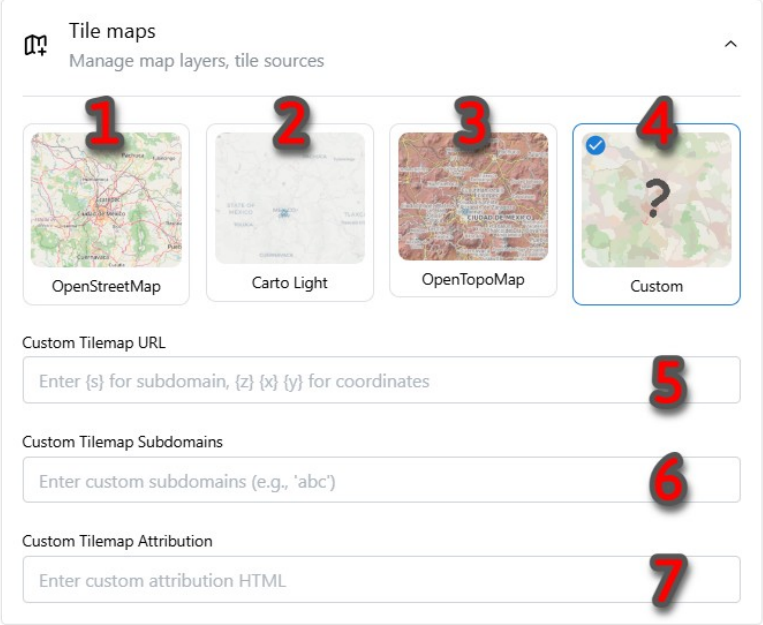

Figure 4.4: Tile map selection interface with built-in options (1–3), a custom layer (4), and input fields for configuration (5–7).

4.4 Appearance

Figure 4.5 shows the interface for customizing the visual style of the application, including how roads, intersections, markers, and incidents appear on the map. It is accessed by clicking the Appearance button (4.1.4) in the Settings interface.

- **Visual settings:** Users can control the appearance of roads and markers using the sliders for intersection size, road width, and marker size (4.5.1). Additionally, you can enable or disable marker scaling with zoom (4.5.2). This option determines whether markers scale in size as you zoom out, or remain the same relative size on the map.
- **Displayed components:** The multi-select field (4.5.3) lets users choose which elements (roads, intersections, incidents) are shown on the map. Selections are shown as removable tags.
- **Color customization:** Colors for road elements and incidents can be edited directly. Road network colors (4.5.4) allow changes to intersection and road segment colors. Incident colors (4.5.5) define how

different incident types, like Unknown, Accident, Fog or Dangerous Conditions, are displayed.

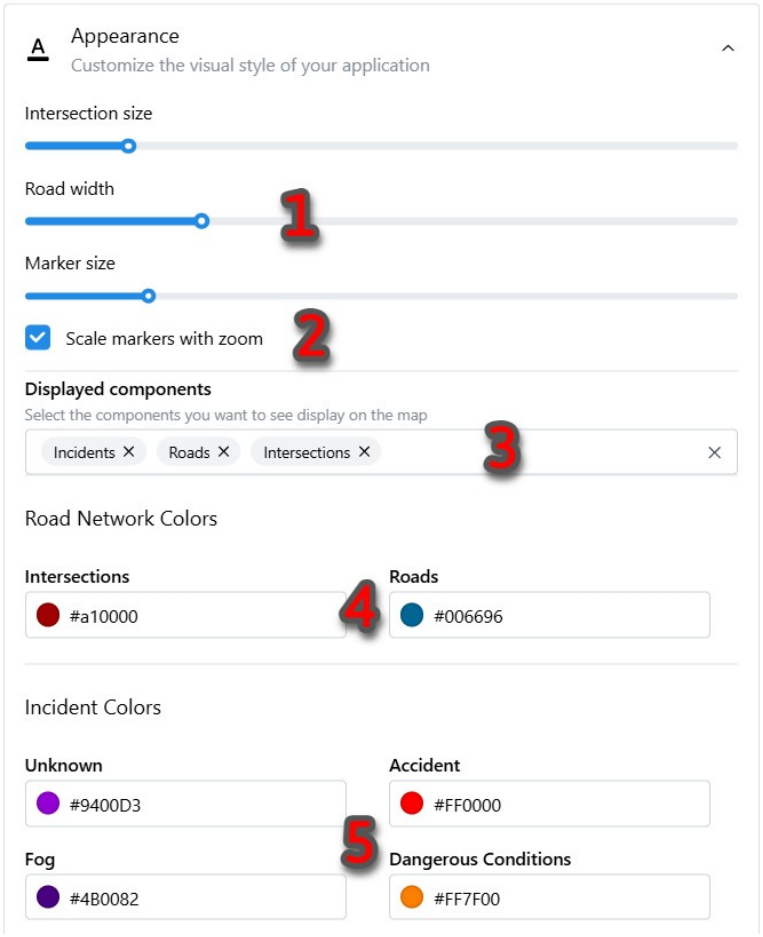

Figure 4.5: Appearance settings with controls for visual settings (1, 2), marker scaling (2), map components (3), roadmap colors (4), and incident colors (5).

Chapter 5

Using SUMO

This section explains the SUMO component of our project. Using SUMO, you can run a traffic simulation on the road network. The simulation runs in the background and collects traffic statistics, which are then visualized directly on our dashboard.

5.1 Navigating to SUMO and back

To navigate to the SUMO page, click the button with the car icon located next to the search bar (2.1.3). This will load the SUMO section of the dashboard. When you're finished simulating the network, you can return to the main dashboard by clicking the button with the house icon (5.1.1).

Figure 5.1: Main page for SUMO, with the home button (1), settings button (2) and a closed road (3).

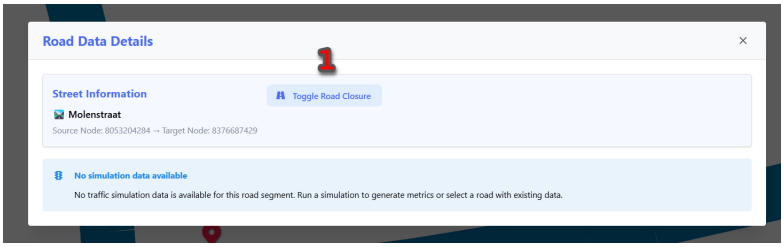

Figure 5.2: Road details and a button for toggling the closure of a specific road (1).

5.2 Closing streets for the Simulation

The simulation uses all currently visible roads in the road network. If you are interested in analyzing the impact of closing a specific road or multiple roads on various traffic statistics, you have the option to exclude that road from the simulation. There are two ways to close roads:

- **Custom roads:** To close a specific road, simply click on it within the road network. This will open a menu, as shown in Figure 5.2. By clicking the 'Toggle Road Closure' button (5.2.1), the selected road will be closed and excluded from the simulation. To reopen a closed road, simply click the same button again. This will include the road back in the simulation.

- **Roads with incidents:** To close all roads that contain an incident, open the settings menu by clicking the button in the upper right corner (5.1.2). Then navigate to the simulation settings (5.3.1). Click the 'Toggle All Roads with Incidents' button (5.4.4) to close all roads affected by incidents. Clicking the button again will reopen all previously closed roads.

- **Specific road with incident:** To close a specific road segment associated with an incident, simply click the incident marker. This will immediately close the linked road segment. If a road segment is already closed, clicking its associated marker will reopen it.

When a road is closed, it appears in a lighter color on the roadmap (5.1.3), indicating its closed status. For a quick overview of all currently closed roads, you can refer to the table in the Simulation Settings, which lists all excluded roads (5.4.3).

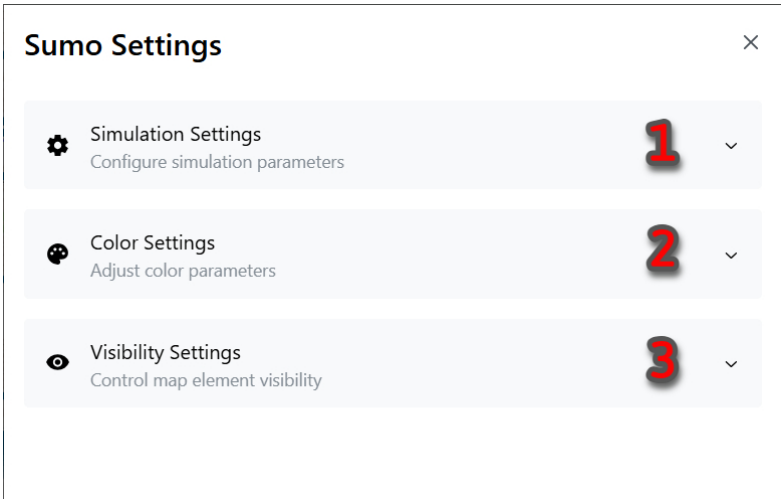

Figure 5.3: SUMO Settings, with the following categories: simulation settings (1), color settings (2) and visibility settings (3).

5.3 Running SUMO

This section explains how to run a simulation using SUMO and how to visualize the resulting statistics on the road network. Starting a new simulation is straightforward: navigate to the Settings menu (5.1.2), then open the Simulation Settings (5.3.1). To run the simulation, you need to fill in the following two fields:

- **Number of Vehicles:** The 'Number of Vehicles' field (5.4.1) specifies how many vehicles will be used in the simulation. This value can range from 1 to 10,000. It's recommended to choose a number that reflects the size of the current road network. Larger networks typically require more vehicles to produce meaningful results. For a standard-sized network, around 2,000 vehicles is usually sufficient to generate insightful and realistic outcomes.

- **Number of Steps:** The 'Number of Steps' field (5.4.2) determines how long the simulation will run. This value can range from 1 to 10,000 and represents the number of simulated seconds. Note that this does not correspond to real-time duration, the simulation runs faster than real time. Instead, it means the vehicles will behave as if they are driving through the road network for the specified number of seconds. For example, a value of 3,600 simulates one hour of traffic flow.

After specifying the number of vehicles and simulation steps, you can start

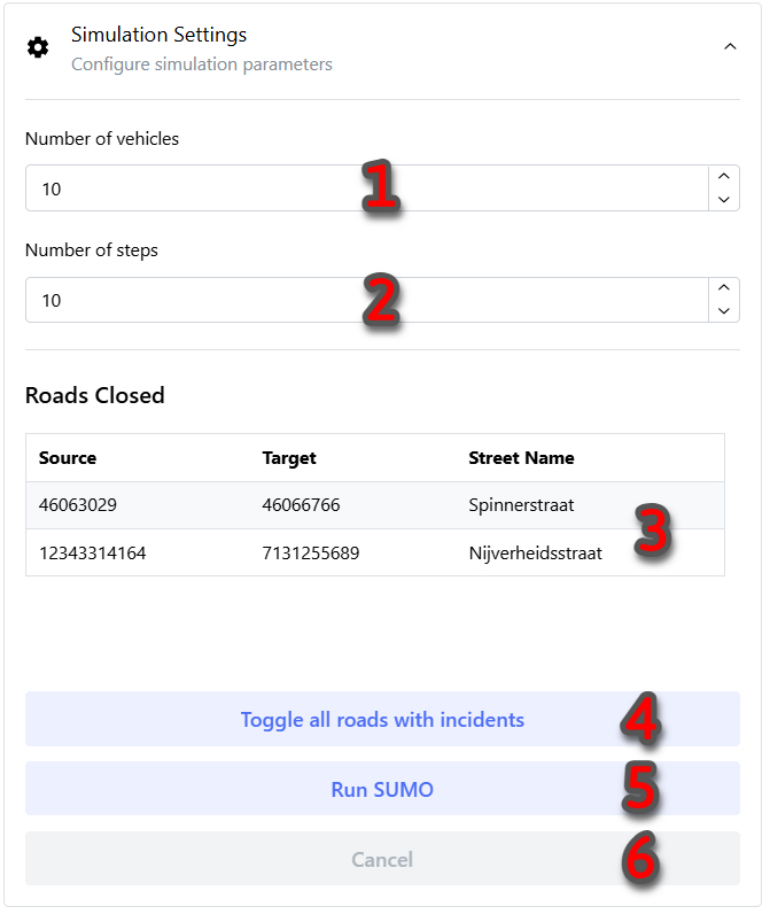

Figure 5.4: SUMO Simulation Settings for vehicles (1), steps (2), closed roads (3, 4), running SUMO (5) and canceling SUMO (6).

the simulation by clicking the 'Run SUMO' button (5.4.5). The simulation will use the current road network, the values you've entered, and any roads marked as closed (as listed in the table on the same page (5.4.3)). Please note that the simulation may take some time to complete. You can also stop the simulation at any point by clicking the cancel button (5.4.6). If you stop the simulation manually, no data will be generated or visualized. Once it has finished, you will receive a notification and you can take the steps described in section 5.4 to visualize the calculated data.

5.4 Visualizing SUMO

After running the simulation, you can visualize the results by navigating to the settings menu (5.1.2) and opening the color settings section (5.3.2). Within this section, use the dropdown menu (5.5.1) to select the traffic characteristic you want to visualize on the road network. The following options are available:

- **Speed:** Speed represents the average speed of vehicles on a given road segment. A higher value indicates that vehicles are moving quickly along that road, suggesting smoother traffic flow.
- **Speed Relative:** Speed Relative represents the average speed of vehicles on a given road segment, relative to the maximum speed limit of that road. A higher value indicates that vehicles are moving closer to the speed limit, while a lower value suggests slower traffic flow and potential congestion.
- **Congestion:** Congestion represents the number of vehicles per kilometer on a given road segment. A higher value indicates greater congestion, meaning that the road is more crowded and traffic is likely slower.
- **Occupancy:** Occupancy indicates the percentage of the road's capacity occupied by vehicles. A value of 100 percent means that every available space on the road is filled, with cars standing bumper to bumper.
- **Waiting Time:** Waiting Time indicates the number of seconds vehicles have been halted on a given road segment. A high value suggests that vehicles are frequently stopping or experiencing delays, which may indicate traffic congestion or bottlenecks.

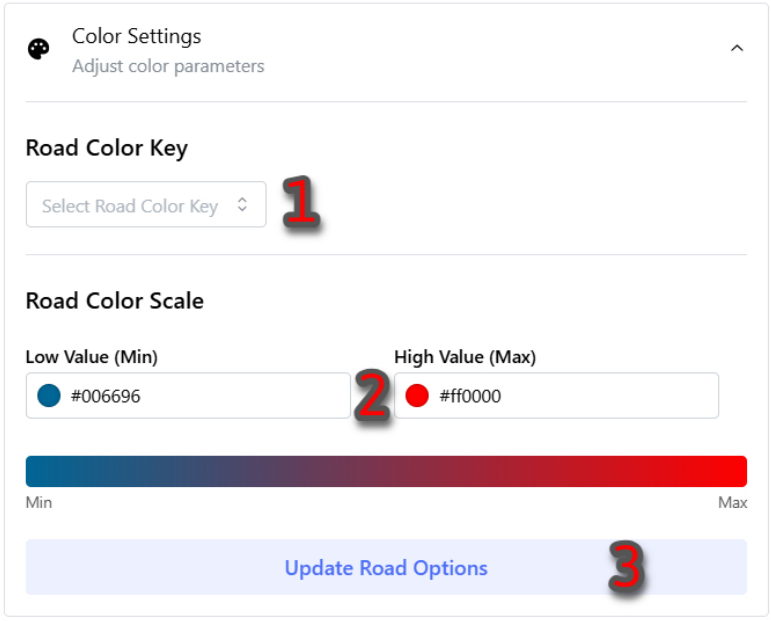

Figure 5.5: SUMO Color Settings to visualize a characteristic (1) in a specific color (2) and updating it (3).

- **Time Loss:** Time Loss indicates the number of seconds vehicles lost by driving slower than their optimal or allowed speed. A high value suggests significant delays, often caused by congestion, traffic signals, or other disruptions.

Once you have selected the traffic characteristic you want to visualize, you can customize its appearance using the Road Color Scale (5.5.2). The 'Low Value' color represents road segments with lower values for the selected characteristic, while the 'High Value' color represents segments with higher values. A gradient between these two colors will be applied to reflect values in between, and this gradient is also previewed beneath the input fields. When you want to apply your settings and update the road network visualization accordingly, click the 'Update Road Options' button (5.5.3).

5.5 Statistics for SUMO

After running a simulation, you can view detailed statistics for a specific road segment by clicking on it in the road network. This will open a popup, as shown in figures 5.6 and 5.7, displaying all relevant data from the SUMO simulation. The first table in the popup presents data for each of the char-

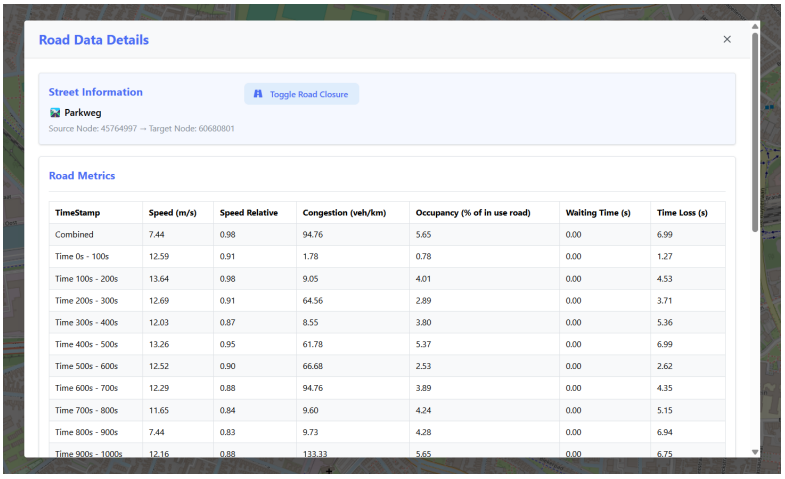

Figure 5.6: SUMO Statistics Table.

acteristics described in the previous section. The results are organized into timeframes, each covering a 100-second interval of the simulation. The charts visualize the same characteristics in graph form, plotting each value against time. This provides a clear overview of how each metric evolves throughout the simulation.

5.6 Hiding Markers

To hide all incident markers, navigate to the Settings menu (5.1.2) and open the Visibility Settings section (5.3.3). You can toggle the visibility of the markers on or off using the switch control (5.8.1). This can be useful if you want a clearer view of the visualized traffic statistics on the road network.

Figure 5.7: SUMO Statistics Charts.

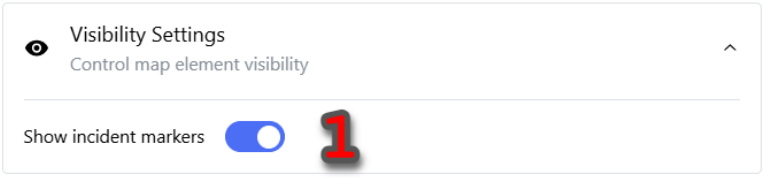

Figure 5.8: SUMO Visibility Settings for incident markers (1).

Appendix A

CSV Field Descriptions and Example

This appendix describes the structure of the CSV file used for traffic incident data, including both a field-by-field explanation and a sample dataset. The CSV file must include a header row with the following column names, in this exact order and spelling: `id, hrn, originalId, originalHrn, startTime, endTime, entryTime, roadClosed, criticality, type, codes, description, summary, location_length, location_points`. Any missing, reordered, or misspelled headers will result in the file being rejected or misinterpreted.

Field Descriptions

id (`int`) A unique identifier for the current version of the incident. *Example:* `4015520102142450738`

hrn (`string`) Human Readable Name (HRN) assigned to this version of the incident. *Example:* `here:traffic:incident:4015520102142450738`

originalId, originalHrn (`int, string`) Identifiers for the original version of the incident.
Example: `3629793078195143164`, `here:traffic:incident:3629793078195143164`

startTime, endTime, entryTime (`string, ISO 8601`) Timestamps in UTC. `startTime` and `endTime` define incident validity; `entryTime` marks when the incident was added to the system. *Example:* `2024-01-19T07:41:02Z`, `2024-05-29T13:41:02Z`, `2024-05-08T12:38:18Z`

roadClosed (`boolean`) Indicates whether the road is fully closed due to the incident. *Example:* `True`

criticality (`string`) Severity level: one of `low`, `minor`, `major`, `critical`. *Example:* `critical`

type (`string`) Incident category, e.g., `accident`, `construction`, `roadClosure`, etc. You may use arbitrary incident types. *Example:* `roadClosure`

codes (`list of int`) A prioritized list of AlertC codes that classify the incident. The first code is the primary cause. *Example:* `[401]`

description (`string`) A detailed, human-readable explanation of the incident. *Example:* `Closed`

summary (`string`) A short version of the description, intended for display without location context. *Example:* `Closed`

location_length (`float`) Total length in meters of the affected area. *Example:* `90.0`

location_points (`JSON string`) A stringified JSON array of objects describing the polyline of the affected road segment(s). Each object typically includes fields such as `lat`, `lng`, and optionally `length`.
Example: `['points': ['lat': 33.97593, 'lng': -118.41651], 'length': 90.0]`

Note: The application does not use the following fields for any internal logic or calculations: **id**, **hrn**, **originalId**, **originalHrn**, **entryTime**, **codes**, **summary**, and **location_length**. These fields are used for display purposes only. If your dataset does not include these fields, you may set them to arbitrary or placeholder values—functionality will not be affected.

CSV Example

Listing A.1: Example of raw CSV input

```
id,hrn,originalId,originalHrn,startTime,endTime,entryTime,roadClosed,criticality,type,codes,description,summary,location_length,
location_points
40155201,incident:4015522,3629307,incident:36297964,2024-01-19T07:41:02Z,2024-05-29T13:41:02Z,2024-05-08T12:38:18Z,True,critical,
roadClosure,[401],Closed,Closed,90.0,"[{""points"": [{""lat"": 33.97593, ""lng"": -118.41651}, {""lat"": 33.97664, ""lng"": -118.41697}],
""length"": 90.0}]"
1300713381898310574,here:traffic:incident:1300713381898310574,1300713381898310494,here:traffic:incident:1300713381898310494,2024-05-08T12
:12:47Z,2024-05-29T12:12:47Z,2024-05-08T12:38:18Z,True,critical,roadClosure,[401],Closed,Closed,186.0,"[{""points"": [{""lat"": 34.02513,
""lng"": -118.23793}, {""lat"": 34.02494, ""lng"": -118.23706}], ""length"": 83.0}, {""points"": [{""lat"": 34.02494, ""lng"": -118.23706},
 {""lat"": 34.02479, ""lng"": -118.2365}], ""length"": 54.0}, {""points"": [{""lat"": 34.02479, ""lng"": -118.2365}, {""lat"": 34.02465, ""
lng"": -118.236}], ""length"": 49.0}]"
```