ARUP

Technical Assistance - Improving Resilience and Safety of the Local Road Transport Network in the Republic of Serbia

Local Road Transport Network Resilience Diagnostic Tool and Practical Guidelines
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Abbreviations

Abbreviation list	Meaning
API	Application Programming Interface
ASP.NET Core	Free and open-source web framework developed by Microsoft, runs on full .NET Framework, on Windows, and the cross-platform .NET
GIS	Geographic Information System
iOS	Mobile operating system for Apple mobile devices (iPhone, iPad, iPod)
LSG	Local self-government
m	Meter
MaPLoRds	Local Road Transport Network Resilience Diagnostic Too
MVC	design pattern to decouple user-interface (View), data (Model), and application logic (Controller)
OGC	Open Geospatial Consortium
POI	Points of Interests
Pr	Prioritization
RESTfull API	Representational State Transfer interface that two computer systems use to exchange information securely over the internet
RoA	Road asset
RoL	Road link
RoSL	Road sub-link

1.   MaPLoRds system architecture

1.1   Introduction

Purpose of this Report is to help users to apply the Methodology developed for the Climate Resilience of the Local Roads Network using the MaPLoRds software system.

The MaPLoRds system is an essential tool for applying the Methodology as it enables users to assess the climate resilience of the local road network by analyzing the road network's characteristics, climate hazards, and vulnerability. The system provides a user-friendly interface and visualization tools to support the decision-making process.

This guide also provides step-by-step instructions on how to use the MaPLoRds application tool. By following these practical guidelines users will be able to use the application tool to its full potential.

1.2   Report scope

The Practical Guidelines document describes how to assess exposure, vulnerability, risk, and criticality of local transport networks by applying prescribed Methodology (a detailed separate document). A MaPLoRds software system comprises a set of tools developed to facilitate implementation of Practical Guidelines. Two pilot LSGs: Kraljevo and Aleksandrovac are presented as a case study for demonstration of tools within Practical Guidelines and its integration into local transport network management. Although the Practical Guidelines is piloted on Kraljevo and Aleksandrovac, the developed methodology and system are applicable to other LSGs in the country and to the countries in the region as well.

A tool for mobile devices (mobile application) is developed to facilitate the data collection in the field and web application is developed for data analysis, resilience and priority assessment based on the developed methodology (described in the separate document - Methodology). The tools are simple to use, intuitive and with user friendly interface for utilization by engineers in the local level administration.

Collected data are stored first on mobile device database and then in back-office central database to be easily accessible to different users for various analysis. Set of different reports are available onscreen and for export to Excel. This will enable authorities to prioritize the activities, review the types of hazards, network, and links vulnerabilities, etc. The content of the Report is in accordance with developed methodology.

The MaPLoRds system is supported by GIS open data, through open maps, available both in the field work using mobile devices and, in the office using web application.

In general, development of information systems includes design of components for data collection, system analysis, requirements gathering, asset data definition and data management processes, levels of GIS service and implementation of basic API-s (application programming interface).

Development of the MaPLoRds mobile application (for Android and iOS) and web GIS application enables users to perform continuous data collection related to occurred road hazards events, upon which priority assessment will be made based on the developed methodology. The workflow overview of the developed system is presented in Figure 1. The implemented decision support system will rely on both up-to-date field data and data obtained through the background modelling (spatial modelling of specific hazard types, road vulnerability and criticality).
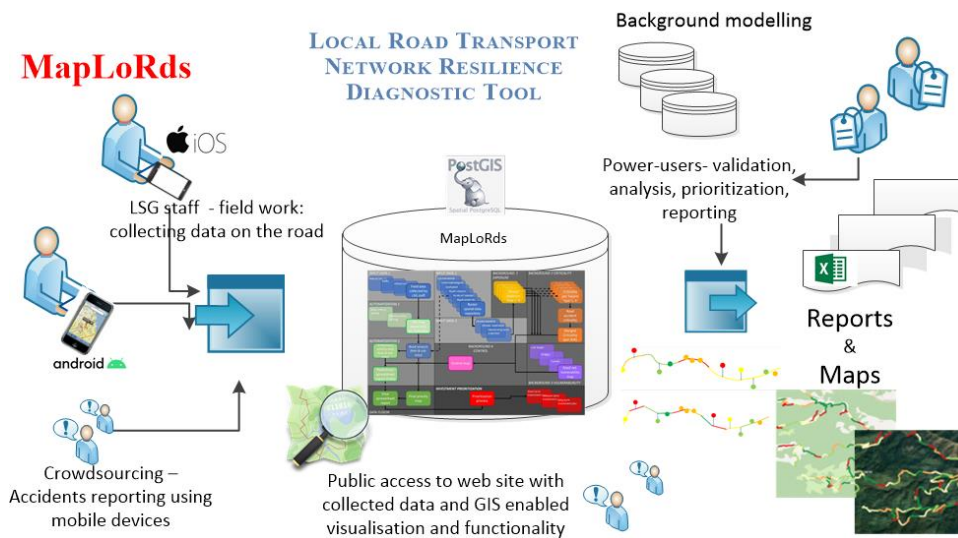
Figure 1 MaPLoRds system data collection and analysis workflow

The language of the mobile and web application is Serbian, Latin alphabet by default. Application interface and data classification labels includes English as well. However, multilingual support is available and fully implemented. Therefore, application is being developed in a way that additional languages could be installed at any time as per need. The content in different languages is stored in the central database with available web service for generation of JSON resource files (non-executable configuration data that is required by the application and is deployed along with the application). The bilingual glossary, in Serbian and English, is produced for developed version of the application, introducing key terms and phrases that are required for the MaPLoRds interface, both for mobile and web application.

The system is developed to the highest industry standards and in accordance with Platform Security and Personal Data Protection rules. Personal Data of the users (e.g., password) are stored in encrypted form in the central database. All other non-sensitive data are not encrypted.

The main dataset includes the following: coordinates, date/time, field photographs, user log, type of occurrences/problem, main feature for the hazards (e.g., landslide, rockfall), the size of the affected road section, level of road damage, road surface type (macadam, asphalt…), etc. Full extent of dataset will be presented throughout the document with screen capture illustrations.

1.3   MaPLoRds system development

The MaPLoRds mobile application is developed using .Net MAUI[1] as Multiplatform App User Interface and C# programming language. The web services that are used for communication between mobile app and back-office (central) database are developed using ASP.NET Core Web API. The web application, allowing for several modules with features such as: data visualization, validation of data, consistency check-ups, is developed as web application using ASP.NET Core[2] (Core6, MVC app).

The user management component is implemented, and the accessibility of application features it has been tailored to accommodate various roles. The list of roles includes System Administrator, Power-user for all LSGs, Power-user per one LSG, Field specialist and Public users. Details of user roles will be explained later in the text.

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[1] https://dotnet.microsoft.com/en-us/apps/maui

[2] https://learn.microsoft.com/en-us/aspnet/core/introduction-to-aspnet-core?view=aspnetcore-7.0

The database management system used is PostgreSQL[3] 14.4 with pgAdmin[4] 14 tools. Database name is: maplords_db. The GIS database support is using PostGIS[5]. The geospatial data sharing is implemented by GIS web services relying on GeoServer[6] 2.21, also an open-source tool. More precisely, Geospatial Information System Web RESTfull API - Services that follow the Open Geospatial Consortium (OGC) standards for web services: Web Mapping Services (WMS) and Web Feature Services (WFS) are used.

Figure 2 presents main component of the system and data flow interaction. On the left side is mobile application for data collecting in the field. Data are stored in local database, where from upon synchronization request and via available internet connection   alphanumeric data (1) are sent via Rest API for storage in MaPLoRds database (2).

Set of Rest APIs is also used to exchange alphanumeric data (3) with MaPLoRds Web Application. WebGIS Rest APIs are used to read data (5) from central database and to serve WMS layer for mobile application (4), as well as for web application (6).

Business logic is implemented in business layer over central database as set of procedures that perform all required calculations (score calculations) and deductions (priority class assignment) (8), whose results are retrieved by web application together with other required data (7).
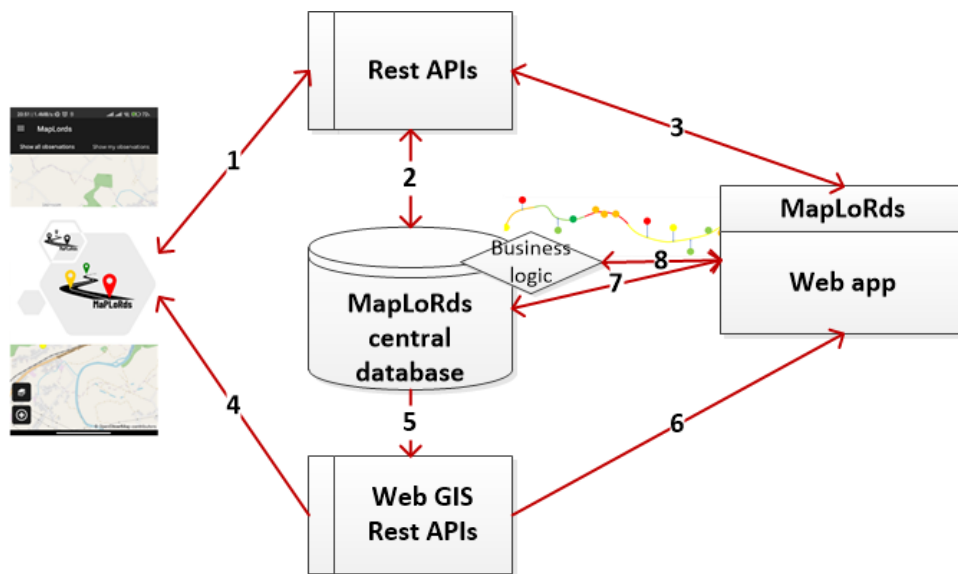
Figure 2 Components of MaPLoRds system

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[3] https://www.postgresql.org/ PostgreSQL 14.4 is a free and open-source relational database management system)

[4] https://www.pgadmin.org/ PgAdmin is set of PostgreSQL Tools

[5] https://postgis.net/ PostGIS is an open-source PostgreSQL external extension that adds support for geographic objects to the PostgreSQL object-relational database.

[6] https://geoserver.org/

2.   MaPLoRds mobile application

2.1   MaPLoRds installation

Installation "apk" file is available on http://maplords.rgf.bg.ac.rs/data/. The final version of application will be published on Google Play (https://play.google.com/) and for IOS on App Store by the end of the Project.

After installation, the Field user authorized for data collection can start with his registration. Verification of the registration is to be provided by the Power-user (described in next section and in user management module, Section 3.1).

Figure 3 provides an overview of main screens in the MaPLoRds mobile application. Mobile application displays a map with a background of the surrounding area of the current location (automatically defined by navigation module of mobile device in both online and offline mode), with a radius or zoom level specified in settings configuration.

User friendly interface guides the user to report an observed issue that will be called *observation* (using a button on a map). The users are offered to choose type of the road hazards by image-clicks for easier selection, upon which several forms follow with further data collection requirements.

The user of mobile application has the following options for data collection:

- self-registration module, user login, password change,

- collection of new observation data,

- search, view, and filter of collected data (with option to see own data and data of other users in same LSG),

- editing of collected data, except geolocation and date/time.

Figure 3 presents screens after user login and creating new observation point, he/she is guided further to insert hazard, optionally several hazards within the same observation, followed by traffic and infrastructure screen. It is possible to take field photos from any of these screens and all acquired pictures are automatically uploaded to central database on the server within synchronization process.

Figure   3
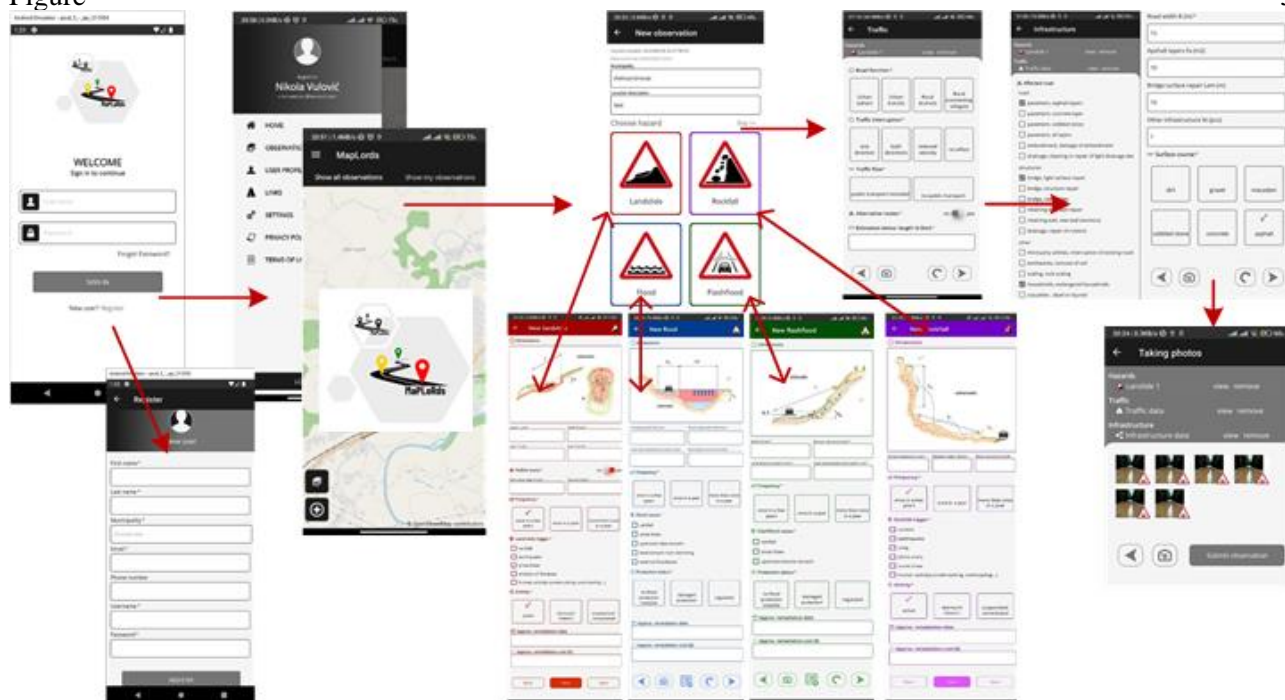
Figure 3 Overview of main screens with dataflow in mobile application

After finishing all required data entries, a pin location on the map is generated. The click on pin opens the form with the saved data. In case a new issue needs to be reported on an existing issue from the past, both entries (old and new) will be saved to the database, but the old entry will be marked as inactive.

Mobile application is enabled to work in online and offline mode. Frequently, internet connectivity may not be accessible on location. In such cases, offline mode operation enables the collection of necessary field data and its storage in a local database on a mobile device. Once an internet connection is re-established, the status or datasets will be updated, transferred, and synchronized with the backend database.

2.2 Registration and login

The first application panel is *Login* panel, see Figure 4. The new user needs to access the user registration form and click on *Register* link (Figure 4). The existing user uses his own, already generated, username and password to log in.

Upon clicking on the *Register* link, the new user will be prompted to fill in the information displayed in Figure 5 which includes their first and last name, telephone number (optional), select municipality (LSG), username and password. The checkbox "I have read and accept privacy, terms and conditions" with appropriate links to documents must be checked before proceeding with application use.

Figure 4 Login panel (with registration link)

The system's initial list of roles includes the following: System Administrator (responsible for user and role management), Power-user for all LSGs, Power-user for a specific LSG, Field Specialist, and Public users (with restricted access to available data on the site – read only mode). The user assigned the role of Field Specialist is intended to use the mobile application with rights to create observations, fill in data forms, capture photos, and submit data to the central database.

Before login, account must be approved by System Administrator. The whole procedure of registering is explained in several steps:

1) Fill in the form in Figure 5 and click *Register*,
2) Data are transmitted and stored in the central database, where the password is encrypted and saved so that only the user can access and read it. The status of the user account will be marked as "*requested*".
3) Upon account creation, both in-app and email notifications are automatically sent to the Administrator, informing them of the new account.
4) The Administrator assigns the appropriate role (access rights) to the user based on a predefined list, after which the user account status will be marked as "*active*".
5) The user receives an e-mail confirming that their account has been activated, along with a link to tutorials and guidelines on how to use the application.
6) The application allows users to login and access features based on their assigned user rights. Once registered and verified by the municipality Administrator users can start data collection.

In addition to the registration button, the *Login* panel, also includes a *Request* button for resetting a forgotten password.

Registration fields are:

Full name (first and last name),
E-mail,
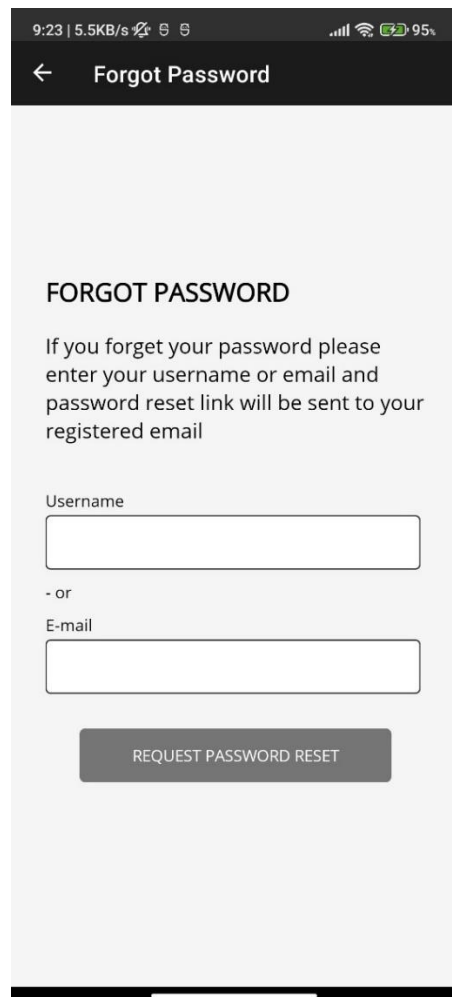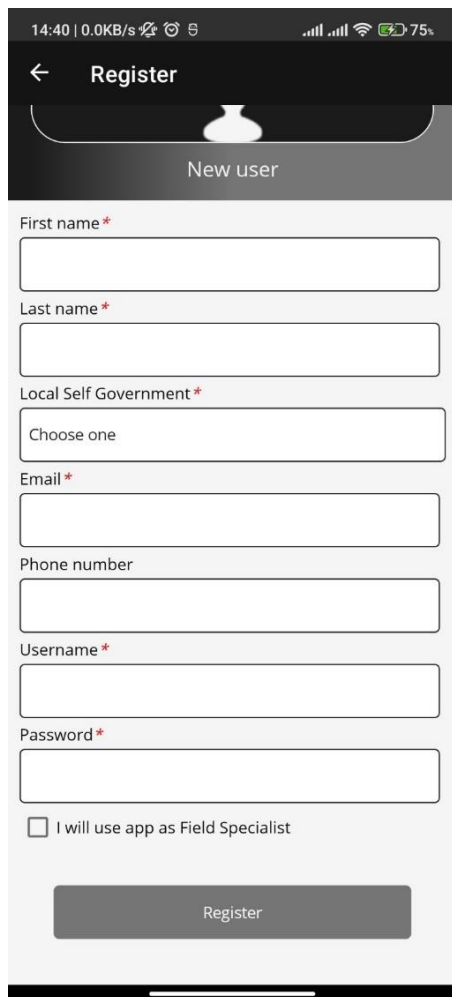Municipality (LSG),
Username,
Password.

Figure 5 Registration panel

Figure 5 on the left side presents form with data required for registering a user, while on the right side is a form for password reset. To ensure the security of password changes, users will be authenticated via email verification.

2.3   Data collection - general

 The reporting of (hazard-related) problems on road infrastructure will be facilitated by a user-friendly interface that includes a background map. Users will be able to select one or more types of occurrences (slide, landslide, flood, torrent) on the road by choosing from offered images, making the selection process easy. They will then be prompted to fill out several forms for data collection, including data on traffic and estimated investments.

After completing all required data entries, a pin on the map will be generated. Clicking on the pin will open a form with saved data. If a new observation is reported for a location that has an existing observation, both entries (old and new) will be saved in the database. The ordinal number (*observation_id* field) of the new entry will be increased by one, so the old entries have smaller ordinal numbers. After successful login user can preview and enter new observation, change profile, modify settings, read Privacy Policy and Terms of Use.
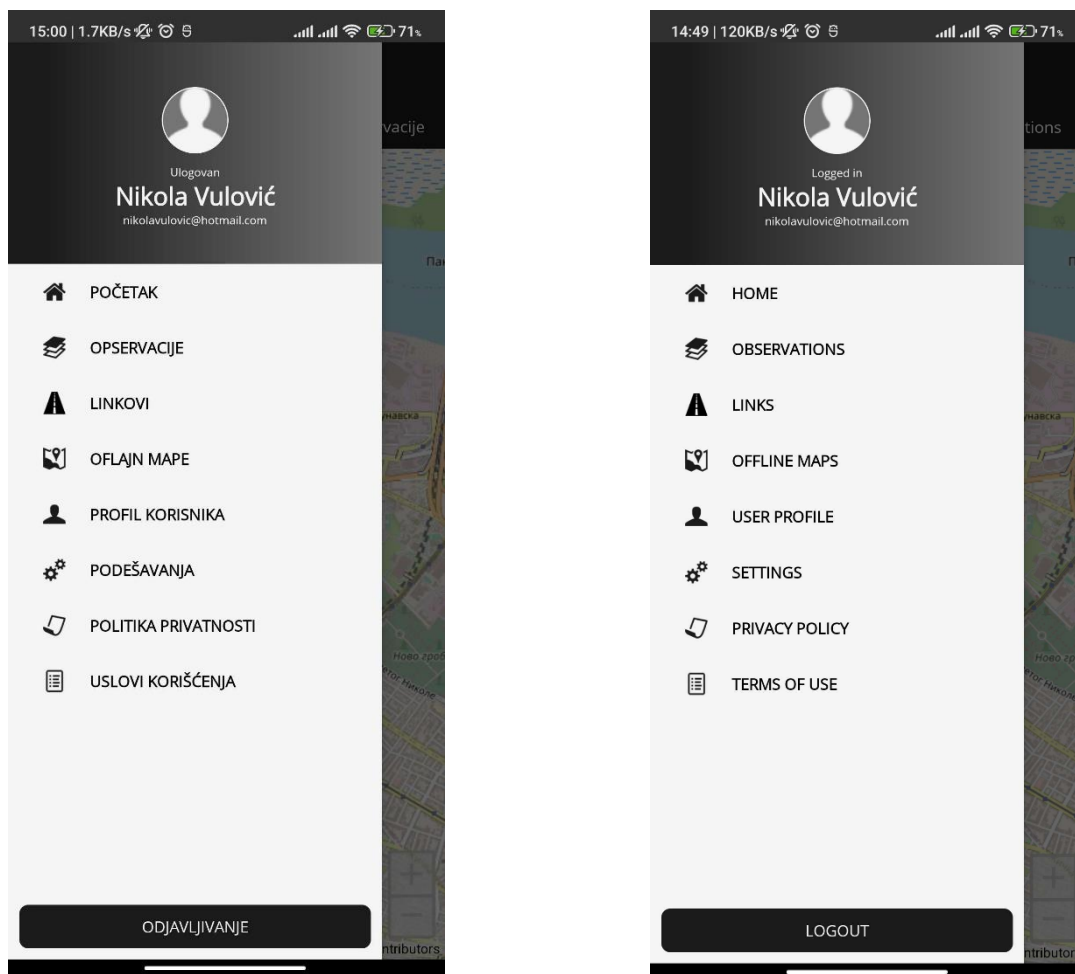
Figure 6 Home panel

The Home panel depicted in Figure 6 (in Serbian to the left and in English to the right) includes a base map in the background and a menu docked leftward. The application will provide following options: 1) add a new observation; 2) display all existing observations; and 3) display only the observations recorded by the current (logged) user.

Figure 7 shows points on the background map, which correspond to existing observations. Colors and symbols of points will be adapted to computed priority score (the numerical value of the score defines the color of the point), as described in the Methodology. Clicking on one of these points will bring up a screen that displays information on existing hazards, traffic, and infrastructure information, which will be elaborated in the next

section. In brief, to begin inputting a new observation, the user should click on plus sign button that looks like: ⊕, located in the left corner of the screen, and the system will automatically read and save coordinates, user account and date/time, while all other inputs will be provided by the user on the field.

Note: Please, note that the test dataset used in this document is not real data collected in the field. The colors of the panel may appear slightly different in mobile applications. The colors of the points are related to prioritization, with 1-5 classes represented by different colors ranging from green to red, and an additional class for unclassified data (blue), while current location point is in purple. The web application periodically assigns appropriate classes and colors through the prioritization process. The point size remains the same.
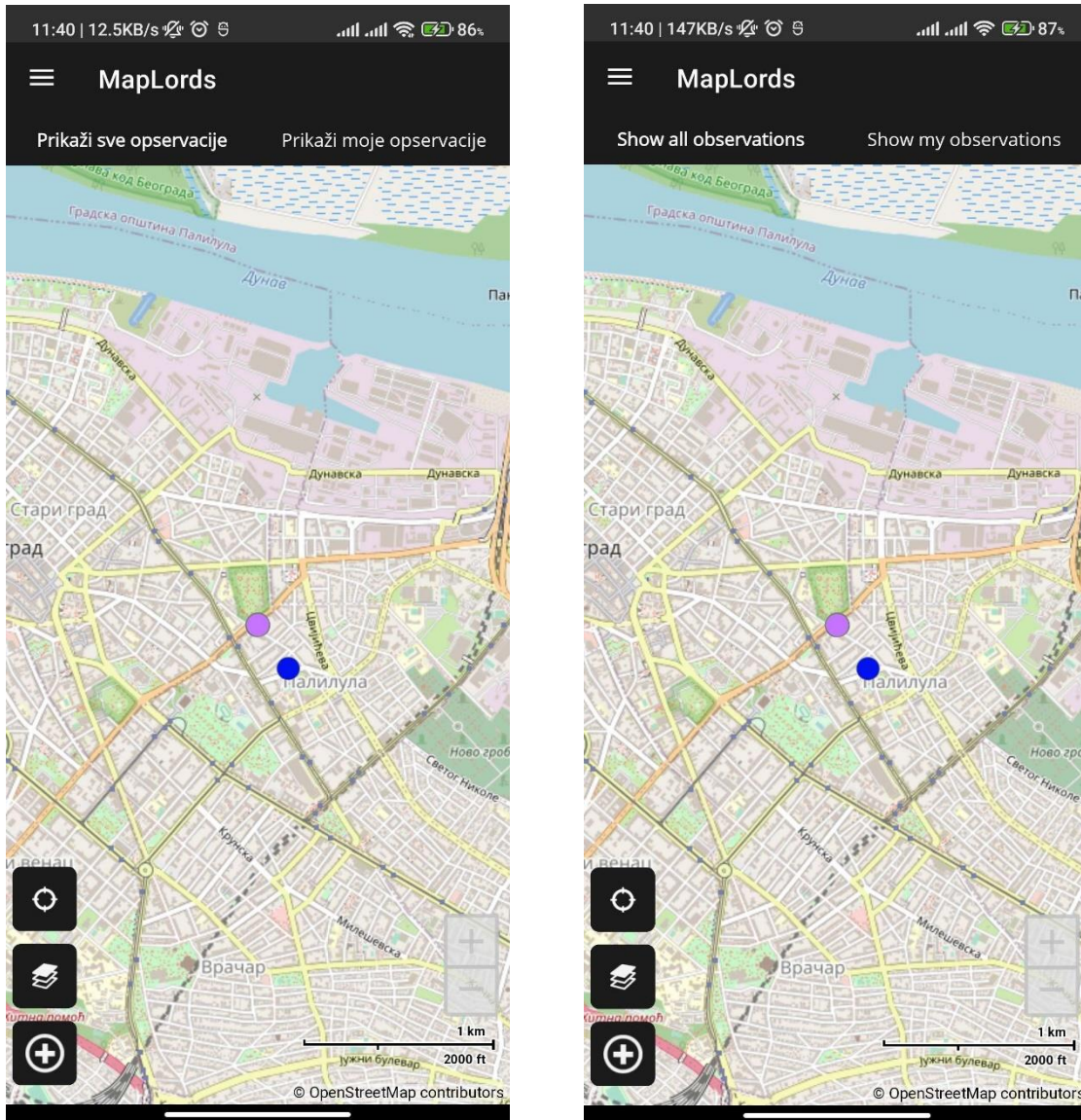
Figure 7 Application interface in Serbian and English language

As shown in Figure 7 the interface includes both Serbian and English language options, with the same set of functionalities available in both languages.
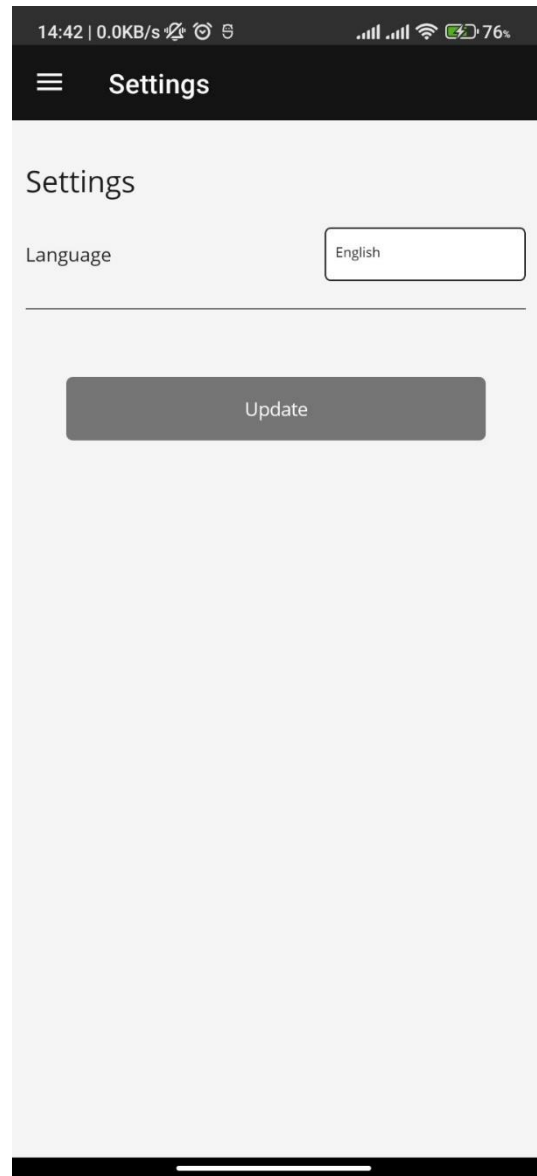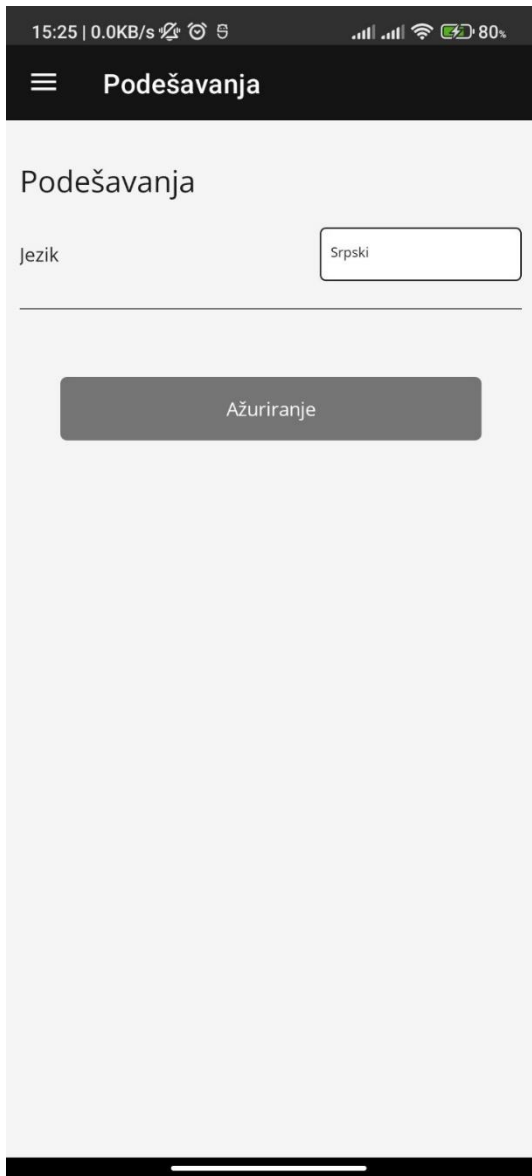
Figure 8 Language setting panel

The Settings panel, as depicted in Figure 8 (in both languages) allows the user to change default language (English) for interface. The Municipality (LSG) selected by the user should be verified by System Administrator, and the appropriate role should be assigned to the user. The available languages are Serbian and English, but solution is flexible and new languages can be added through the Glossary module of the web application.

Figure 9 Profile panel

The panel shown in Figure 9 allows the user to view their profile data. It is important to note that the email and username cannot be changed from this panel.

Figure 10 Privacy Policies

Privacy Policy (http://maplords.rgf.bg.ac.rs/Policy) and Terms of Use (http://maplords.rgf.bg.ac.rs/Terms) are shown in Figure 10 and Figure 11, respectively.

Figure 11 Terms of Use

The preferred and default functionality of the application is to use online maps. However, in areas where internet is not available, the user can select to work with offline maps that are prepared and available on project server. Download of maps per LSG is automated, as shown in the following set of screenshots (Figure 12): starting with no offline maps available on device, followed by screen for download and finally with downloaded offline maps that can be set to be visible or invisible.
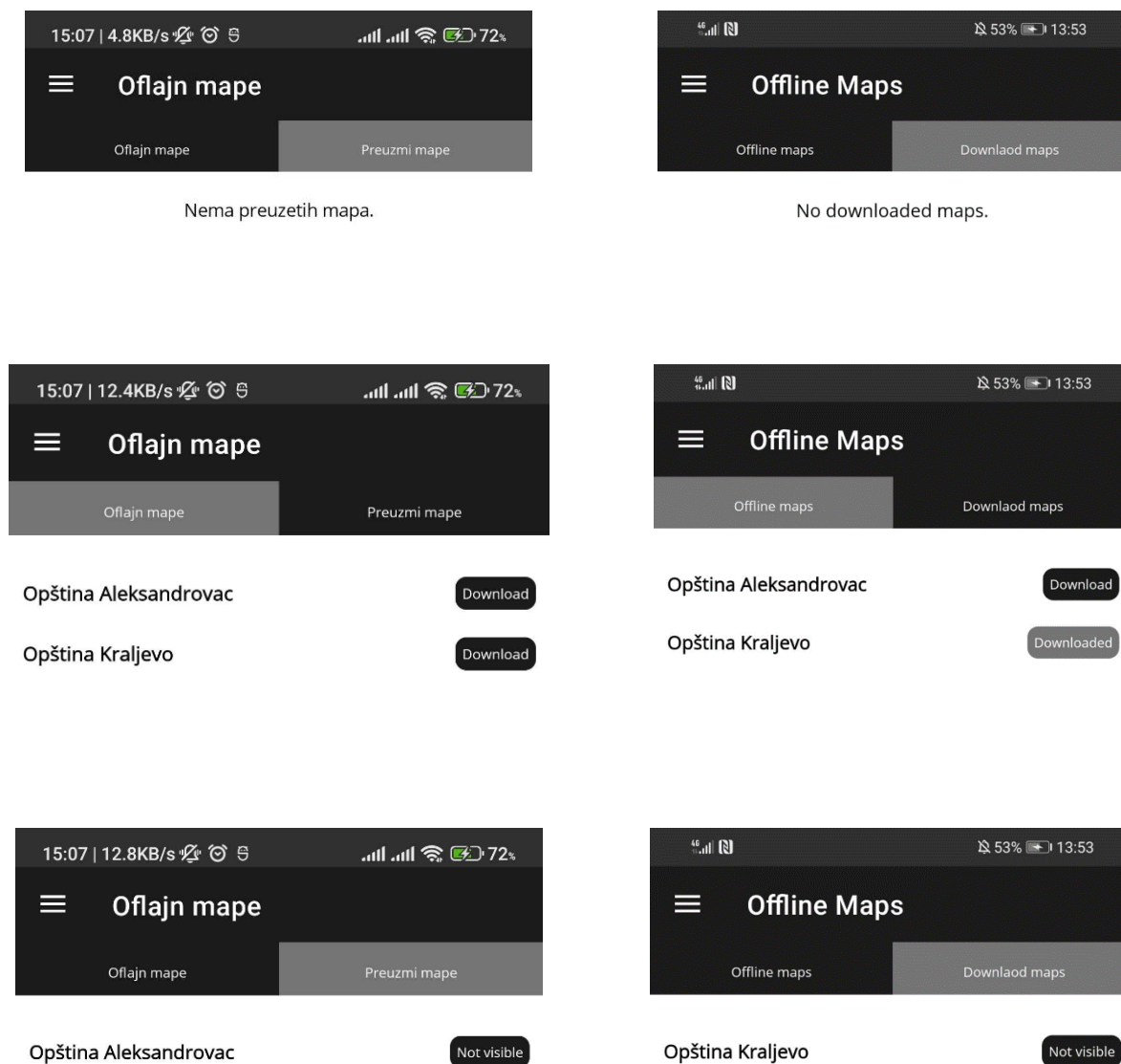
Figure 12 Offline maps download page

2.4   Data collection - new observation

To start a new observation in a different location, the user can click on the Add new button or icon ⊕ located in the lower left part of the screen, as displayed in Figure 14. The system will then automatically calculate and record the current user's location, along with the corresponding date and time, and save the collected data. It is assumed that in real time the user is present at the road location road being observed. The system will later automatically align recorded observation points with road links, by using distance measurement to match the point with the road links accurately.
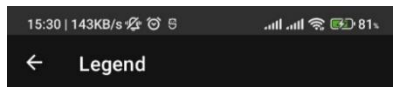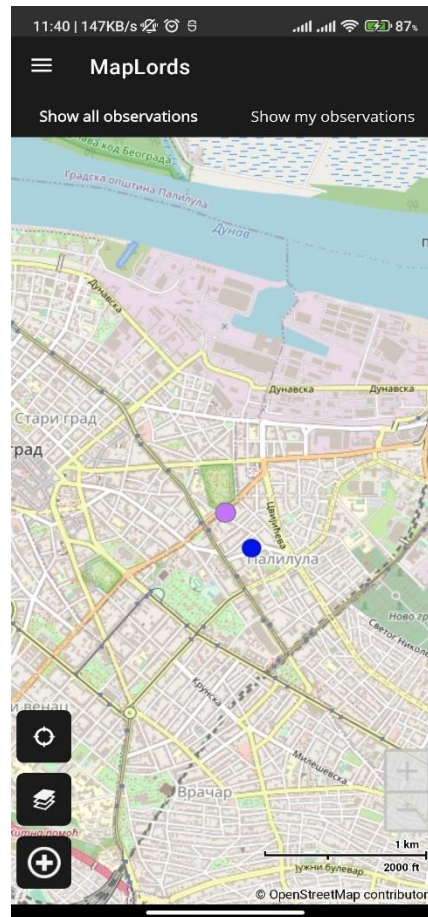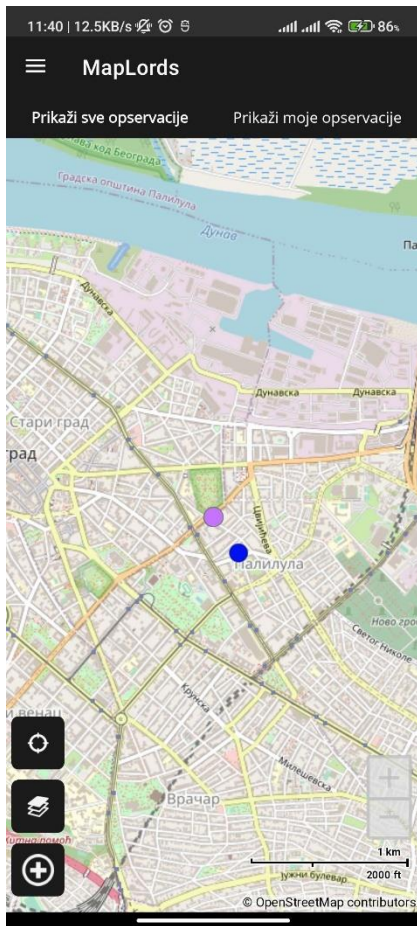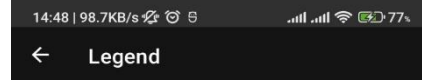
Figure 13 Application interface in Serbian and English language

After clicking the Add new button or icon ⊕, a panel is displayed, as illustrated in Figure 14. The panel contains read-only data that is displayed in grey, and a textbox that enables the user to enter (optionally) a specific location description.
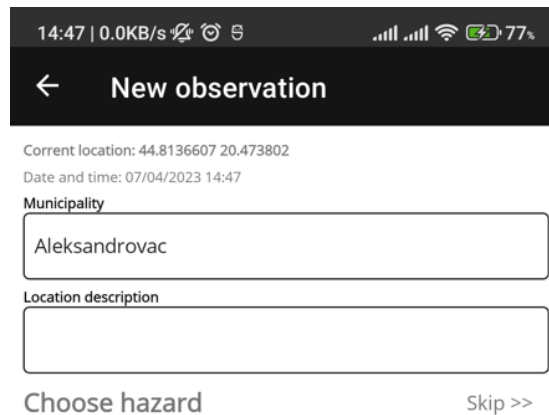
Figure 14 New observation panel

The displayed panel provides two options for the user. They can either select a hazard data entry by clicking on one of the four pictures offered (see Figure 15).
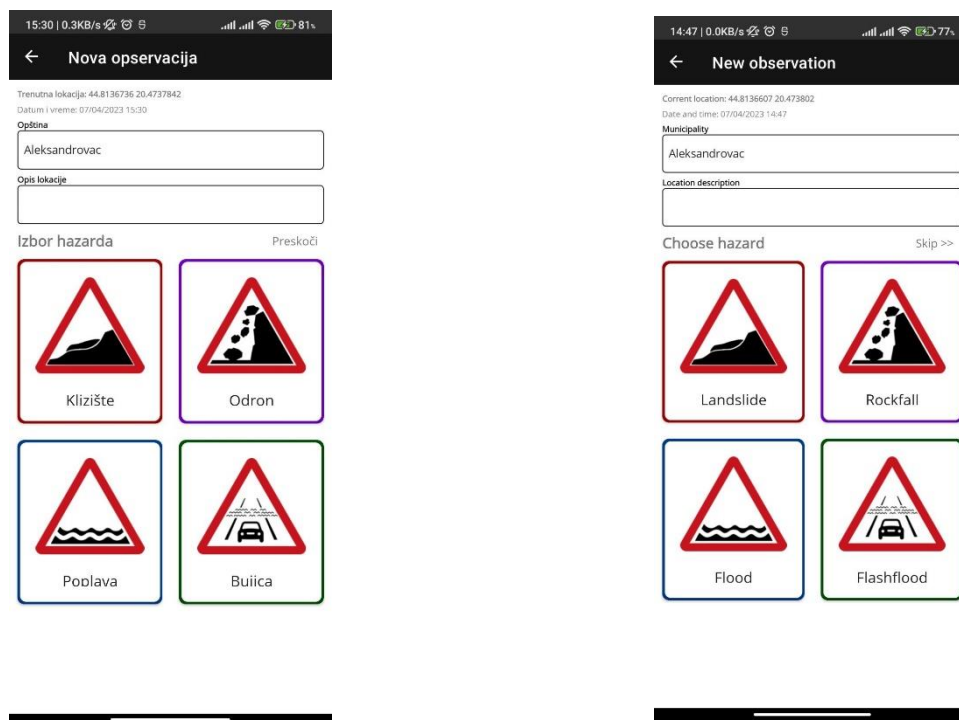
Figure 15 New observation, hazard selection

Four types of hazards are available, namely, landslide, rockfall, flood and flash flood. Each hazard type has a distinct color scheme. The data entry forms also include button 📷 to take photos, which is present in the panels for hazards, traffic, and infrastructure data. Instructions for managing photos and other multimedia, including videos if recorded, will be provided in Section 2.6.3

After selecting a button corresponding to the identified hazard type, the user can access the appropriate data entry form Figure 15 Upon completing the data entry for one hazard, the user will be redirected to the previous panel to record additional hazards for the same observation, if applicable.

2.5 Panels for hazard

This section presents data management for each of the four hazards, utilizing a distinct color scheme to assist users in directing their attention to the appropriate panel.

2.5.1 Landslide hazard

The landslide panel is distinguished by a dark red color scheme and allows users to insert data specific to the chosen type of landslide hazard.

Figure 16 New landslide panel

The panel begins with a schematic presentation of all quantitative values to provide guidance for users as they complete the form. In dimension data section, users can enter values for *length*, *width*, *depth*, and *area*. Required – obligatory values are indicated by a red asterisk (*) in the caption label. The form is designed to adopt to the required data, so if a user selects *"no"* for *"visible scarp"*, no additional quantitative data will be

needed, and a corresponding text box will not be visible. However, if the user selects *"yes"* for *"visible scarp"*, two text boxes for height and volumes will appear. Logical constraints are also included in the form, such as if the landslide activity is described as *"once in few years"*, it cannot be categorized as *"active"* (by definition).

Categorical variables can be selected in either a single-choice or multiple-choice format. Single-choice format allow the user to select only one option from the offered choices, whereas multiple-choice options allow the user to select zero or more options. s

To enable single-choice selection, option buttons can be used, as presented in Figure 16. For the frequency of landslide occurrence, the user can choose from options such as "*once in a few years*", "*once in a year*" or "*more than once in a year*". Option buttons are designed to be easily selectable on mobile devices, and the selected option is clearly identified by a checkmark (tick mark). For multi-values selection, checkboxes are used. For example, in the case of landslide triggers, the user can select one or more options from the list of offered choices, including "*rainfall*", "*earthquake*", "*snow melt*", "*erosion of the base*" and "*human activity (undercutting, overloading...)*". The final section of the panel is dedicated to the status of activity of the landslide, as well as for the information of remediation if available. Remediation date is recorded in a text field, which allows for the inclusion of partial date such as "2015, end of year", "2016, May" or "2016-05-25". Note that it is very important that first 4 characters are denoting year of the remediation.

After finishing with landslide data entry, user can:

- Add new hazards (using NEW button) (save and go to the home panel, Figure 15),

- Return to the first screen (BACK button) (without saving of current data go to the home panel, Figure 15),

- Take a picture (using button), save it (it is automatically linked to the observation),

- Finish with hazards and go to Traffic form (using NEXT button, go to traffic panel in Figure 20),

- Abandon any entry on current form and skip to the next (traffic) panel by clicking on

Note: User can add more than one landslide.

2.5.2 Rockfall hazard

Rockfall panel has a purple color scheme (Figure 17). When selecting the rockfall hazard type, the user can enter relevant data for the rockfall event.

The rockfall panel begins with a schematic presentation of all quantitative values to provide guidance for the user when filling in the form. Similar approach for option buttons and multiple-choice checkboxes is used as in landslides. The same conditional functionality of buttons and fields, as well as logical consistency check is applied as in landslide case.

In dimension data section, the user can enter values for the *runout*, *release height* and *block volume*. Required – obligatory values are indicated by a red asterisk mark (*) in the caption label.

For multi-values selection in *rockfall triggers*, checkboxes are used, allowing the user to select one or more options from the offered list. The available options to be checked for rockfall triggers include "*rainfall*", "*earthquake*", *"icing"*, *"plant roots"*, "*snow melt*" and "*human activity (undercutting, overloading...)*". Similar to the landslide triggers, for this panel as well at least one selected option is required from the list.

The final section of the panel is dedicated to the *status of the rockfall activity*, as well as for the information of *remediation* if available. Remediation date is recorded in a text field, which allows for the inclusion of partial date such as "end of 2015" or "May 2016".

After finishing with rockfall data entry, user can:

- Add new hazards (using NEW ⊞ button) (save and go to the home panel, Figure 15)

- Return to the first screen (BACK ◀ button) (without saving of current data go to the home panel, Figure 15)

- Finish with hazards and go to Traffic form (using NEXT ▶ button go to traffic panel Figure 20)

- Open camera, take a picture and save it ⊡ (it is automatically linked to the observation),

- Abandon any entry on current form and skip to the next (traffic) panel clicking on ↻

Note: User can add more than one rockfall.

2.5.3 Flood hazard

Flood panel has a blue color scheme (Figure 18). The user inserts data for flood as a chosen type of hazard.
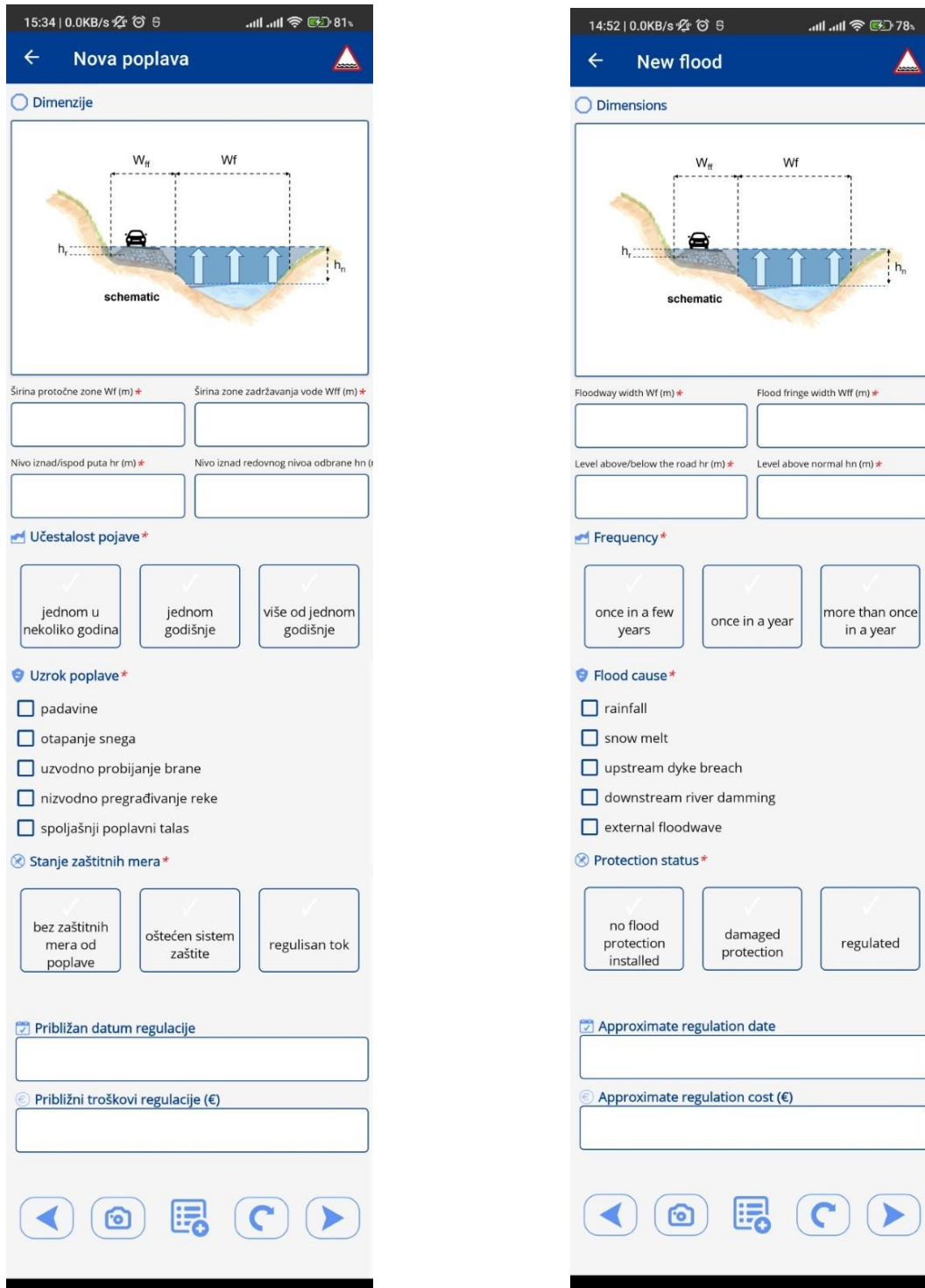
Figure 18 New flood panel

Panel starts with schematic presentation of all quantitative values to guide the user in filling the form. Similar approach for option buttons and multiple-choice checkbox is used as in previous hazard types, as well as similar entry conditioning and logical cross-check.

The following values are defined in the dimension section: *floodway width*, *flood fringe width*, *level above normal*, *level above the road*.

A trigger is one or more options from the list: "*rainfall*", "*snow melt", "upstream dam breach", "downstream river damming", "external flood wave"*. The frequency is similar to other types of hazards.

For protection status, the user can select one of the following options: *"no flood protection installed"*, *"damaged protection"*, *"regulated"*. If available, *approximate date* and *cost of regulation* installation should be provided.

After finishing with flood data entry, user can:

- Add new hazards (using NEW ⊞ button) (save and go to the home panel, Figure 15)

- Return to the first screen (BACK ◀ button) (without saving of current data go to the home panel, Figure 15)

- Finish with hazards and go to Traffic form (using NEXT ▶ button, go to Figure 20)

- Open camera, take a picture and save it 📷 (it is automatically linked to the observation),

- Abandon any entry on current form and skip to the next (traffic) panel clicking on ↻

2.5.4 Flash flood hazard

The flash flood panel has a green color scheme (Figure 19). User inserts data for flash flood as a chosen type of hazard.
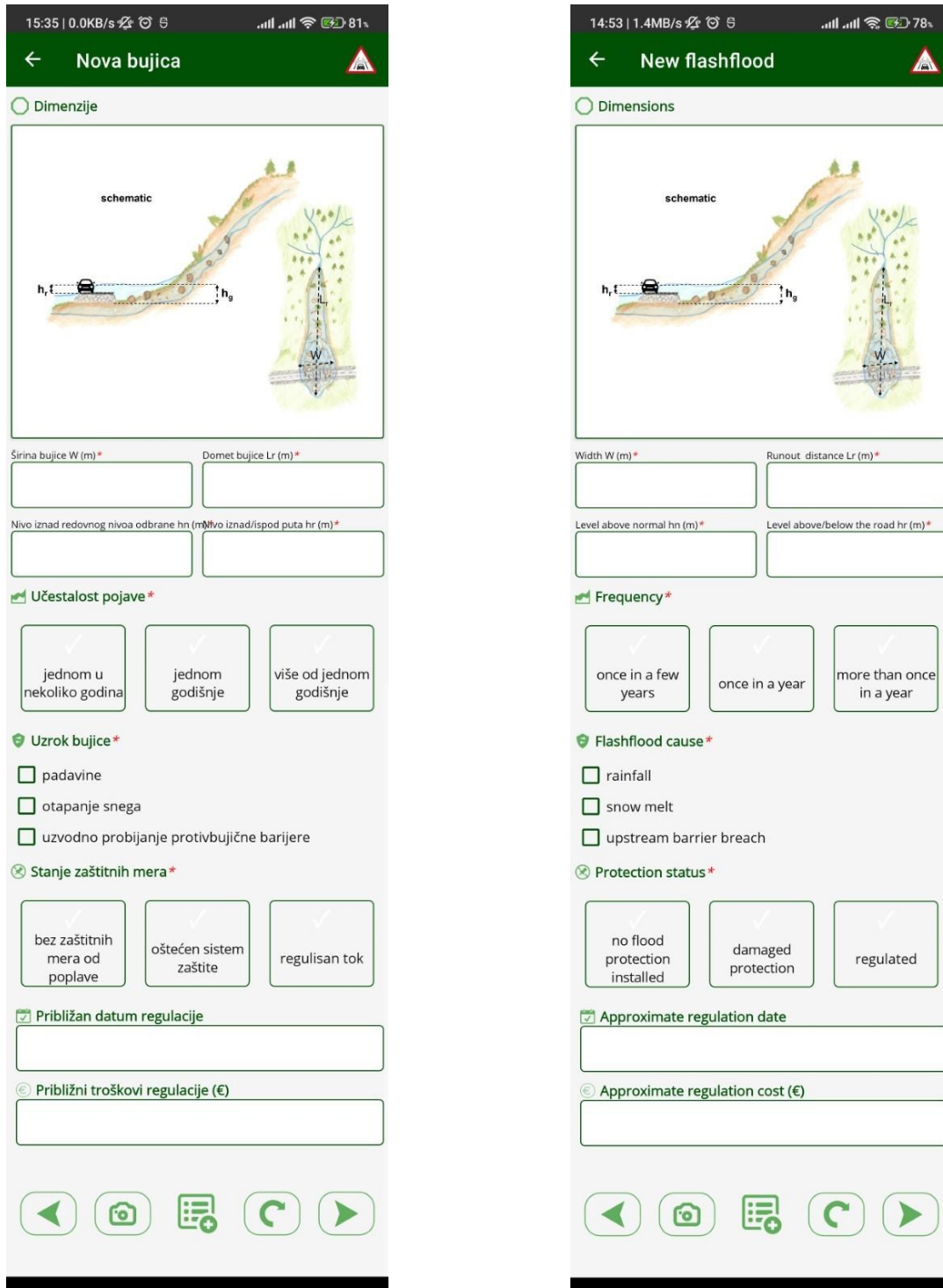
Figure 19 New flash flood panel

Panel starts with schematic presentation of all quantitative values to guide the user in filling the form. Similar approach for option buttons and multiple-choice checkbox is used as in previous hazard types, as well as similar entry conditioning and logical cross-check.

For dimensions related to the flash flood the following quantitative values are expected to be filled in: *width, runout, level above normal* and *level above/below the road*.

Trigger for the flash flood can be one or more options selected from the list: "*rainfall*", "*snow melt*", "*upstream dam breach*".

For protection status user can select one of the following options: *"no flood protection installed", "damaged protection", "regulated".* If available, *approximate regulation date* and *cost* of installation should be provided.

The following parameters *protection status*, *installation date* and *cost* are like for floods.

After finishing with flash flood data entry, user can:

- Add new hazards (using NEW button) (save and go to the home panel, Figure 15)

- Return to the first screen (BACK button) (without saving of current data go to the home panel, Figure 15)

- Open camera, take a picture and save it (it is automatically linked to the observation),

- Abandon any entry on current form and skip to the next (traffic) panel clicking on

- Finish with hazards and go to Traffic form (using NEXT button go to Figure 20)

2.6   Traffic, infrastructure, and multimedia

2.6.1   Adding traffic information

Once all hazard information has been added, the traffic information panel becomes available. To provide a better overview of the recorded hazard data, a list of all previously recorded hazards is displayed at the top of the panel, with links for viewing and removing functionality if necessary (as shown in Figure 20).
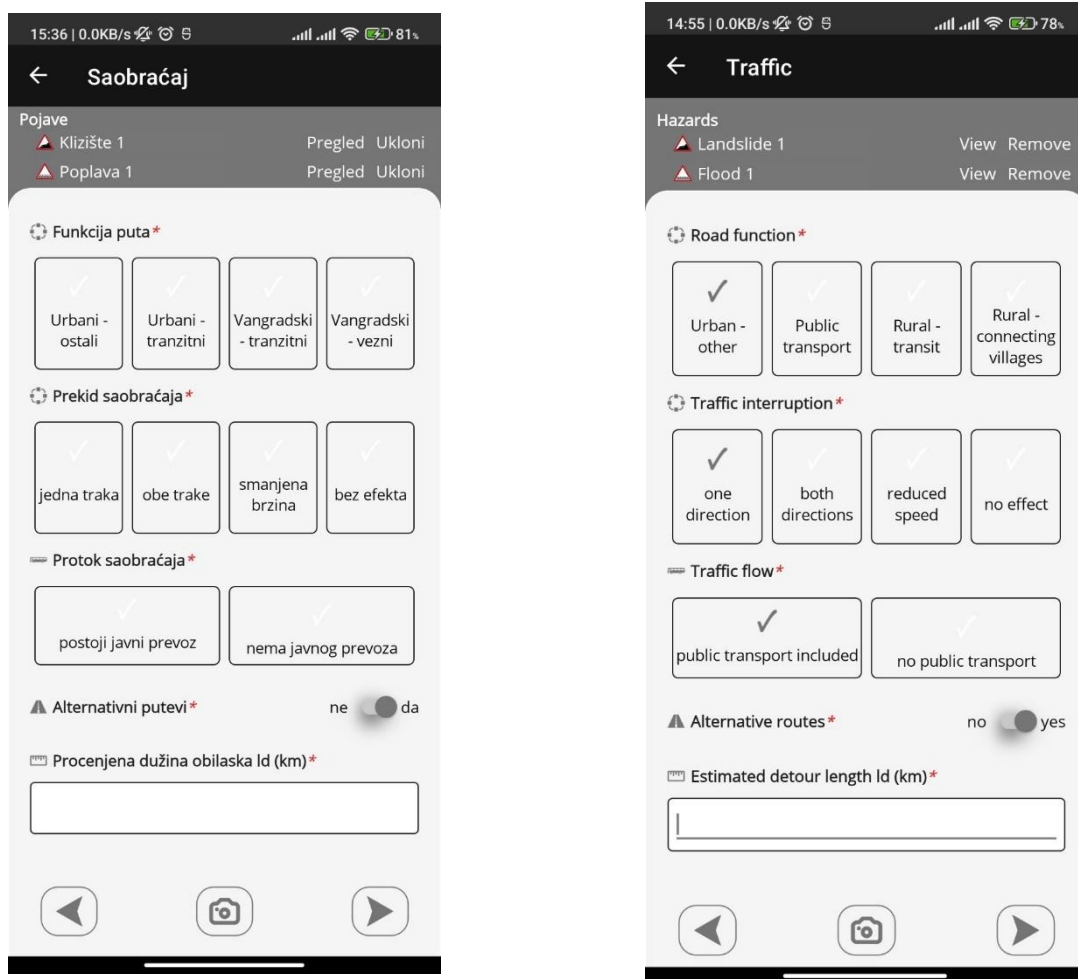
Figure 20 New traffic panel

For the traffic interruption type, one of the following options can be selected: "*single lane*", "*both lanes*", "*reduced speed*", "*no effect*".

For traffic flow type, one of the following options can be selected: public transport included or no public transport.

The *alternative routes* parameter is implemented as a "*no/yes*" switch. If is the user selects "*yes*" then the *estimated length* of the alternative route is required.

After finishing with traffic data entry, user can:

- Return to the hazard screen (BACK ◀ button) (without saving of current data go to the home panel)

- Open camera, take a picture and save it 📷 (it is automatically linked to the observation),

- Abandon any entry on current form and skip to the next (traffic) panel clicking on ↻

- Finish with Traffic and go to Infrastructure form (using NEXT ▶ button go to Figure 21 or Figure 22)

2.6.2 Adding infrastructure information

Affected road options, to be filled in if applicable, are presented in Figure 21 in Serbian and Figure 22 in English.

Figure 21 New infrastructure panel (Serbian language)
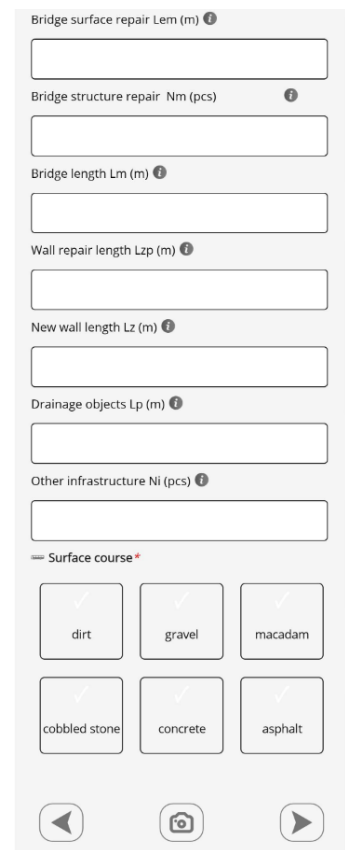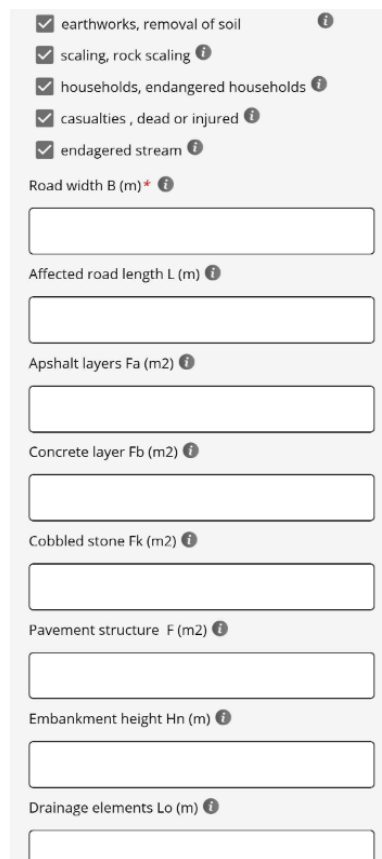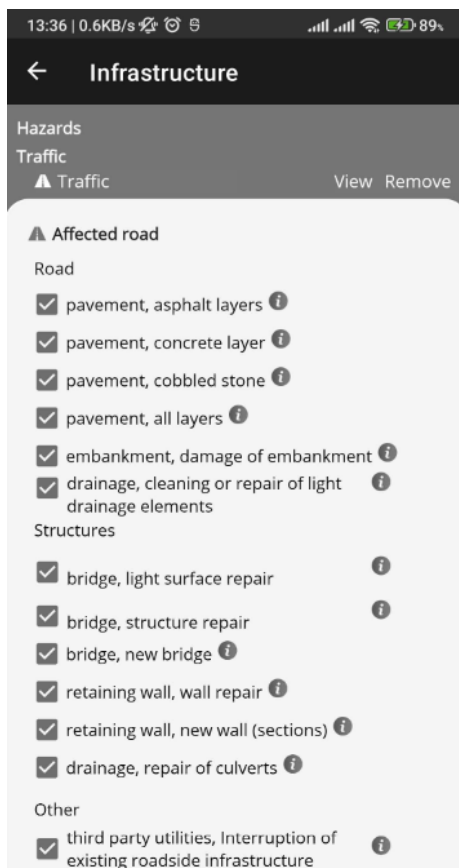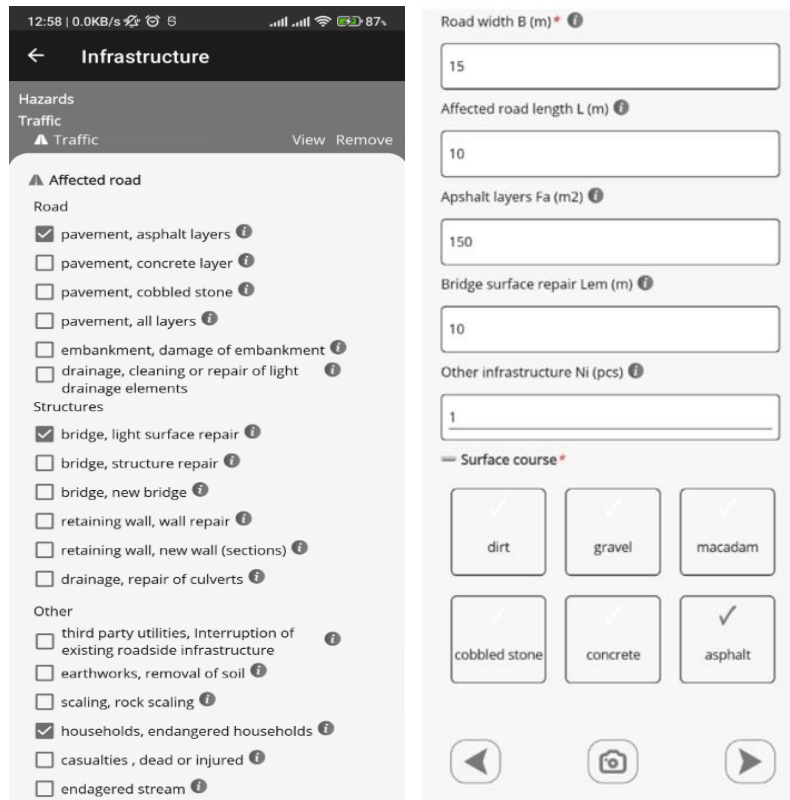
Figure 22 New infrastructure panel (English language)

The *Affected Road* part of panel is divided in three logical parts:

- *Road: "pavement, asphalt layers"; "pavement, concrete layer"; "pavement, cobbled stone"; "pavement, all layers"; "embankment, damage of embankment"; "drainage, cleaning or repair of light drainage elements";*

- *Structure*: "*bridge, light surface repair*"; "*bridge, structure repair*"; "*bridge, new bridge*"; "*retaining wall, wall repair*"; "*retaining wall, new wall (sections)*"; "*drainage, repair of culverts*";

- *Other*: "*third party utilities, interruption of existing roadside infrastructure*"; "*earthworks, removal of soil*"; "*scaling, rock scaling*"; "*households, endangered households*"; "*casualties, dead or injured*", "*endangered stream*".

The quantitative value for *Road width* (designation *B*) is required (obligatory) data.

The extensive list of boxes is presented to explain the interface, but usually only a few of these boxes will be visible. Specifically, depending on the selected options for the *Affected Road,* only relevant quantitative values will become visible. To specify the type of *Surface course,* the user can select one option from the list provided, which includes: "*dirt*", "*gravel*", "*macadam*", "*cobbled stone*", "*concrete*", and "*asphalt*".

Clicking the ▶ NEXT button will take you to a multimedia panel (Figure 24), while selecting the BACK button will return you to the transport panel (Figure 20).Figure 23 To obtain more information, the user can click on "*i*" button. Figure 23 illustrates an example of a descriptive explanation of the selected option.
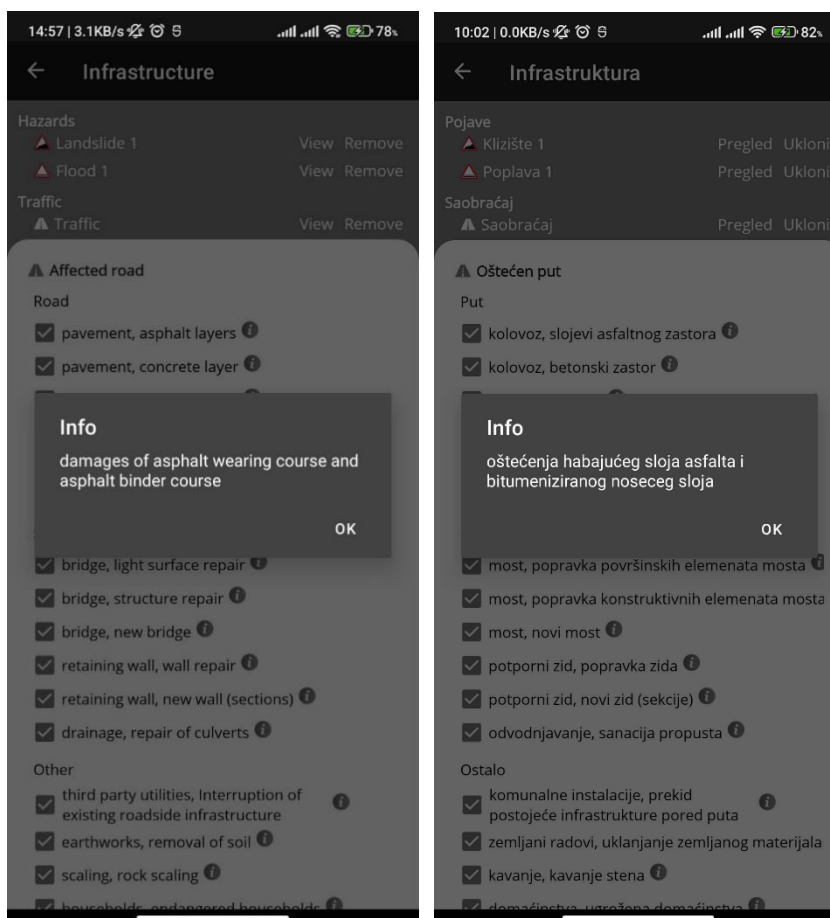
Figure 23 Example of popup with explanation of label (option)

2.6.3   Upload photos (images)

As already explained at the panel for new observation, button 📷 can be used for taking pictures from any of the panels. In addition, users have the option to take pictures outside of the application and later link them to the observation entry by uploading them on the screen presented in Figure 24.
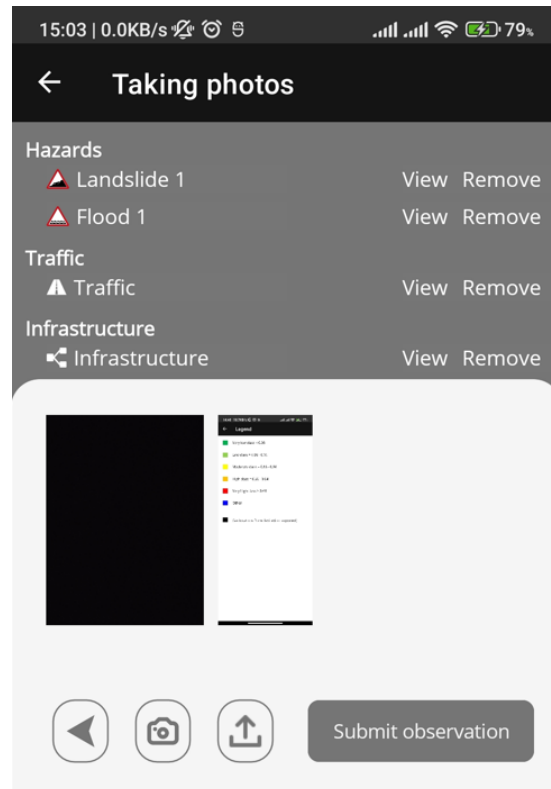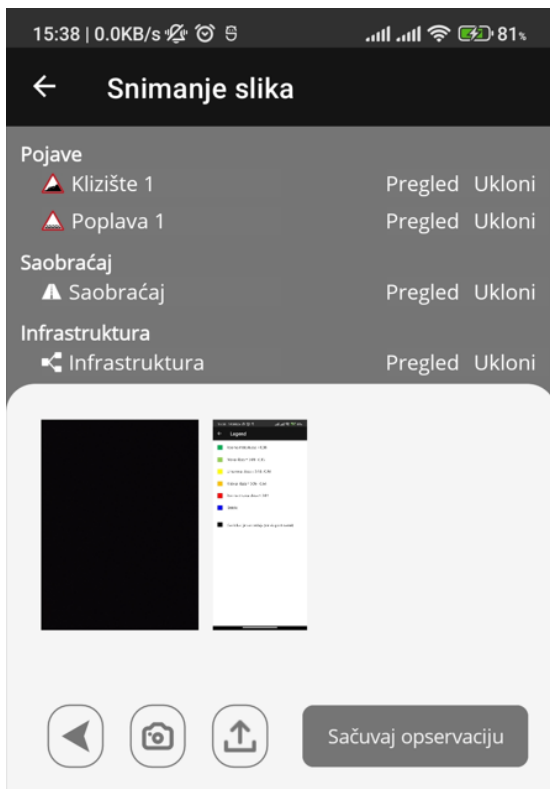
Figure 24 Panel for photos upload

Photos from the fields will be automatically sent to the server along with other data (as one batch) to record the visual evidence of the observation. Later, users can use the web application to describe the photos. The export procedure is outlined in Figure 30.

2.7　　Data preview

On the Home panel, users have the option to select the data preview feature, which displays a list of observations. After choosing a particular observation from the list, its details are presented. It is worth noting that a location can be observed multiple times during the designated period, and all data is recorded and available for preview. However, the most recent data will be displayed at the top and used for scoring.
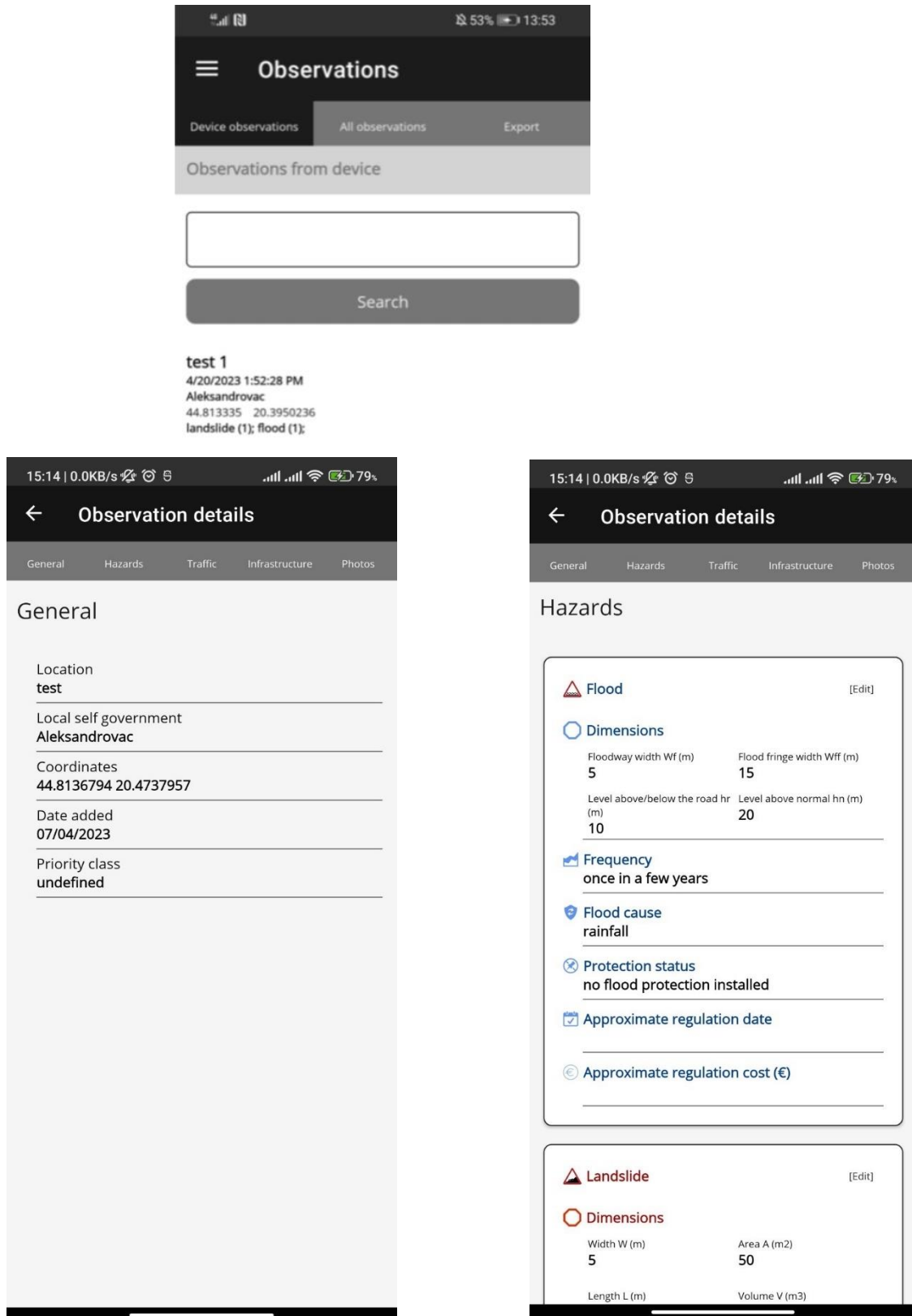
Figure 25 Observation details panel
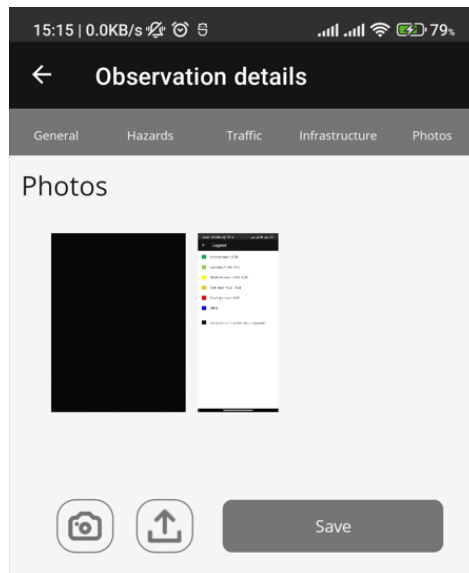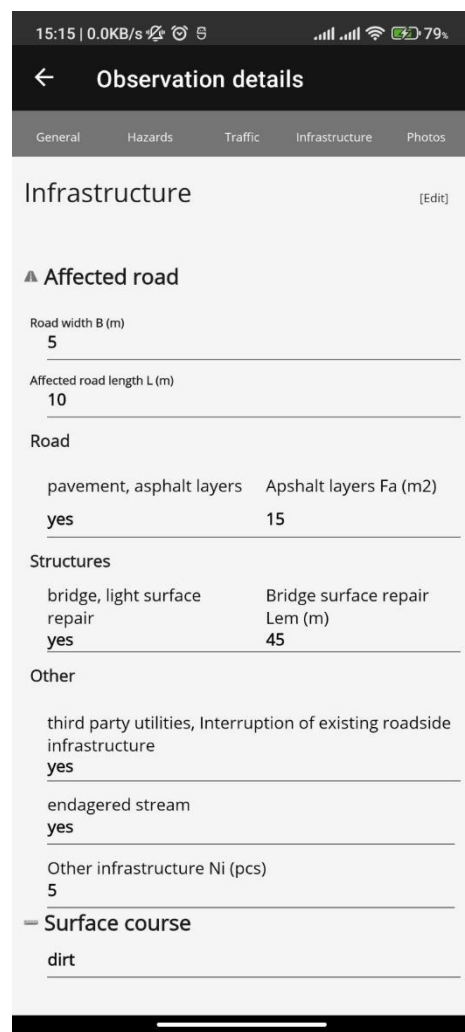
Figure 26 Observation details panel: preview of traffic, infrastructure, and photos

An overview of recorded data is presented in next panels: data are accessible via tabs Hazard (Figure 25), Traffic, Infrastructure and Photos (Figure 26). Photos that are taken out of the application can be uploaded and assigned to the relevant observation as well.
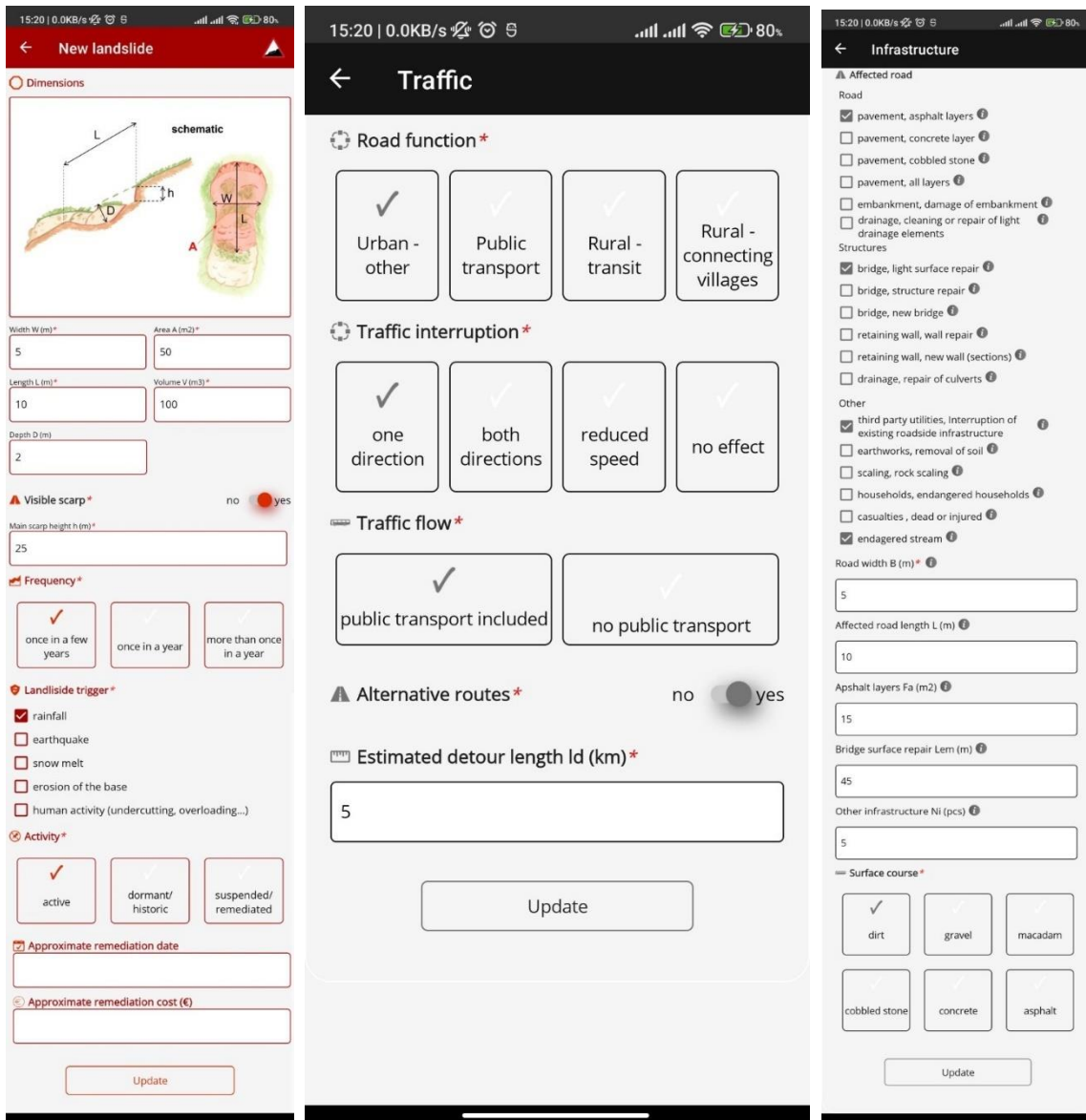
Figure 27 Editing / updating (examples)

Examples of editing options for different data groups are presented in Figure 27.
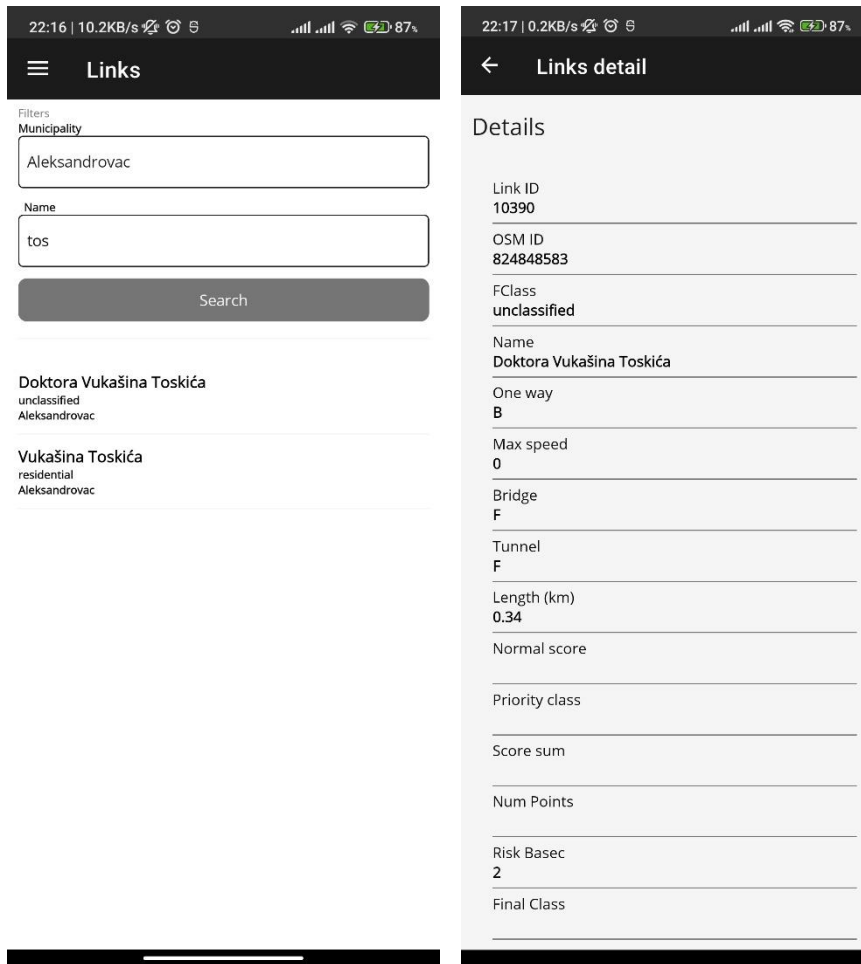
Figure 28. Links page with search and Links details

Figure 28 presents the example of link data panel that are downloaded and prepared for use in the mobile application.
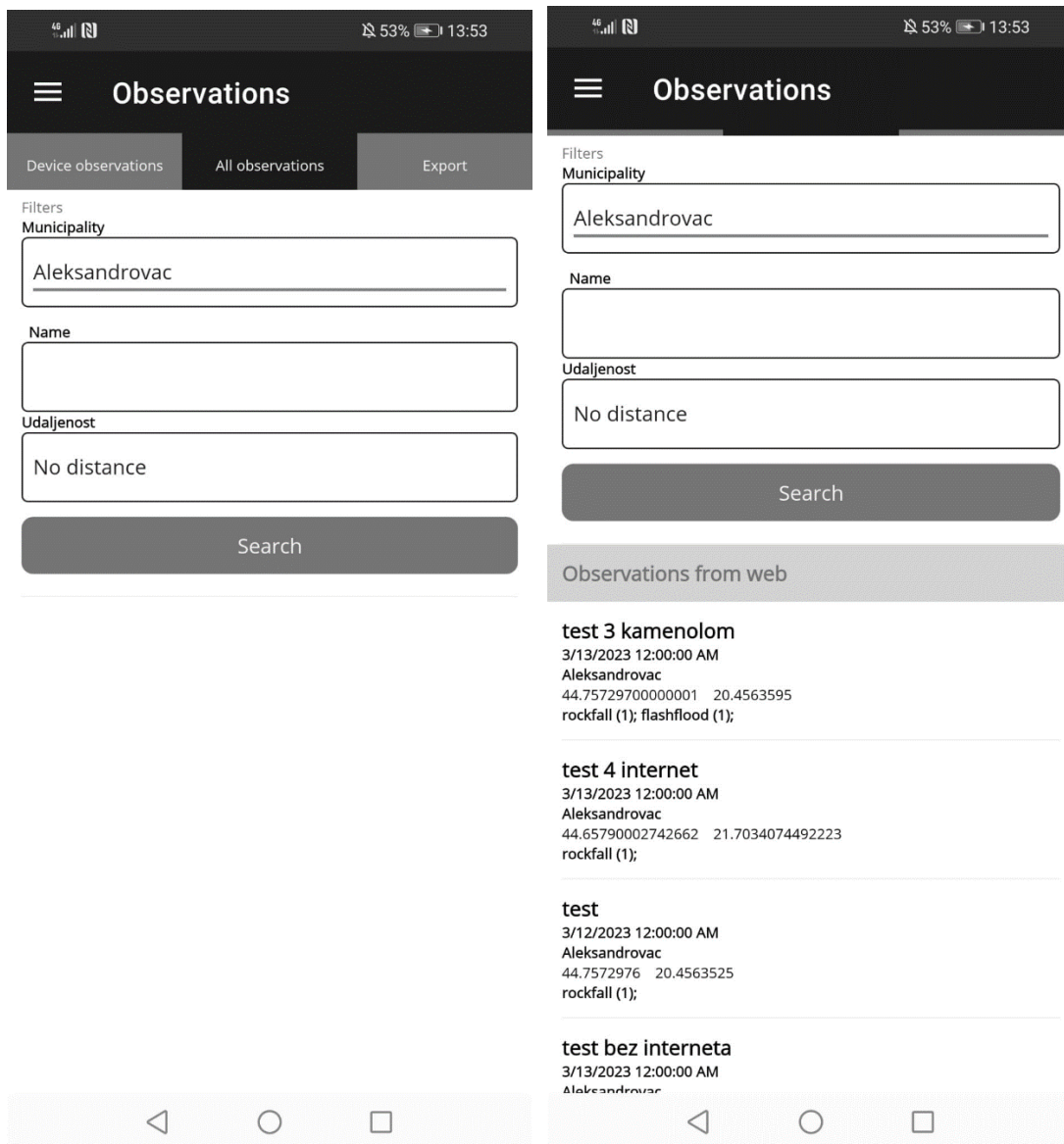
Figure 29 All observations tab

Figure 29 presents the screenshots with observation list preview, where several filter options are available.

Once all the necessary data has been provided, the observation data can be uploaded to the server. If photos are included in the data, they will be exported automatically as well. Figure 30 provides an example of the data export process. The user has the option to select specific observations for export or choose to export all observations at once. It is important to note that a successful export requires the mobile device to be connected to the internet. After a successful upload, the exported data is removed from the list of observations for upload.

2.8   Public user crowdsourcing?

A simplified version of map preview is available for public users allowing them to report irregularities on the road via a straightforward notification form. We use well-known expression "crowdsourcing" which involves obtaining work, information, or opinions from a large group of people who submit their data via the Internet, social media, and smartphone apps. The user must be registered, but procedure for registration is simple and "self-registration" is explained in Section 2.2. However, the public user is unable to access the interface described in the previous section. Instead, a simplified menu with a map (Figure 31) and a simplified notification form (Figure 32) are available.
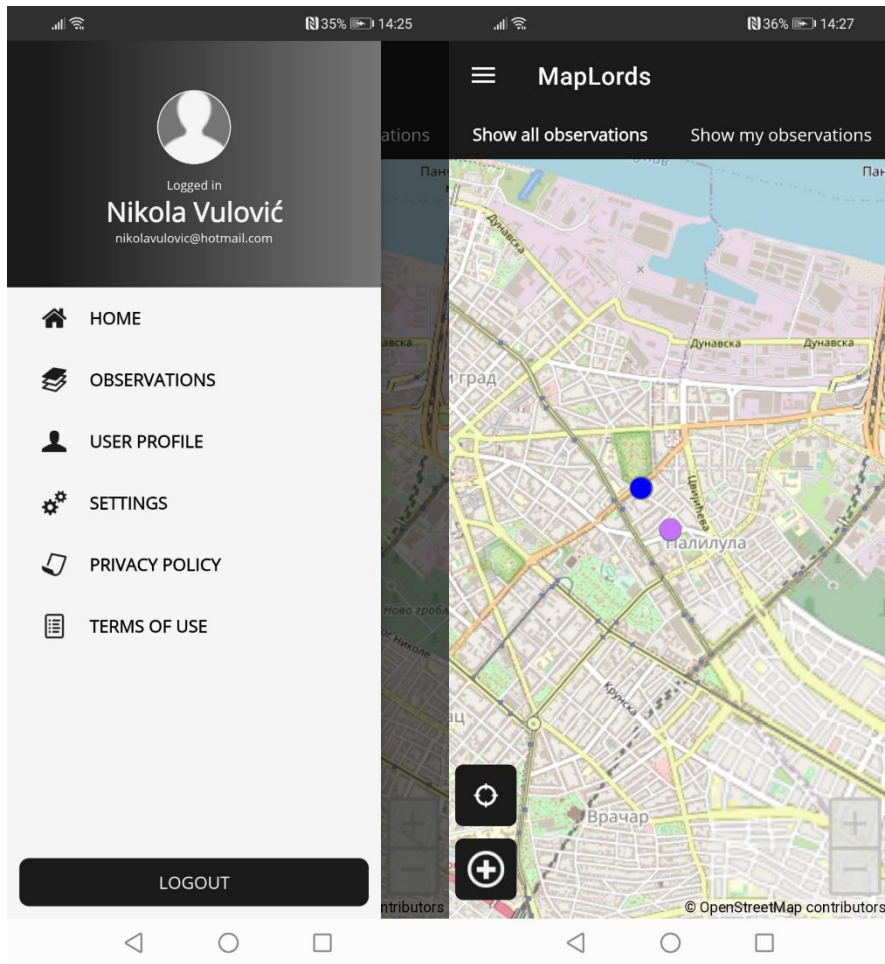
Figure 31 Public user menu preview

Figure 31 presents a simple menu with a limited number of options, including a map that automatically positions the user's current location and allows them to add a point to indicate the location of the reported irregularity.
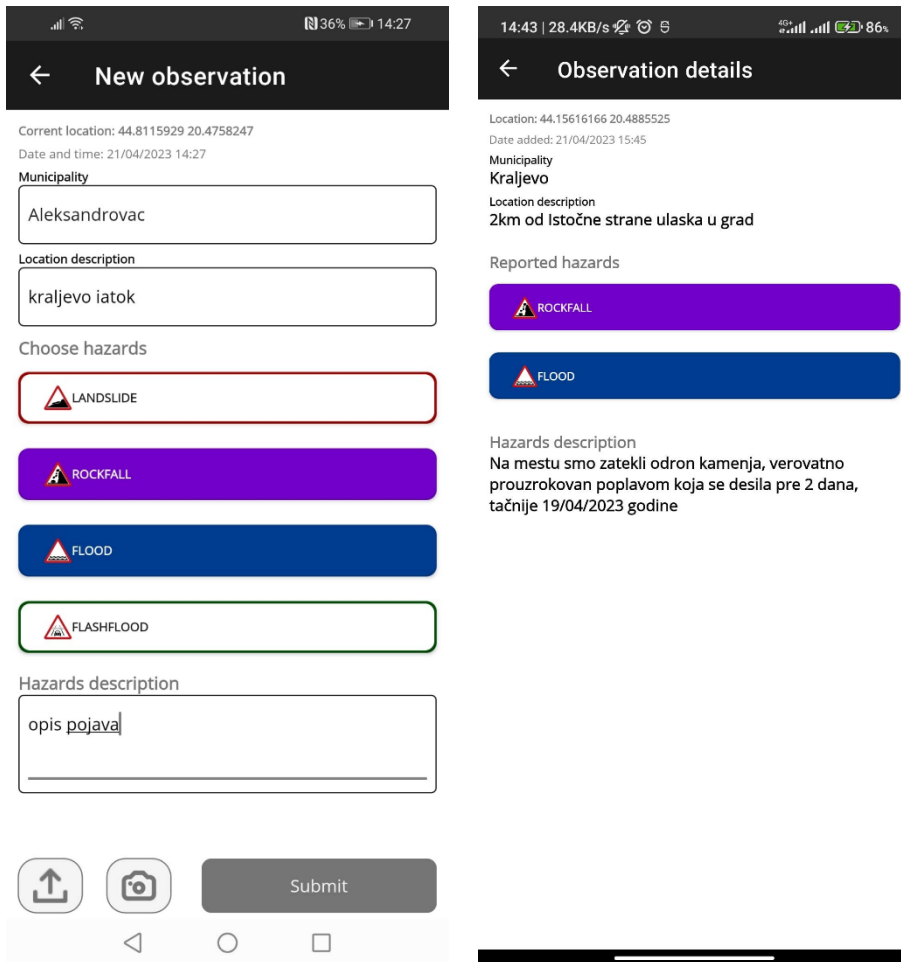
Figure 32 Panel for public users

Figure 32 shows a simple panel where a public user can submit a notification about an event or undesirable situation on the road. The user can add a location description, select the type of hazard (which will be displayed in an assigned color) and provide additional information about the observed situation. The user can also submit illustrative photos as part of the notification.

3. Web app outline

The users with maximum privileges are referred to as power users, who can be analyst for one or all LSGs, as well as administrators and field specialists, each with different authorization rights:

- administrative part: user management, user account's role and status assignment, user activity logs control,

- Catalogue management includes defining the types and characteristics of observed hazardous event collected via the mobile app, setting up a Priority matrix rule for determining the preliminary priority value, configuring input data categories (as specified in Task 1) such as numeric, categorical, and string data, and setting weights for prioritization required for weighted sum calculation in the Control layer. It also involves managing the recommendations catalogue.

- The GIS base layers include the road network (OSM – OpenStreetMap) with feature exploded to a suitable size (1 km or as proposed within Task 1) and Control layer, which is only accessible to authorized users.

Public access to the portal will have the following functions:

- search, browse and filter of collected data,

- simple statistical overview: per section, within LSG area etc.,

- download area (shape files, excel and csv with input and output data).

All data are stored in backend database, which is also managed by the web application, dedicated to user management, glossary editing for multilingual support, data search, preview, and analysis, as well as for the reporting, including data export into an excel file. The web application is available at https://maplords.rgf.bg.ac.rs/ with core functionalities.

The reports are designed as a series of web pages that allow user to start with an overview report (as presented in Figure 76 and Figure 77) and drill-down to the overview of point data (Figure 73 and Figure 74). Users will also be able to further drill-down to obtain detailed information about the observed data in the field.

In addition to the HTML report, an excel format is also available as it provides better flexibility for handling tables with numerous columns. Users can exclude irrelevant data from the Excel report and generate a PDF version from there.

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3.1 User management

Log in panel for users is presented in Figure 33.
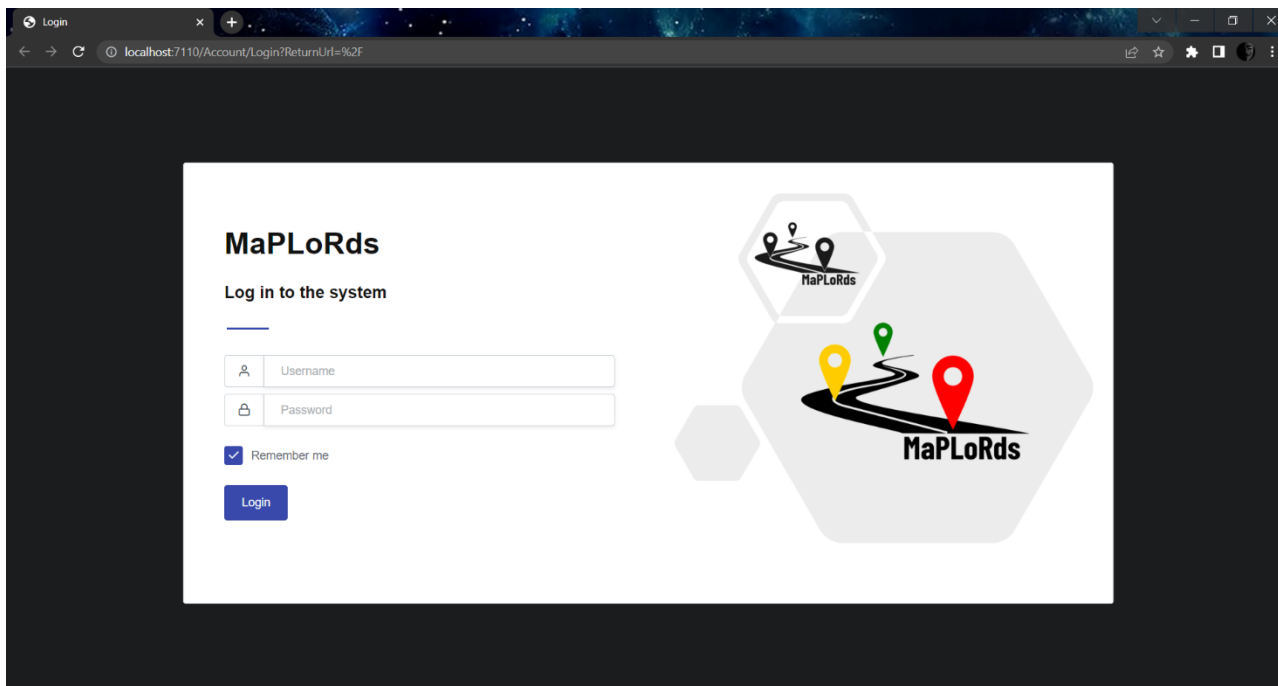
Figure 33 Log in panel for web application

The user management feature allows for the customization of the application's features and accessibility based on different users by assigning appropriate roles. The initial list of roles include:

- Administrator of the system (user profile and user role management),

- Power-user for all LSGs, (management of all data for all LSGs - mobile and web application)

- Power-user per one LSG, (management of all data for one LSG - for mobile and web application)

- Field specialist (data collecting in the field using mobile application) and

- Public users (reading role plus notification about hazards on the roads).

The proposed roles will be further refined based on feedback from the LSGs to ensure clear specification of authorization and use cases.

The administrative part of the web application requires login and admin roles. Figure 34 presents forms for user management: adding new user and editing. A typical scenario for a new user is to self-register as explained in the *Registration and login* section, after which the administrator can assign a role through this panel. However, for administration purposes, there is also an option to add a user through the web application.
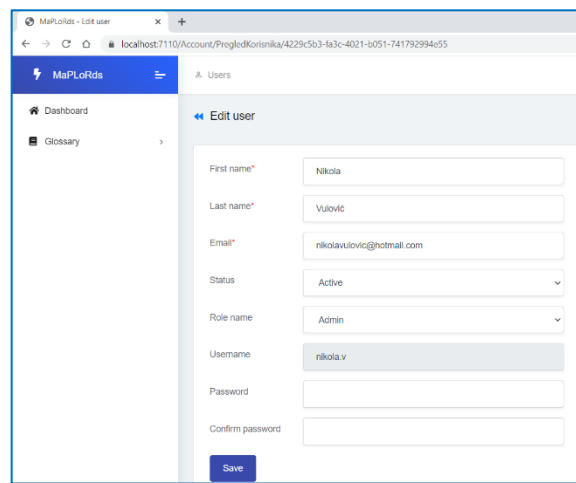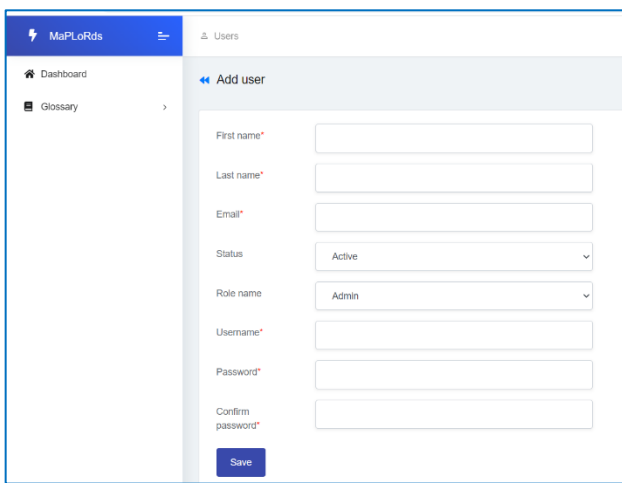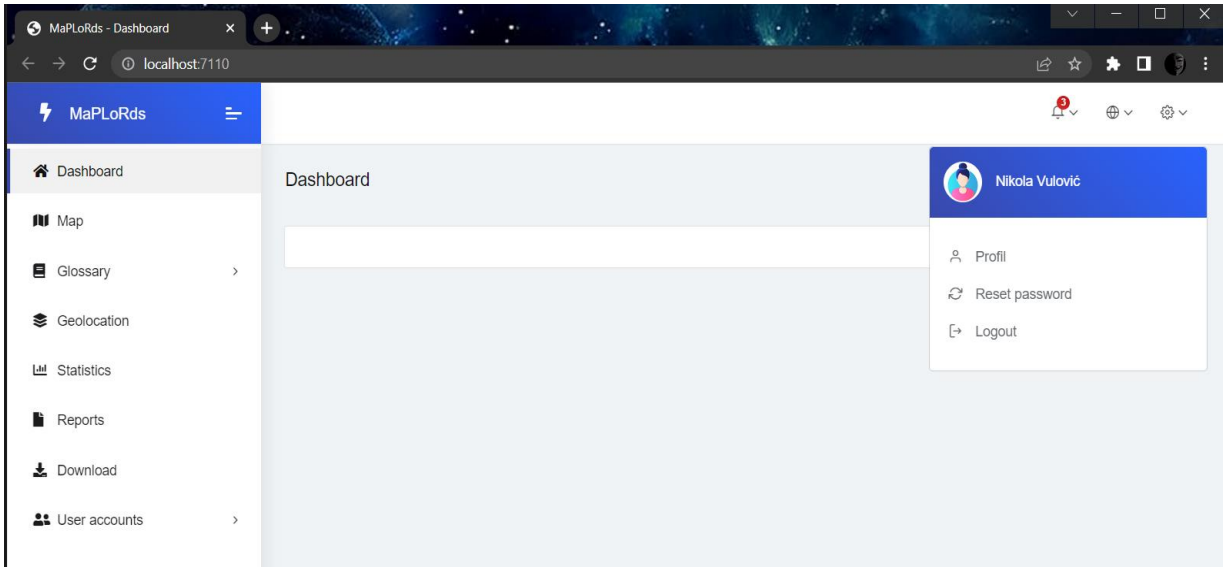
Figure 34 User management panels
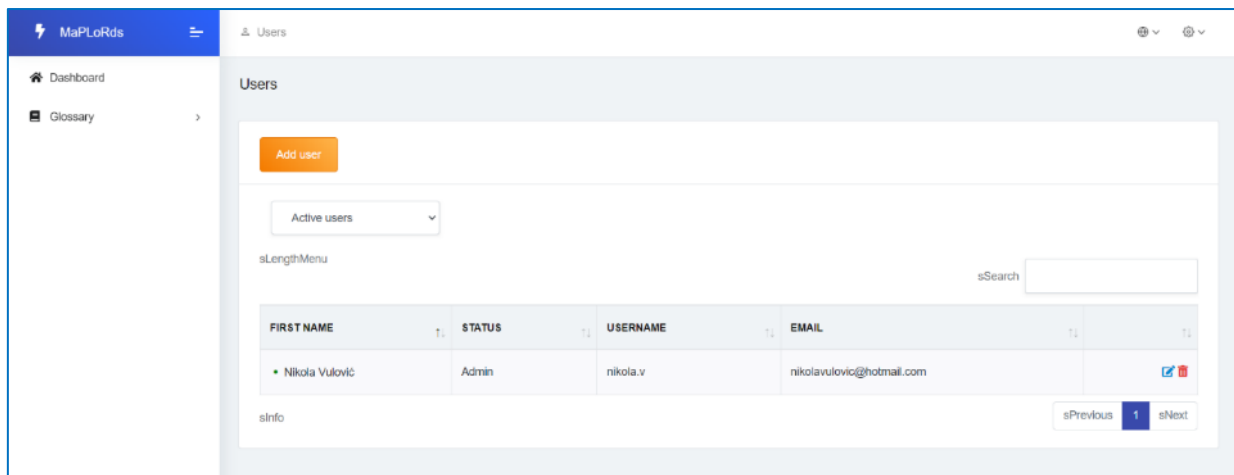
Figure 35 Tabular preview of users with search option

Figure 35 presents a panel for searching of existing users in tabular layout.

3.2   Glossary management

The system provides multilingual support through its database model, allowing an unlimited number of languages. The main catalogue contains all labels for user forms in both mobile and web applications, as well as supporting messages and database content. Each concept in the catalogue has a translation equivalent with a term and definition for all defined languages. Initially, the system supports English and Serbian, but additional languages can be added. For easy access to the mobile application interface, JSON localization file for each language is generated from database content using open web service. Figure 36 illustrates the language management process, including how to preview, add, and edit information for new languages in the system.
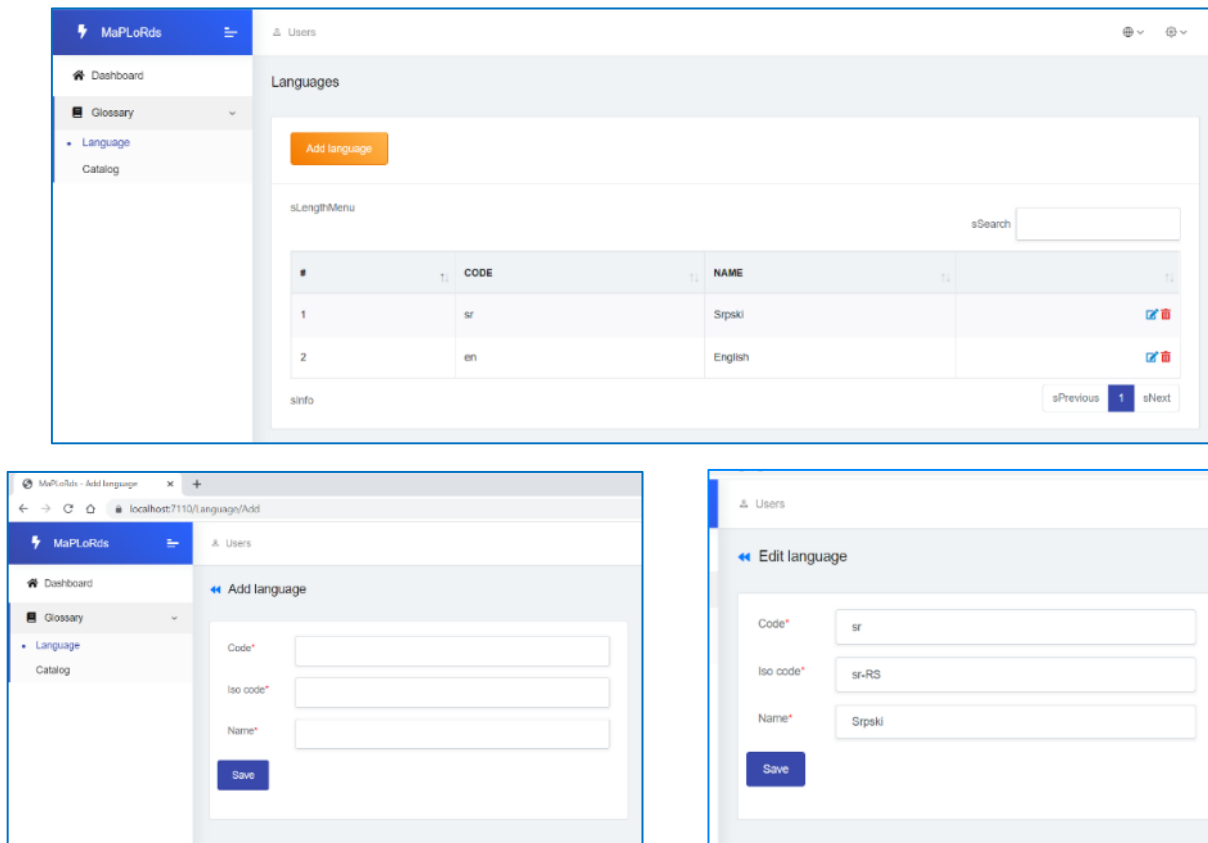
Figure 36 Language management forms

For each language, 2-character ISO 639-1 code is assigned as unique identifier. This is followed by a 4 latter IETF language tag and narrative name of the language. All domains, domains values (concepts) and variables used in the system, along with the massages, are stored in the shared catalogue. The system also stores measurement units and designations for qualitative variables where applicable, in addition to the term and definitions.

The schematic presentation of the panel includes information on the measurement unit and designation for quantitative variables. Just to emphasize that labels and other content presented in bilingual user-interface in previous sections are managed by this component.

The overview of selected quantitative data is presented in Figure 37.

Label	Entry@en	Entry@sr	measur	designation	f
landslide	landslide	klizište			
dimensions	dimensions	dimenzije			
length	length	dužina	m	L	
width	width	širina	m	W	
depth	depth	dubina	m	D	
visible_scarp	visible scarp	vidljiv ožiljak (škarpa)			
main_scarp_height	main scarp height	visina glavnog ožiljka (škarpe)?	m	h	
area	area	površina	m2	A	
volume	volume	zapremina	m3	V	
rockfall	rockfall	odron			
runout	runout distance	domet odrona	m	Lr	
release_height	release height	visina mesta odronjavanja	m	hb	
block_volume	block volume	zapremina bloka	m3	Vb	
flood	flood	poplava			
floodway_width	floodway width	širina protočne zone	m	Wf	
flood_fringe_width	flood fringe width	širina zone zadržavanja vode	m	Wff	
level_above_normal	level above normal	nivo iznad redovnog nivoa odbrane	m	hn	
level_above_the_road	level above/below the road	nivo iznad/ispod puta	m	hr	
flashflood	flashflood	bujica			
flashflood_width	width	širina bujice	m	W	
runout	runout distance	domet bujice	m	Lr	
level_above_ground	level above ground	nivo iznad površine terena	m	hg	
level_above_the_road	level above/below the road	nivo iznad/ispod puta	m	hr	

Figure 37 An excerpt in bilingual glossary for multilingual support of quantitative variables

Even qualitative variables that are controlled by domains, such as single choice and multiple choice, are also managed by the catalogue. This can be observed in Figure 38 Figure 36.

Label	Entry@en	Entry@sr	measur
frequency	frequency	učestalost pojave	
once_in_a_few_years	once in a few years	jednom u nekoliko godina	
once_in_a_year	once in a year	jednom godišnje	
more_than_once_in_a_year	more than once in a year	više od jednom godišnje	
landliside_trigger	landliside trigger	uzrok klizišta	
rainfall	rainfall	kiša	
earthquake	earthquake	zemljotres	
snow_thaw	snow thaw	otapanje snega	
erosion_of_the_base	erosion of the base	erozija nožice	
human_activity	human activity (undercutting, overloading...)	ljudska aktivnost (potkopavanje, preopterećenje...)	
rockfall_trigger	rockfall trigger	uzrok odrona	
rainfall	rainfall	kiša	
earthquake	earthquake	zemljotres	
icing	icing	zaleđivanje	
plant_roots	plant roots	korenje biljaka	
snow_thaw	snow thaw	otapanje snega	
human_activity	human activity (undercutting, overloading...)	ljudska aktivnost (potkopavanje, preopterećenje...)	
flood_trigger	flood trigger	uzrok poplave	
rainfall_flood	rainfall	padavine	
snow_thaw	snow thaw	otapanje snega	
upstream_dyke_breach	upstream dyke breach	uzvodno probijanje brane	
downstream_river_damming	downstream river damming	nizvodno pregrađivanje reke	
external_floodwave	external floodwave	spoljašnji poplavni talas	
flashflood_trigger	flashflood trigger	uzrok bujice	
rainfall_flood	rainfall	padavine	
snow_thaw	snow thaw	otapanje snega	
upstream_barrier_breach	upstream barrier breach	uzvodno probijanje protivbujične barijere	

Figure 38 An excerpt in bilingual glossary for multilingual support of domains for qualitative values

Forms presented in Figure 39 and Figure 40 will be used for catalogue and glossary management. Figure 39 presents editing of one term in two languages, but, if more than two languages are defined, they would be listed below.
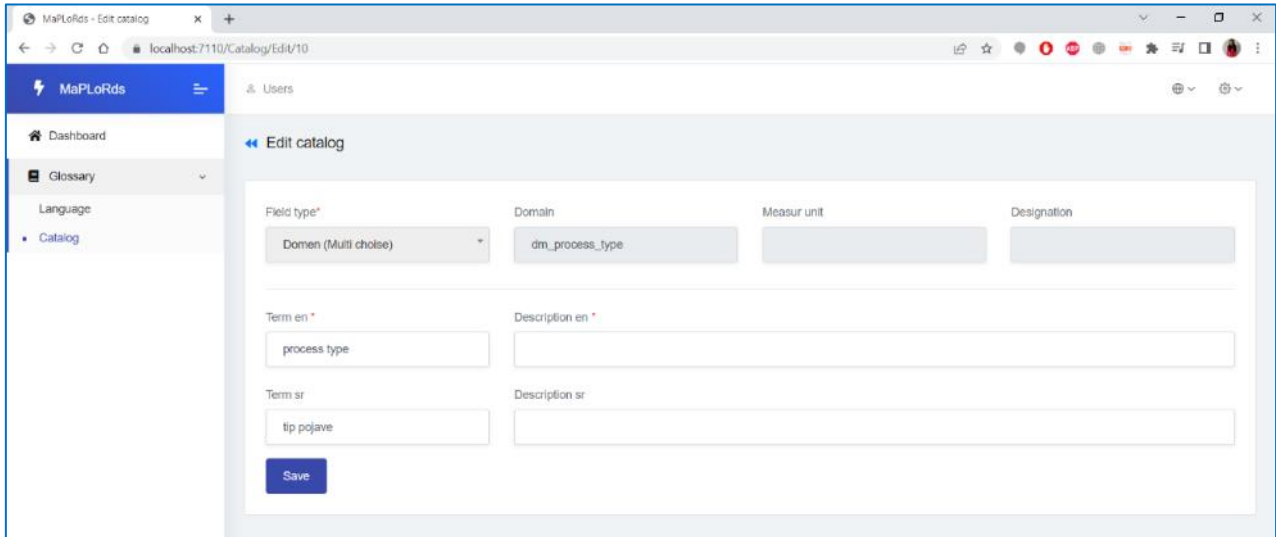
Figure 39 Editing of catalogue

Figure 40 Tabular preview of catalogue terms with search option

3.3 Dashboard notifications

For some actions required, for example for role assignment for new user, the notification will be provided as presented in Figure 41.
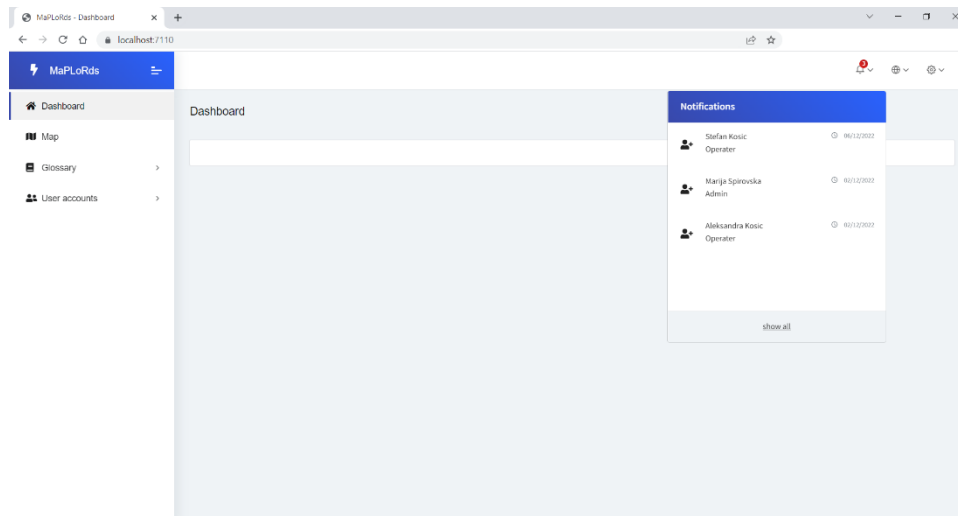
Figure 41 Notifications panel

3.4 Backend map preview

The web application should display road links and sub-links, which can be used to visually analyze problematic parts on the roads in LSG. The problematic parts can be identified as points with observations and will be classified in five classes ranging from 1 (low) to 5 (heigh) priority. Each class will have an appropriate color scheme, starting with green for lower priority and going up to red for higher priority:

- Very low class <0.08 ⇒ color code **dark green**

- Low class = 0.08-0.16 ⇒ color code **light green**

- Moderate class = 0.16-0.36 ⇒ color code **yellow**

- High class = 0.36-0.64 ⇒ color code **orange**

- Very high class > 0.64 ⇒ color code **red**

The observed points will only be visible when the user zooms in to a smaller extent since they may not be informative at larger scales.
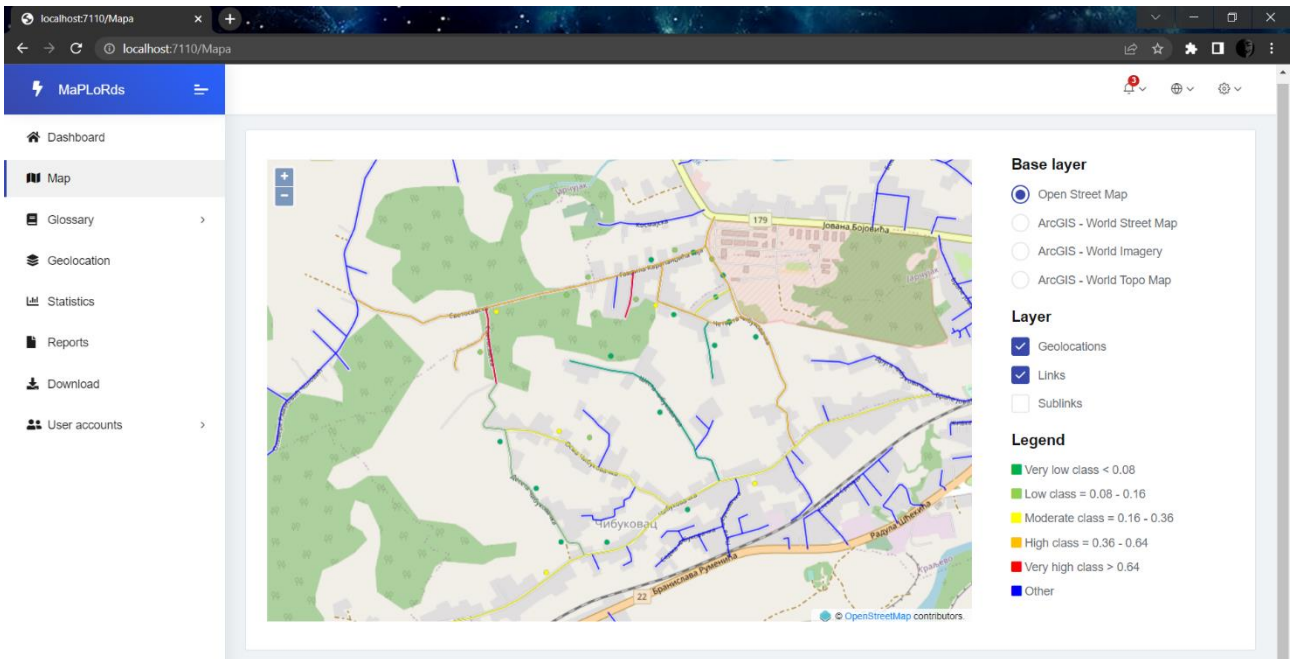
Figure 42 Web GIS form with Open Street base map

The point features with assigned priority values are used in the calculation of links and sub-links priority values, which considers the number of observations, the assigned point values and the length of segment. The line features (road links and sub links) can be selectively shown or hidden by the user via the panel and will be color-coded according to their priority class as previously explained.

The point features (observations), on the other hand, will only become visible when zoomed in and when user selects the "visible" layer option. The user also has the option to choose from several base layers, as presented in Figure 42 with Open Street Map and Figure 43 with ArcGIS World Imagery. Visibility of layers check list, Base layers selection and Legend are conveniently located on the right side of the panel for easy access by the user.
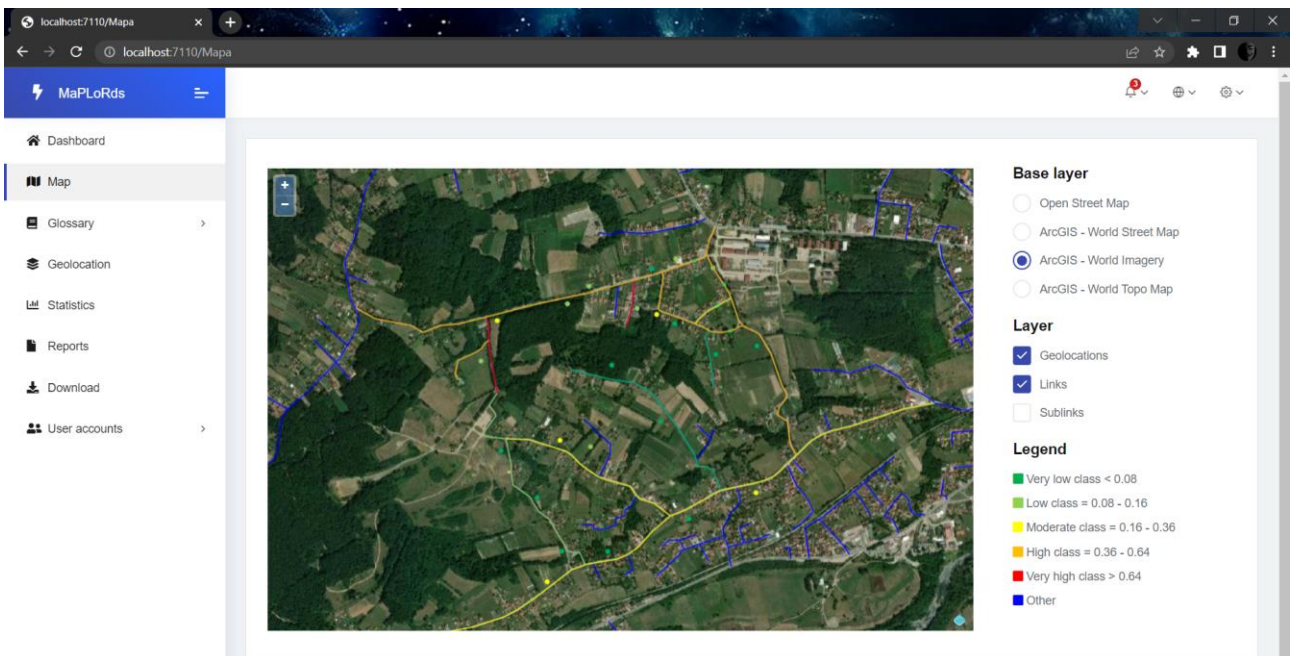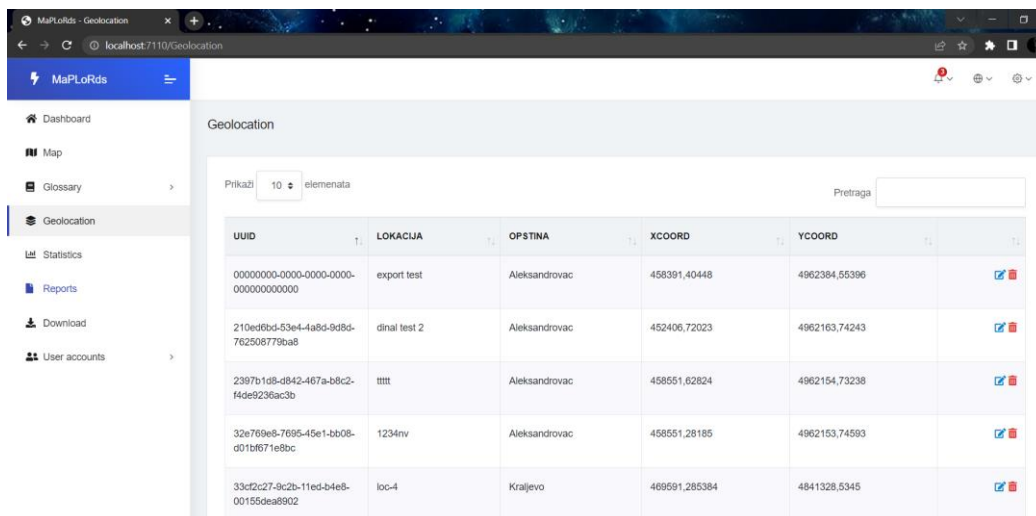
Figure 43 Web GIS form with ArcGIS World Imagery

 The web GIS form with ArcGIS World Imagery supports a click event online on point features, which allows the user to preview detailed data when they click on a specific point on the map. Additionally, when the user zooms in on the point and line features, the names of streets or locations will be visible using zoom-in labels.

3.5 Geolocation and observation

The geolocation section on the web panel provides an overview of all geolocations with possibility to browse to detailed data for selected row. Icon for delete 🗑 marks a record that is deleted, however, it is not actually deleted from the database. This option is enabled just to Power user for that LSG. The column UUID is visible only to admin role. It is a global unique identifier serving as a primary key.

Figure 44 Overview of geolocations

To preview data for an observed geolocation (Figure 45), the user needs to click on a symbol 📝 to see the detailed information split into several sections (tabs): 1) Main data, 2) Hazards, 3) Traffic, 4) Infrastructure. Figure 45 represent part of panel with tabs on detailed page.
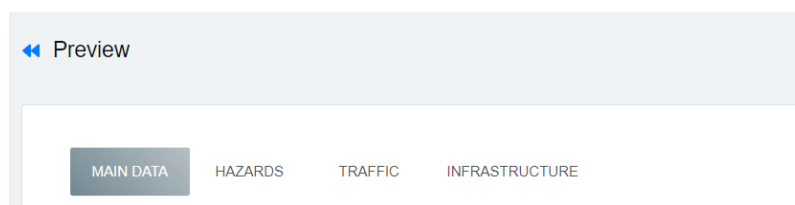
Figure 45 Tabs on page with details of observed data

The main data section (Figure 46) shows general information about geolocation and observation such as date of observation, user, coordinates, location name etc. Also, photographs for selected geolocation are shown on main panel.
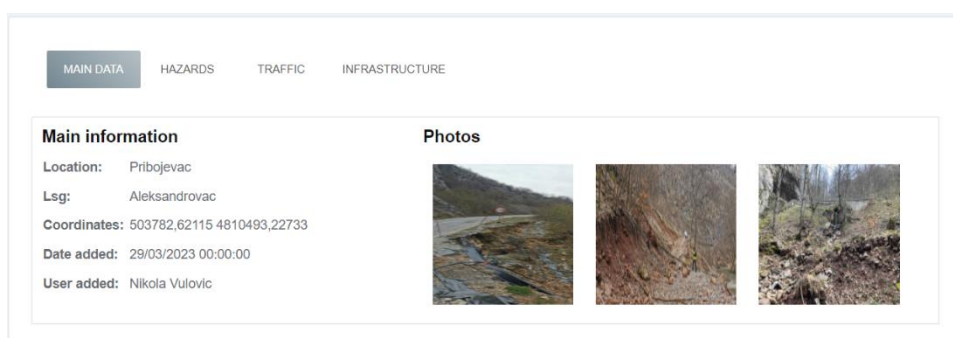
Figure 46 Details page: main data tab

The Hazard tab in Figure 47 displays a list of all hazards observed for selected geolocation. For presented example, a landslide is the observed hazard and all relevant information from the database is shown. Just to mention that preview and interface are displayed in the language in the user's preferences. The data editing mode can be accessed by clicking on the icon 📝 .
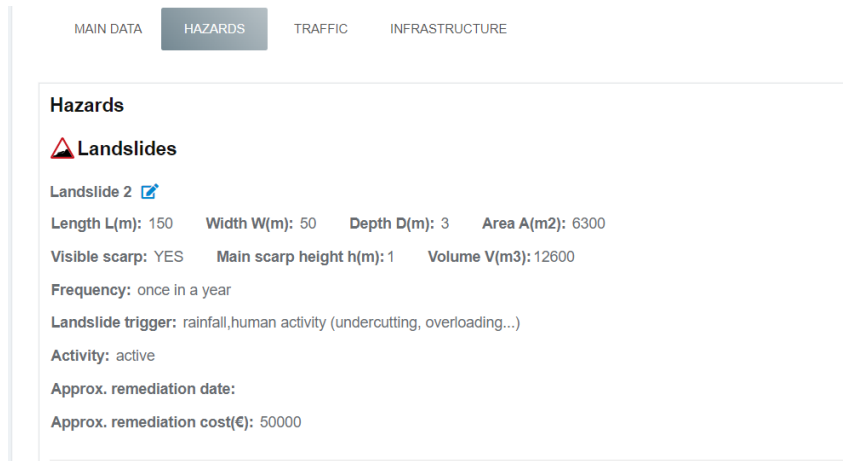
Figure 47 Details page: hazards tab

The left side of Figure 48 the Traffic tab displays traffic data. On the right-side, Infrastructure tab shows infrastructure data.
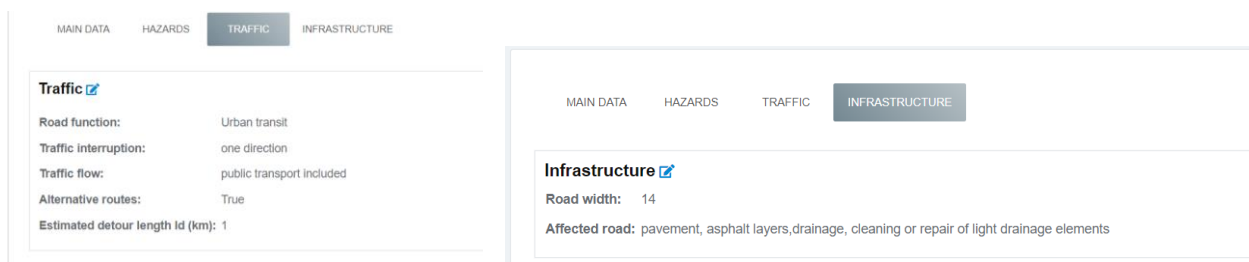
Figure 48 Details page: traffic and infrastructure tabs

Editing of data collected in the field is enabled for the authorized user, by using the icon ☑ next to tab dataset name. Figure 49 present an option for editing of landslide data. When selecting a symbol on the left panel, data will appear in modal popup (on the right panel).
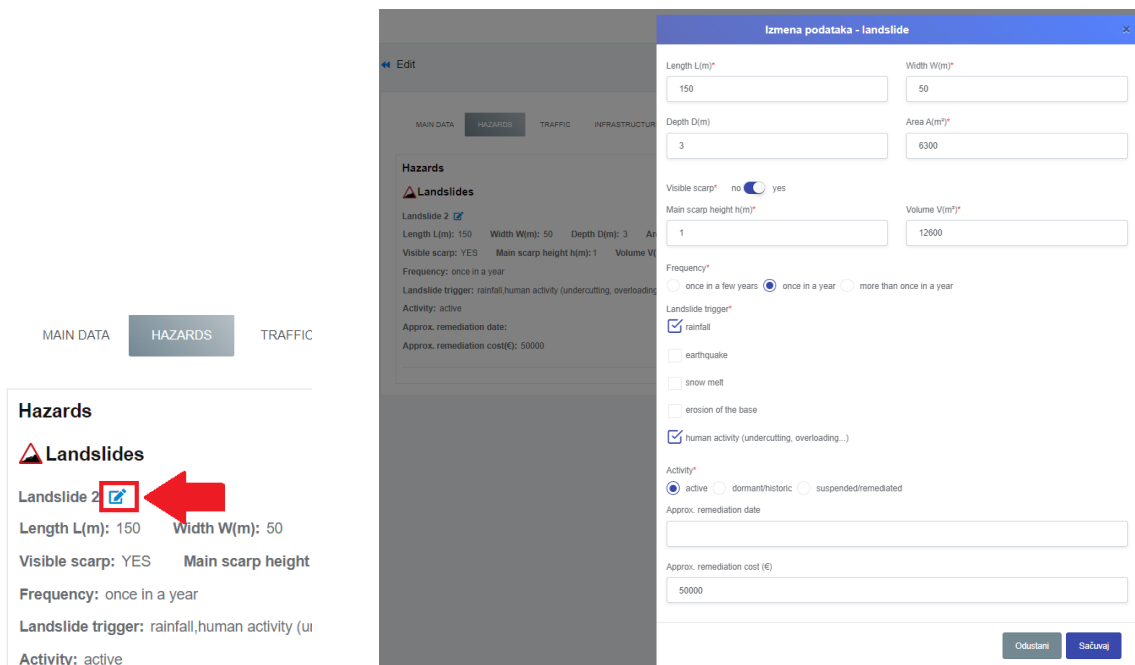
Figure 49 Editing of data collected in the field

3.6 Support area

The download section currently contains apk files, but other resources will be available here: additional data and document, guidelines, other relevant links. Figure 50 presents the initial version of such page.
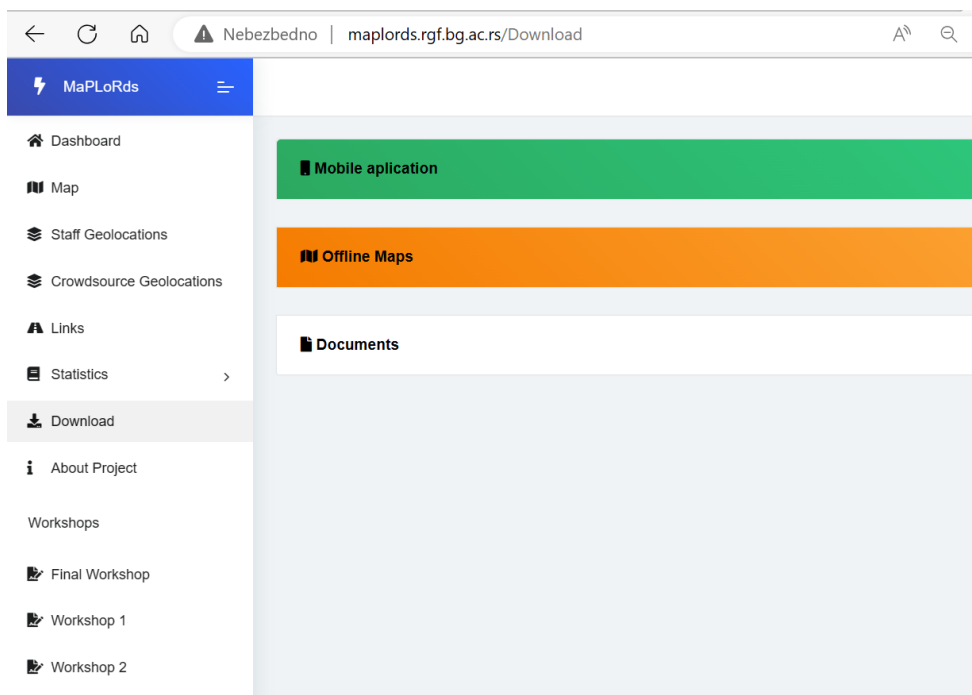
Figure 50 Download area

Supporting data can comprise background datasets, guidelines for data analysis, use cases and other relevant documents.

Figure 51 presents tabular preview of links with possibility to update relevant links data (Figure 52).
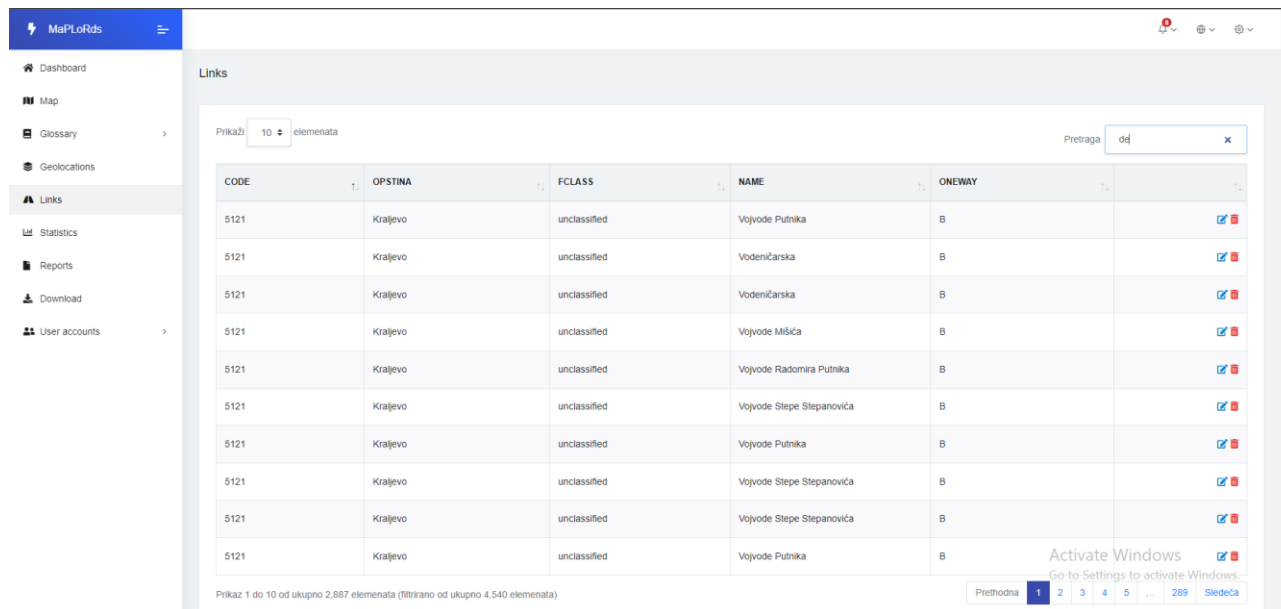
Figure 51 Tabular preview of links

Figure 52 Updating of links related data

Figure 53 presents a part of data form with another preview of links' data. Similar approach for presenting data is for sub links.

Figure 53 Preview of link data

3.7 Web services specification

Web services are a way for different software components to communicate with each other over the internet providing a standardized way for applications to exchange data and functionality.

In the context of MapLoRds web and mobile applications, web services are used to integrate data and functionality from different sources into a single application. The mobile application uses a web service to retrieve data from a remote server, such as information about road links and all observation details and display it in the app's user interface.

Similarly, a web application might use a web service to access functionality provided by a third-party service, such as base or additional layers on the map. MaPLoRds web services use standard protocols such as

HTTP, XML, and JSON to enable communication between components and Representational State Transfer (REST), which is commonly used in web and mobile application development.

MaPLoRds web services are divided into following groups:

- Geolocation services
- Language services
- Referral Values services (LSG specific)
- User services

Figure 54 presents part of the screen with list of services presenting its group, type (GET or POST) and relative path.

Figure 54 List of MaPLoRds web services

3.7.1   Geolocation services

Geolocation services implement actions related to geolocation objects.

Service: GetGeolocations is of type *GET*, without parameters. The service return list of all geolocations to be used in data view grid, map preview etc. Figure 55 presents an example of its usage.

Url: https://maplords.rgf.bg.ac.rs/api/api/Geolocation/GetGeolocations

```
Curl

curl -X 'GET' \
  'https://localhost:7059/api/Geolocation/GetGeolocations' \
  -H 'accept: */*'

Request URL

https://localhost:7059/api/Geolocation/GetGeolocations
```

Figure 55 Web service *GetGeolocations* request

The override version of service will have a parameter LSG and then it will extract geolocations for the requested LSG only.

Service: GetGeolocationsByID is o type: GET and it has one parameter: *Geolocation_UUID*. Service returns geolocation for requested identifier of geolocation, with one (or more) observations, containing hazards (landslides, rockfalls, floods, flash floods), traffic and infrastructure. Figure 56 presents an example of its usage.

Url: https://maplords.rgf.bg.ac.rs/api/Geolocation/GetGeolocationByID

```
Curl

curl -X 'GET' \
  'https://localhost:7059/api/Geolocation/GetGeolocationByID?uuid=4ddecd72-9c2b-11ed-b504-00155dea8902' \
  -H 'accept: */*'

Request URL

https://localhost:7059/api/Geolocation/GetGeolocationByID?uuid=4ddecd72-9c2b-11ed-b504-00155dea8902
```

Figure 56 Web service *GetGeolocationByID* request

Service: GetGeolocationByFilter is of type *GET*, with several parameters: *Location name, LSGID, Distance, CurrentLocationX, CurrentLocationY*. User can filter data by Location name or LSGID value. There is possibility to find all geolocation in radius of 100m, 250m, 500m 1km, 5km or 10km.

Url:
https://maplords.rgf.bg.ac.rs/api/api/Geolocation/GetGeolocationsByFilter?name=LOCATION&lsgid=LSGID&distance=DISTANCE

Figure 57 presents an example of its usage.

```
Curl

curl -X 'GET' \
  'https://localhost:7059/api/Geolocation/GetGeolocationsByFilter?name=loc-&lsgid=0&distance=0&token=123F5' \
  -H 'accept: */*'

Request URL

https://localhost:7059/api/Geolocation/GetGeolocationsByFilter?name=loc-&lsgid=0&distance=0&token=123F5
```

Figure 57 Web service *GetGeolocationByFilter* request

Service: SaveGeolocation is of type POST, with a string parameter geolocation. Service provides adding new geolocation into database, where geolocation data are passed as string. String is formatted in JSON and deserialization of string creates Geolocation object that can be saved into database. Object contains geolocation data with observation and hazard lists, traffic, and infrastructure.

Url: https://maplords.rgf.bg.ac.rs/api/Geolocation/SaveGeolocation
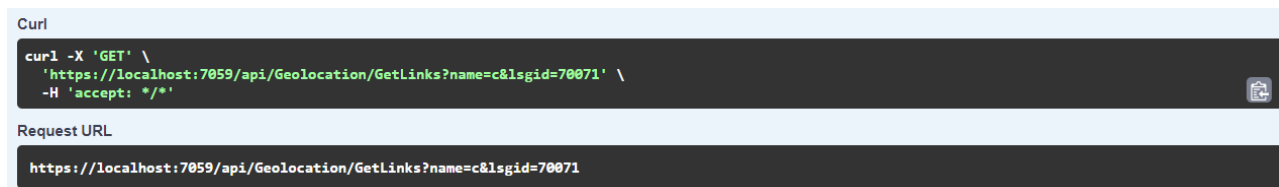
Service: UpdateGeolocation is of type POST, with a string parameter geolocation. It provides updating geolocation data. Service gets geolocation data as string. String is generated as JSON and deserialization of string gives us Geolocation object that can be updated. Object contains geolocation data with observation and hazard lists, traffic, and infrastructure. Service updates all data which values are changed.

Url: https://maplords.rgf.bg.ac.rs/api/Geolocation/UpdateGeolocation

Service: GetLinks is of type *GET*, with lsgid and name parameters. The service return list of all links to be shown in grid on user request. Figure 558 presents an example of its usage.

Url: https://maplords.rgf.bg.ac.rs/api/api/Geolocation/GetLinks?name=NAME&lsgid=LSGID
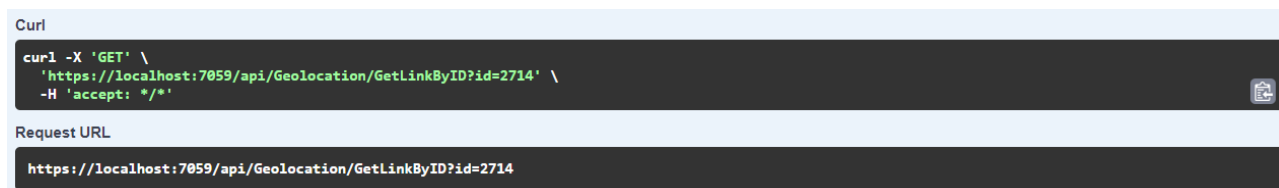
```
Curl
curl -X 'GET' \
  'https://localhost:7059/api/Geolocation/GetLinks?name=c&lsgid=70071' \
  -H 'accept: */*'

Request URL
https://localhost:7059/api/Geolocation/GetLinks?name=c&lsgid=70071
```

Figure 58 – Web service GetLinks request

The override version of service will have a parameter LSG and then it will extract geolocations for the requested LSG only.

Service: GetLinkByID is o type: GET and it has one parameter: *LinkID*. Service returns link for requested identifier. Figure 59 - Web service GetLinkByID request presents an example of its usage.

```
Curl
curl -X 'GET' \
  'https://localhost:7059/api/Geolocation/GetLinkByID?id=2714' \
  -H 'accept: */*'

Request URL
https://localhost:7059/api/Geolocation/GetLinkByID?id=2714
```

Figure 59 - Web service GetLinkByID request

Url: https://maplords.rgf.bg.ac.rs/api/Geolocation/GetLinkByID
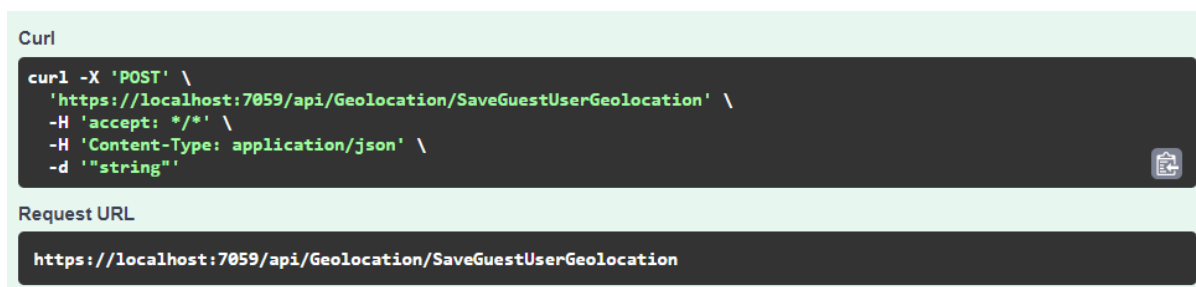
Service: UploadImages is o type: POST and it has two parameters: *Observation_UUID* and *ImagesList*. Service saves information about images into database and copy images from device to server.

Url: https://maplords.rgf.bg.ac.rs/api/Geolocation/UploadImages

Service: SaveGuestUserGeolocation is of type POST, with a string parameter geolocation. Service enables adding a new geolocation for guest users (not field workers) into database, where geolocation data are passed as string. String is formatted in JSON and deserialization of string creates Geolocation object that can be saved into database. Object contains geolocation data with location name and description. Figure 60 Web service SaveGuestUserGeolocation request presents an example of its usage.

Url: https://maplords.rgf.bg.ac.rs/api/Geolocation/SaveGuestUserGeolocation

```
Curl
curl -X 'POST' \
  'https://localhost:7059/api/Geolocation/SaveGuestUserGeolocation' \
  -H 'accept: */*' \
  -H 'Content-Type: application/json' \
  -d '"string"'

Request URL
https://localhost:7059/api/Geolocation/SaveGuestUserGeolocation
```

Figure 60 Web service SaveGuestUserGeolocation request

3.7.2   Language services

Language services provides JSON files that contains labels and data translations on Serbian and English languages.

Service: GetCatalog is of type GET, with a string parameter *language*. Service provides JSON file for specific language that is further used for interface and system massages. Service can accept "sr" for Serbian or "en" for English language. Figure 61 presents an example of its usage.

Url: https://maplords.rgf.bg.ac.rs/api/Language/GetCatalog/{lang}

```
Curl

curl -X 'GET' \
  'https://localhost:7059/api/Language/GetCatalog/en' \
  -H 'accept: */*'

Request URL

https://localhost:7059/api/Language/GetCatalog/en
```

<p align="center">Figure 61 Web service GetCatalog request</p>

Service: GetLngs is of type GET, with a string without parameters. Service returns list of all available languages in json format. Figure 61 presents an example of its usage.

Url: https://maplords.rgf.bg.ac.rs/api/Language/GetLngs

```
Curl

curl -X 'GET' \
  'https://localhost:7059/api/Language/GetLngs' \
  -H 'accept: */*'

Request URL

https://localhost:7059/api/Language/GetLngs
```

<p align="center">Figure 62 Web service GetLngs request</p>

3.7.3 Referral Values services

Referral value services provide different data that are necessary in application.

Service: GetMunicipalities is of type GET, without parameters and returns list of municipalities (LSGs). Figure 63 presents an example of its usage.

Url: https://maplords.rgf.bg.ac.rs/api/ReferralValues/GetMunicipalities.

```
Curl

curl -X 'GET' \
  'https://localhost:7059/api/ReferralValues/GetMunicipalities' \
  -H 'accept: */*'

Request URL

https://localhost:7059/api/ReferralValues/GetMunicipalities
```

<p align="center">Figure 63 Web service GetMunicipalities request</p>

Service: GetOfflineMaps is of type GET, without parameters and returns list of maps in *mbtile* format that could be used in offline mode. Figure 63 presents an example of its usage.

Url: https://maplords.rgf.bg.ac.rs/api/ReferralValues/GetOfflineMaps.

```
Curl

curl -X 'GET' \
  'https://localhost:7059/api/ReferralValues/GetOfflineMaps' \
  -H 'accept: */*'

Request URL

https://localhost:7059/api/ReferralValues/GetOfflineMaps
```

<p align="center">Figure 64 Web service GetOfflineMaps request</p>

User services provide different actions with user accounts.

Service: RegisterUser is of type: POST, without parameters. Service gets new user object, check if email already exists or username is taken. If not exists, it saves the new user into database, otherwise, service return error message about this.

Url: https://maplords.rgf.bg.ac.rs/api/Users/RegisterUser

Service: LoginUser is of type: POST, with parameter: User object. Service check if user exists and allows users login into mobile application. Service check if username exists, if password is correct and if is status active. If everything is ok, service returns status ok. In other case, service returns appropriate status value.

Url: https://maplords.rgf.bg.ac.rs/api/Users/LoginUser

Service: UpdateUser is of type POST, with parameter: User object. Service gets User object and update user data.

Url: https://maplords.rgf.bg.ac.rs/api/Users/UpdateUser

Service: DeleteUser is of type POST, with parameter: User object. Service gets User object and delete user from database. This is possible only if there is no user activity recorded in the system.

Url: https://maplords.rgf.bg.ac.rs/api/Users/DeleteUser

3.8   Defining priority matrix

The priority matrix is based on scoring system that will be described in this section. For each group of data are given parameters that are scored with seven score classes: c_05, c_075, c_1, c_2, c_3, c_4, c_5. For numerical and quantitative parameters such as length, width, and depth, each score class is defined by a range of values. Only parameters related to remediation have classes c_05, c_075, c_1, where ponders are 0.5, 0.75 and 1 respectively. All other parameters have classes c_1, c_2, c_3, c_4, c_5, where c_1 is lowest (1) and c_5 is highest score (5), indicating a greater hazard. For example, quantitative value: Length of landslide smaller than 10 has score 1, while over 500m has highest score 5.

For descriptive and qualitative values such as Frequency and Activity, specific values are listed for each score class. For parameters that are not self-explanatory additional descriptions are provided to help clarify the scoring system. It is important to note that the scoring system is stored in a database, and is not hardcoded, meaning that there is flexibility to make changes to scoring ranges and options through a web interface.

ordinal numbe	process type	param	description	c_	c_075	c_1	c_2	c_3	c_4	c_5
101	landslide	Length (m)				0-10	10-50	50-200	200-500	500-...
102	landslide	Width (m)				0-5	5-10	10-50	50-200	200-...
103	landslide	Depth (m)				0-5	5-10	10-20	20-30	30-...
104	landslide	Visible scarp				0-1				1-...
105	landslide	Main scarp height (m)				0-0.5	0.5-1	1-2	2-3	3-...
106	landslide	Area (m2)				0-50	50-500	500-10000	10000-100000	100000-...
107	landslide	Volume (m3)				0-250	250-5000	5000-200000	200000-3000000	3000000-...
108	landslide	Frequency	number of occurrences per unit of time			once in a few years		once in a year		more than once in a year
109	landslide	Landliside trigger				erosion of the base	human activity (undercutting, overloading...)	snow melt	rainfall	earthquake
110	landslide	Activity	indication of whether process is currently engaged in some form of activity or not			suspended/re mediated		dormant/histo ric		active
111	landslide	Approximate remediation date		0-1	1-5	5-...				
112	landslide	Approximate remediation cost (€)		0-500	500-3000000	3000000-...				

ordinal numbe	process type	param	description	c_	c_075	c_1	c_2	c_3	c_4	c_5
101	klizište	Dužina (m)				0-10	10-50	50-200	200-500	500-...
102	klizište	Širina (m)				0-5	5-10	10-50	50-200	200-...
103	klizište	Dubina (m)				0-5	5-10	10-20	20-30	30-...
104	klizište	Vidljiv ožiljak (škarpa)				0-1				1-...
105	klizište	Visina glavnog ožiljka (škarpe)? (m)				0-0.5	0.5-1	1-2	2-3	3-...
106	klizište	Površina (m2)				0-50	50-500	500-10000	10000-100000	100000-...
107	klizište	Zapremina (m3)				0-250	250-5000	5000-200000	200000-3000000	3000000-...
108	klizište	Učestalost pojave	broj pojava u jedinici vremena			jednom u nekoliko godina		jednom godišnje		više od jednom godišnje
109	klizište	Uzrok klizišta				erozija nožice	ljudska aktivnost (potkopavanje, preopterećenje...)	otapanje snega	padavine	zemljotres
110	klizište	Aktivnost	indikacija da li je proces trenutno uključen u neki oblik aktivnosti ili ne			saniran		umiren/arhivsk i		aktivan
111	klizište	Približan datum sanacije		0-1	1-5	5-...				
112	klizište	Približni troškovi sanacije (€)		0-500	500-3000000	3000000-...				

Figure 65 Landslides scoring system

Figure 65 presents a scoring system for landslides comprising of 12 parameters. It includes 7 mandatory quantitative values numbered from 101 to 107, 3 qualitative values numbered from 108 to 110, and optional data related to remediation. In the remediation section, a score of 0.5 is allotted if the remediation time is less than one year, a score of 0.75 is assigned if the time period is between 1 to 5 years, and a score of 1 is given if the remediation is not done or if it is older than 5 years.

ordinal number	process type	param	description	c_	c_075	c_1	c_2	c_3	c_4	c_5
201	rockfall	Runout distance (m)				0-50	50-100	100-300	300-1000	1000-...
202	rockfall	Release height (m)				0-5	5-10	10-50	50-100	100-...
203	rockfall	Block volume (m3)				0-0.3	0.3-1	1-5	5.okt	10-...
204	rockfall	Frequency	number of occurrences per unit of time			once in a few years		once in a year		more than once in a
205	rockfall	Rockfall trigger	factors that cause a rockfall, which can include weathering, seismic activity, soil/vegetation removal, human activity, and			icing, plant roots	human activity (undercutting, overloading...)	snow melt	rainfall	earthquake
206	rockfall	Activity	indication of whether process is currently engaged in some form of activity or not			suspended/remediated		dormant/historic		active
207	rockfall	Approximate remediation date		0-1	1-5	5-...				
208	rockfall	Approximate remediation cost (€)		0-500	500-3000000	3000000-...				

ordinal number	process type	param	description	c_	c_075	c_1	c_2	c_3	c_4	c_5
201	odron	Domet odrona (m)				0-50	50-100	100-300	300-1000	1000-...
202	odron	Visina mesta odronjavanja (m)				0-5	5-10	10-50	50-100	100-...
203	odron	Zapremina bloka (m3)				0-0.3	0.3-1	1-5	5.okt	10-...
204	odron	Učestalost pojave	broj pojava u jedinici vremena			jednom u nekoliko godina		jednom godišnje		više od jednom godišnje
205	odron	Uzrok odrona	faktori koji izazivaju odron kamenja, što može uključivati vremenske uticaje, seizmičku aktivnost, uklanjanje tla/vegetacije, ljudske aktivnosti i prirodne događaje			zaleđivanje, korenje biljaka	ljudska aktivnost (potkopavanje, preopterećenje...)	otapanje snega	padavine	zemljotres
206	odron	Aktivnost	indikacija da li je proces trenutno uključen u neki oblik aktivnosti ili ne			saniran		umiren/arhivski		aktivan
207	odron	Približan datum sanacije		0-1	1-5	5-...				
208	odron	Približni troškovi sanacije (€)		0-500	500-3000000	3000000-...				

Figure 66 Rockfall scoring system

A scoring system for rockfall is presented in Figure 66 , which consists of six parameters - three quantitative and three qualitative - required to collect data. There are also two optional parameters related to remediation included in the system. This system is similar to the previously explained scoring system used for landslides.

ordin numb	process type	param	description		c_075	c_1	c_2	c_3	c_4	c_5
301	flood	Floodway width (m)				0-10		10-50		50-...
302	flood	Flood fringe width (m)				0-50		50-300		300-...
303	flood	Level above normal (m)				0-2		2-5		5-...
304	flood	Level above/below the road (m)				...--2		-2-0		0-...
305	flood	Frequency	number of occurrences per unit of time			once in a few years		once in a year		more than once in a
306	flood	Flood cause	factors that lead to a flood, which can include heavy rainfall, snowmelt, coastal storms, dam or levee failures, urbanization, and other human activities that alter natural drainage patterns or increase			external floodwave	downstream river damming	rainfall	snow melt	upstream dyke breach
307	flood	Protection status	level of security or safety measures that are in place to protect a particular object, system, or entity from harm or			regulated		damaged protection		no flood protection installed
308	flood	Approximate remediation date		0-1	1-5	5-...				
309	flood	Approximate remediation cost (€)			0-500	500-3000000	3000000-...			

ordin numb	process type	param	description		c_075	c_1	c_2	c_3	c_4	c_5
301	poplava	Širina protočne zone (m)				0-10		10-50		50-...
302	poplava	Širina zone zadržavanja vode (m)				0-50		50-300		300-...
303	poplava	Nivo iznad redovnog nivoa odbrane (m)				0-2		2-5		5-...
304	poplava	Nivo iznad/ispod puta (m)				...--2		-2-0		0-...
305	poplava	Učestalost pojave	broj pojava u jedinici vremena			jednom u nekoliko godina		jednom godišnje		više od jednom godišnje
306	poplava	Uzrok poplave	faktori koji dovode do poplava, što može uključivati obilne padavine, otapanje snega, obalne oluje, kvarove brana ili nasipa, urbanizaciju i druge ljudske aktivnosti koje menjaju prirodne obrasce odvodnjavanja ili povećavaju površinsko			spoljašnji poplavni talas	nizvodno pregrađivanje reke	padavine	otapanje snega	uzvodno probijanje brane
307	poplava	Stanje zaštitnih mera	nivo bezbednosnih ili bezbednosnih mera koje su na snazi za zaštitu određenog objekta, sistema ili entiteta od štete ili oštećenja			regulisan tok		oštećen sistem zaštite		bez zaštitnih mera od poplave
308	poplava	Približan datum sanacije		0-1	1-5	5-...				
309	poplava	Približni troškovi sanacije			0-500	500-3000000	3000000-...			

Figure 67 Flood scoring system

Figure 67 presents a flood scoring system that comprises four quantitative and three qualitative parameters to collect data, along with two optional parameters related to remediation.

ordinal number	process type	param	description		c_075	c_1	c_2	c_3	c_4	c_5
401	flash flood	Width (m)				0-50	50-100	100-...		
402	flash flood	Runout distance (m)				0-0.5	0.5-1	1-3	3.okt	10-...
403	flash flood	Level above ground (m)				0-2		2-5		5-...
404	flash flood	Level above/below the road (m)				...--2	-2-0	0-...		
405	flash flood	Frequency	number of occurrences per unit of time			once in a few years		once in a year		more than once in a
406	flash flood	Flashflood cause	factors that lead to a flash flood, which can include heavy rainfall, sudden snowmelt, dam or levee failures, and other events that cause rapid and intense runoff, often in urban or mountainous areas			upstream barrier breach	snow melt	rainfall		
407	flash flood	Protection status	level of security or safety measures that are in place to protect a particular object, system, or entity from harm or			regulated		damaged protection		no flood protection installed
408	flash flood	Approximate remediation date			0-1	1-5	5-...			
409	flash flood	Approximate remediation cost (€)			0-500	500-3000000	3000000-...			

ordinal number	process type	param	description		c_075	c_1	c_2	c_3	c_4	c_5
401	bujica	Širina bujice (m)				0-50	50-100	100-...		
402	bujica	Domet bujice (m)				0-0.5	0.5-1	1-3	3.okt	10-...
403	bujica	Nivo iznad površine terena (m)				0-2		2-5		5-...
404	bujica	Nivo iznad/ispod puta (m)				...--2	-2-0	0-...		
405	bujica	Učestalost pojave	broj pojava u jedinici vremena			jednom u nekoliko godina		jednom godišnje		više od jednom godišnje
406	bujica	Uzrok bujice	faktori koji dovode do naglih poplava, što može uključivati obilne padavine, iznenadno otapanje snega, kvarove brana ili nasipa i druge događaje koji izazivaju brzo i intenzivno oticanje, često u urbanim ili			uzvodno probijanje protivbujične barijere	otapanje snega	padavine		
407	bujica	Stanje zaštitnih mera	nivo bezbednosnih ili bezbednosnih mera koje su na snazi za zaštitu određenog objekta, sistema ili entiteta od štete ili oštećenja			regulisan tok		oštećen sistem zaštite		bez zaštitnih mera od poplave
408	bujica	Približan datum sanacije			0-1	1-5	5-...			
409	bujica	Približni troškovi sanacije			0-500	500-3000000	3000000-...			

Figure 68 Flash flood scoring system

Figure 68 presents a flash flood scoring system that consists of four quantitative and three qualitative parameters to collect data, along with optional remediation parameters.

Hazard score is weighted sum of landslide, rockfall, flood and flash flood scores. For landslide minimal score value is 11 and maximal score is 50, while weight (ponder) is 5. For rockfall the minimal score value is 7 and the maximal score is 30, while weight (ponder) is 2. For flood minimal value is 8 and maximal score is 35, while weight (ponder) is 3. For flash flood minimal value is 8 and maximal score is 30, while weight (ponder) is 4.

ordinal numb	process type	param	description		c_075	c_1	c_2	c_3	c_4	c_5
501	Traffic	Road function	purpose or intended use of a particular roadway or transportation route			Urban - other		Public transport	Rural - transit	Rural - connecting villages
502	Traffic	Traffic interruption	temporary or permanent disruption of transportation flow, usually due to an			no effect		reduced speed	one direction	both directions
503	Traffic	Traffic flow	movement of vehicles, pedestrians, or goods along a transportation network, such as a road, highway, or sidewalk			no public transport				public transport included
504	Traffic	Alternative routes				1-...				0-1
505	Traffic	Estimated detour length				0-1	1-5	5-...		

ordinal numb	process type	param	description		c_075	c_1	c_2	c_3	c_4	c_5
501	Saobraćaj	Funkcija puta	namena ili nameravano korišćenje određenog puta ili saobracajnog pravca/ deonice			Urbani - ostali		Urbani - tranzitni	Vangradski - tranzitni	Vangradski - vezni
502	Saobraćaj	Prekid saobraćaja	privremeni ili trajni prekid transportnog toka, obično zbog incidenta ili			bez efekta		smanjena brzina	jedna traka	obe trake
503	Saobraćaj	Protok saobraćaja	kretanje vozila, pešaka ili robe duž transportne mreže, kao što je put, autoput ili trotoar			nema javnog prevoza				postoji javni prevoz
504	Saobraćaj	Alternativni putevi				1-...				0-1
505	Saobraćaj	Procenjena dužina obilaska (km)				0-1	1-5	5-...		

Figure 69 Traffic scoring system

Figure 69 presents a traffic scoring system that includes three qualitative parameters to collect data, along with optional data related to alternative routes and estimated detour length. However, the approach for score calculation of infrastructure is a different set-up as presented further in the figures.

ordinal numb	process type	param	description		c_075	c_1	c_2	c_3	c_4	c_5
601	Infrastructure	light investment	91,92,93,96,97,104,105							
602	Infrastructure	medium investment	98,100, 102							
603	Infrastructure	heavy investment	94,95,99,101,103							

ordinal numb	process type	param	description		c_075	c_1	c_2	c_3	c_4	c_5
601	Infrastrultura	male investicije	91,92,93,96,97,104,105							
602	Infrastrultura	srednje investicije	98,100, 102							
603	Infrastrultura	velike investicije	94,95,99,101,103							

ID	En	Sr	Score
91	pavement, asphalt layers	kolovoz, slojevi asfaltnog zastora	2
92	pavement, concrete layer	kolovoz, betonski zastor	2
93	pavement, cobbled stone	trotoar, kaldrma	2
94	pavement, all layers	kolovoz, svi slojevi	4
95	embankment, damage of embankment	nasip, oštećenje nasipa	4
96	drainage, cleaning or repair of light drainage elements	odvodnjavanje, čišćenje ili popravka manjih elemenata odvodnjavanja	2
97	bridge, light surface repair	most, popravka površinskih elemenata mosta	3
98	bridge, structure repair	most, popravka konstruktivnih elemenata mosta	4
99	bridge, new bridge	most, novi most	5
100	retaining wall, wall repair	potporni zid, popravka zida	4
101	retaining wall, new wall (sections)	potporni zid, novi zid (sekcije)	5
102	drainage, repair of culverts	odvodnjavanje, sanacija propusta	4
103	third party utilities, Interruption of existing roadside infrastructure	komunalne instalacije, prekid postojeće infrastrukture pored puta	5
104	earthworks, removal of soil	zemljani radovi, uklanjanje zemljanog materijala	1
105	scaling, rock scaling	kavanje, kavanje stena	1
106	households, endangered households	domaćinstva, ugrožena domaćinstva	null
107	casualties , dead or injured	nastradali, poginuli ili povređeni	null
108	endangered stream	ugrožen vodok	null

Figure 70 Infrastructure scoring system

Figure 70 displays tables that are used for scoring of infrastructure. The scoring approach depends on the type of investment - light, medium, or heavy. For each type of investment, a list of infrastructure features is consulted, and the maximum score from the list is taken. If infrastructure data are not available, then a score value of 2 is assigned. The weighting factors that are used to combine the scores are specified within a stored procedure in the database, rather than within the application code. This approach makes it easier to modify the weighting factors, if necessary, without requiring changes to the application code. All values used in this process are consistent with the methodology document that outlines the approach.

Vulnerability assessment is weighted sum of traffic and infrastructure scores. For traffic minimal value is 5 and maximal score is 23, while weight (ponder) is 5. For infrastructure minimal value is 0 and maximal score is 12, while weight (ponder) is 2.

Calculated scores are normalized for hazards, traffic and infrastructure and finally hazard and vulnerability scores are multiplied giving priority value for observed geolocation. From calculated priority value, priority class is assigned: 1 (very low) for priority value < 0.2, 2 (Low class) for priority value 0.2-0.4, 3 (moderate class for priority value 0.4-0.6, 4 (high class) for priority value 0.6-0.8 and 5 (very high class) for priority value ≥ 0.8.

4. Validation and reporting services

The decision support module provides a range of functions to support the decision-making process. These functions include validation, road lifecycle analysis, review of recommendations, and lifecycle asset cost analysis. Additionally, the module will propose a consistent network-wide approach for assessing vulnerable locations.

- Validation (logic control) module – refers to reliability assessment by validation that combines, compares, and analyses historical data and collected field data with a mobile application, with purpose to check consistency of base GIS layers (vulnerability, hazard and other available data) with observed (collected) data.

- Prioritization, Reporting and Data export module (backend database supply reporting module with collected data).

- On-request query within the on-screen selected area will update the list of priorities, enable review of the types of hazards present, network links and segments vulnerabilities, etc. as specified in the Methodology developed under the Task 1. Selected area for reporting can be a part of the administrative area.

  - Reporting with different levels of details, including statistical overview (tabular and graphical) for requested period of time and area with integrated option for export to different formats, e.g., excel, csv.

  - Reviewing vulnerable locations, and the frequency and impact of incidents/problem notifications related to potholes, breakdowns, severe weather problems etc.

- Level of data validation and consistency checks will be different in different areas since level of available historical data will be different.

- Providing consistent guidance for operational response and recovery measures to ensure network resilience and user safety.

Reported issues (points) related to previously collected data (all or by a user) will be displayed as points on the map. The map will also provide a list with the option to view and focus on a map. Furthermore, users can see the attribute data in a user-friendly format and access any attached images previously supplied.

The proposed integrated mobile and web GIS system with introducing a control data that is derived from expert-driven analysis, involves overlapping relevant hazard, vulnerability, and criticality layers. This control data supports the final map together with the field point features.

To facilitate the process of hazard assessment and risk analysis, a kind of wizard or pipeline is developed for the proposed mobile and web GIS system. The pipeline is designed to collect and integrate various types of data, including hazard data such as landslides, rockfall, flood, flash flood, and climate data. In addition, exposure data will be obtained from road network vector data, which will be overlaid with the hazard data. Vulnerability will be assessed using road characteristics data, such as road type and condition.

The risk will be calculated by combining exposure and vulnerability data, while the criticality will be determined by integrating socioeconomic conditions with risk data. Remediation and prevention costs will be required to prioritize the risks. During the Project and a few months after, the Consultant shall provide and maintain storage for the application database using their own resources. The project team suggests that local governments that have the technical capabilities take over the complete system and use it by installing it on their own information resources, while the governments that do not have the technical capabilities and are interested in using it can sign a contract with the Faculty of Mining and Geology of the University of Belgrade on hosting and technical support.

4.1 Reports for observed geolocations

Very detailed reporting for the observed location is aimed to make an overview of all data recorded in database related to scoring and prioritization. Report "Detailed report of observations scores for LSG" is bilingual, Figure 71 presenting English version and Figure 72 Serbian.

- Column A: LsgID - identification of LSG
- Column B: GeolocationUUID - automatically assigned location identification
- Columns C and D: X and Y coordinates of observed location
- Column E: Location – identification of location for user input (optional)
- Column F: Observation uuid – automatically assigned observation identification, the last observation is the current (active), while remaining are the archive that does not affect scoring (prioritization)
- Column G: Table – hazard, transport or infrastructure set of parameters, the numbers will be an ordinal number within one observation, having in mind that one observation can have more than one landslide (landslide 1, landslide 2, …), total points for one hazard (landslide, rockfall, …)
- Column H: Parameter – name of the parameter and measurements unit if applicable
- Column I: Text - value of the parameter (text or numeric)
- Column J: Score - parameters according to the priority matrix from the methodology, describer also in section "Defining priority matrix"
- Column K: Sum Score – sum for one hazard (landslide, rockfall, …) or vulnerability in traffic and infrastructure
- Column L: Sum Scores – sum for all hazards (for all landslides, all landslides, ...), traffic and infrastructure
- Column M: Normal SumScores - normalized value according to formulas in methodology
- Column N: PUser – user name and account for user that collected data

Additional columns might be introduced if user specification from the field requires. The report can be obtained for the whole LSG, or per selected point by clicking on button in last column on the right. Similar content will be visible as HTML page in web application. Sorting for the whole LSG can be by the prioritization of the point. Please note that the exported file has been processed with elementary transformations: merging fields, coloring headers, setting filters, and freezing the first row. An example excel document with a macro for merging is available on the central site in the documents section, the name of the macro is „MergeSameCells".

User can also easily use filtering to put a threshold for preview.

LsgID	GeolocationUl	X	Y	Location	Observation	Table	Parameter	Text	Score	Sum Sc	Sum Sco	Norma	PUser
70017	ce597e81-ff68	508654.271	4804986.161		ced5ecbf-3d;	flash_flood 2	Width (m)	10	1	19	38.00	1.36	Marija Lačnjeva
70017	ce597e81-ff68	508654.271	4804986.161		ced5ecbf-3d;	flash_flood 2	Runout distance (m)	200	5	19	38.00	1.36	Marija Lačnjeva
70017	ce597e81-ff68	508654.271	4804986.161		ced5ecbf-3d;	flash_flood 2	Level above ground (m)	1.5	1	19	38.00	1.36	Marija Lačnjeva
70017	ce597e81-ff68	508654.271	4804986.161		ced5ecbf-3d;	flash_flood 2	Level above/below the road (m)	0.2	3	19	38.00	1.36	Marija Lačnjeva
70017	ce597e81-ff68	508654.271	4804986.161		ced5ecbf-3d;	flash_flood 2	Frequency	once in a few years	1	19	38.00	1.36	Marija Lačnjeva
70017	ce597e81-ff68	508654.271	4804986.161		ced5ecbf-3d;	flash_flood 2	Flashflood cause	rainfall	3	19	38.00	1.36	Marija Lačnjeva

Geoloca	Observa	Type	Parameter	Value	Sore	ScoreH	ScoreO	Norma
1	1	landslide 1	Length (m)	50	3	32	32	0.54
			Width (m)	100	4			
			Depth (m)	0	1			
			Visible scarp	TRUE	5			
			Main scarp height (m)	0	1			
			Area (m^2)	5000	3			
			Volume (m^3)	10000	3			
			Frequency	once in a few years	1			
			Landliside trigger	rainfall, earthquake	5			
			Activity	active	5			
			Approximate remediation date (year or exact date if applicable)	dat.: 2022-03-04	0.5			
			Approximate remediation cost (x 1000 EUR)	100	0.5			
		rockfall 1	Runout distance (m)	30	1	18	18	0.48
			Release height (m)	10	3			
			Block volume (m^3)	1	3			
			Frequency	once in a year	3			
			Rockfall trigger	rainfall	4			
			Activity	dormant/historic	3			
			Approximate remediation date (year or exact date if applicable)	dat.: 2022-03-04	0.5			
			Approximate remediation cost (x 1000 EUR)	100	0.5			
		flood 1	Floodway width (m)	30	3	20	20	0.44
			Flood fringe width (m)	20	1			
			Level above normal (m)	2	3			
			Level above/below the road (m)	-0.5	3			
			Frequency	once in a few years	1			
			Flood cause	snow melt	4			
			Protection status	no flood protection installed	5			
		flash_flood 1	Width (m)	30	1	16	16	0.36
			Runout distance (m)	20	5			
			Level above ground (m)	2	3			
			Level above/below the road (m)	-0.5	2			
			Frequency	once in a few years	1			
			Flashflood cause	upstream barrier breach	1			
			Protection status	damaged protection	3			
		traffic	Road function	Urban (other)	1	12	12	0.39
			Traffic interruption	one direction	4			
			Traffic flow	public transport included	5			
			Alternative routes	TRUE	1			
			Estimated detour length (km)	0.9	1			
		infrastructure	light investment	pavement, asphalt layers	2	7	7	0.58
			heavy investment	retaining wall, new wall (sections)	5			

Figure 71 Observation point scoring overview in English

Geoloka	Observa	Tip	Parametar	Vrednost	Bodov	Bodov	Bodovi	Normali
1	1	landslide 1	Dužina	50	3	32	32	0.54
			Širina	100	4			
			Dubina	0	1			
			Vidljiv ožiljak (škarpa)	TRUE	5			
			Visina glavnog ožiljka (škarpe)?	0	1			
			Površina	5000	3			
			Zapremina	10000	3			
			Učestalost pojave	jednom u nekoliko godina	1			
			Uzrok klizišta	kiša, zemljotres	5			
			Aktivnost	aktivan	5			
			Približan datum sanacije	dat.: 2022-03-04	0.5			
			Približni troškovi sanacije	100	0.5			
		rockfall 1	Domet odrona	30	1	18	18	0.48
			Visina mesta odronjavanja	10	3			
			Zapremina bloka	1	3			
			Učestalost pojave	jednom godišnje	3			
			Uzrok odrona	kiša	4			
			Aktivnost	umiren/arhivski	3			
			Približan datum sanacije	dat.: 2022-03-04	0.5			
			Približni troškovi sanacije	100	0.5			
		flood 1	Širina protočne zone	30	3	20	20	0.44
			Širina zone zadržavanja vode	20	1			
			Nivo iznad redovnog nivoa odbrane	2	3			
			Nivo iznad/ispod puta	-0.5	3			
			Učestalost pojave	jednom u nekoliko godina	1			
			Uzrok poplave	otapanje snega	4			
			Stanje zaštitnih mera	bez zaštitnih mera od poplave	5			
		flash_flood 1	Širina bujice	30	1	16	16	0.36
			Domet bujice	20	5			
			Nivo iznad površine terena	2	3			
			Nivo iznad/ispod puta	-0.5	2			
			Učestalost pojave	jednom u nekoliko godina	1			
			Uzrok bujice	uzvodno probijanje protivbujične barijere	1			
			Stanje zaštitnih mera	oštećen sistem zaštite	3			
		traffic	Funkcija puta	Urbano (drugo)	1	12	12	0.39
			Prekid saobraćaja	jedna traka	4			
			Protok saobraćaja	javni prevoz uključen	5			
			Alternativni putevi	TRUE	1			
			Procenjena dužina obilaska	0.9	1			
		infrastructure	male investicije	kolovoz, slojevi asfaltnog zastora	2	7	7	0.58
			velike investicije	potporni zid, novi zid (sekcije)	5			

Figure 72 Observation point scoring overview in Serbian

In addition to the detailed report on scoring and prioritization, a second report "Observation links report" has been generated that presents aggregated data on geolocation (point) observations, as presented in Figure 73

(English) and Figure 74 (Serbian). Each row of the report presents a single observation point, with accompanying information about the road and link provided. The report has been sorted in descending order according to score, which reflects the prioritization of each observation point. There is also a similar report available that combines points and sub-links.

- Column A: road name, name of the road according to Open Street Map
- Column B: road link, code (number) of the road link according to Open Street Map
- Column C: length(km), automatically calculated length of the link
- Column D: location, user description of the location
- Column E: coord_x, coordinate X in UTM 34N (EPSG: 32634)
- Column F: coord_y, coordinate Y in UTM 34N (EPSG: 32634)
- Column G: landslide, description of key feature values for landslides
- Column H: rockfall, description of key feature values for rockfalls
- Column I: flood, description of key feature values for floods
- Column J: flash flood, description of key feature values for flash floods
- Column K: traffic, description of key feature values for traffic
- Column L: infrastructure, description of key feature values for infrastructure
- Column M: investment category, derived investment category according to infrastructure input data
- Column N: priority score, calculated priority score in rage 0-1, 1 means higher priority, 0 low priority.
- Column O: priority class, 1-5 class derived from priority, 1 low priority, 5 high priority.

Figure 73 Point observation sorted by priority score in English.

Figure 74 Point observation sorted by priority score in Serbian

Figure 75 presents report for data collected by crowdsourcing, observed and reported by volunteers on selected LSG geolocations.

UUID	X KOORD	Y KOORD	LOKACIJA	OPIS LOKACIJE	KLIZIŠTE	ODRON	POPLAVA	BUJICA
33cf2c27-9c2b-11ed-b4e8-00155dea8902	469591.285384	4841328.5345	loc-4		✕	✓	✕	✕
33cf2c28-9c2b-11ed-b4e9-00155dea8902	469510.85189	4841696.83523	loc-5		✓	✕	✕	✕
33cf2c29-9c2b-11ed-b4ea-00155dea8902	469578.585359	4841861.93556	loc-6		✓	✓	✓	✓
33cf2c2a-9c2b-11ed-b4eb-00155dea8902	469868.569272	4841929.66903	loc-7		✕	✓	✓	✕
33cf5352-9c2b-11ed-b4ec-00155dea8902	469957.46945	4842001.63584	loc-8		✕	✕	✕	✓
33cf5353-9c2b-11ed-b4ed-00155dea8902	470316.245167	4842111.79093	loc-9		✓	✓	✓	✕
33cf5354-9c2b-11ed-b4ee-00155dea8902	470218.547576	4842072.0372	loc-10		✕	✕	✓	✕
33cf5355-9c2b-11ed-b4ef-00155dea8902	470155.047449	4841910.11188	loc-11		✓	✓	✕	✕
33cf5356-9c2b-11ed-b4f0-00155dea8902	470392.564	4842101.8215	loc-12		✕	✕	✕	✓
33cf5357-9c2b-11ed-b4f1-00155dea8902	470468.9121	4842074.3613	loc-13		✕	✓	✓	✕

Showing 1 to 10 of 27 entries

Previous 1 2 3 Next

Figure 75 Crowdsourcing report: volunteer observation per geolocations

4.2 Reporting on links

The most important report is general overview of links, which has been sorted by priority score in descending order, see Figure 76 in English and Figure 77 in Serbian. Each row of the report presents values for a single link, providing a clear picture of its importance and priority level.

- Column A: Road name, name of the road according to Open Street Map
- Column B: Road link, code (number) of the road link according to Open Street Map
- Column C: Start X, starting point of link coordinate X in UTM 34N
- Column D: Start Y, starting point of link coordinate Y in UTM 34N
- Column E: End X, ending point of link coordinate X in UTM 34N
- Column F: End Y, ending point of link coordinate Y in UTM 34N
- Column G: Length (km), automatically calculated length of the link
- Column H: Surface course, derived from all surface course for all points on link
- Column I: Road function, derived from all road function for all points on link
- Column J: Hazard type, observations number plus all hazard types (landslides, rockfalls, floods, flash floods) derived from all surface course for all points on link
- Column K: Affected road, derived from infrastructure part from all points on link
- Column L: Investment category derived from infrastructure part from all points on link
- Column M: Priority score, calculate from all points on the link
- Column N: Priority class, derived from the link priority score
- Column O: Bg. base class, derived from background spatial modeling for actual time period
- Column P: Bg. 2050 class, derived from background spatial modeling predicted for 2050. year
- Column Q: Bg. 2100 class, derived from background spatial modeling predicted for 2100. year

Road Name	Road Link	Start X	Start Y	End X	End Y	Length(km)	Surface Course	Road Function	Hazard type	Affected road	Investment category	Priority score	Priority class	Bg.base class	Bg.2050 class	Bg.2100 class
	10348	503794.2	4811888	4811872.3	4811872.3	0.02	asphalt	Urban - other	Observations: 1, landslide:1	drainage, cleaning or repair of light drainage elements:1; earthworks, removal of soil:1	light investment:1	1	5	4	5	5
	10286	508678.4	4805010.1	4805122.8	4805122.8	0.14	asphalt	Rural - transit	Observations: 1, flash flood:2	drainage, cleaning or repair of light drainage elements:1; earthworks, removal of soil:1; pavement, all layers:1; retaining wall, new wall (sections):1	heavy investment:1	0.95	5	2	1	1
	10347	503789.2	4811872.3	4811831.7	4811831.7	0.04	asphalt	Urban - other	Observations: 2, landslide:2	drainage, cleaning or repair of light drainage elements:2; earthworks, removal of soil:2; pavement, asphalt layers:1	light investment:2	0.83	5	4	4	4
Rakljanska	10324	503675.2	4811597.7	4811451	4811451	0.27	asphalt, macadam	Public transport, Rural - transit	Observations: 4, landslide:3, flash flood:1	drainage, cleaning or repair of light drainage elements:1; earthworks, removal of soil:4; embankment, damage of embankment:1; households, endangered households:2; pavement, all layers:3; pavement, asphalt layers:1	light investment:1; heavy investment:3	0.52	4	2	2	2
Doktora Milana Mirkovića	10100	504310.2	4811593.6	4811280	4811280	0.32	asphalt	Rural - transit, Urban - other	Observations: 2, flood:1, flash flood:1	bridge, light surface repair:1; bridge, structure repair:1; drainage, cleaning or repair of light drainage elements:2; drainage, repair of culverts:1; earthworks, removal of soil:2; households, endangered households:2; pavement, asphalt layers:2; third party utilities, Interruption of existing roadside infrastructure:2	heavy investment:2	0.48	4	2	2	2
	10544	497780	4814929.9	4815054.5	4815054.5	0.52	asphalt	Rural - connecting villages	Observations: 1, flash flood:2	earthworks, removal of soil:1; embankment, damage of embankment:1; households, endangered households:1; pavement, all layers:1; pavement, asphalt layers:1	heavy investment:1	0.32	3	1	1	1
	10071	507739.6	4811665.2	4811445.4	4811445.4	0.25	asphalt	Rural - transit	Observations: 2, flood:2	drainage, cleaning or repair of light drainage elements:1; drainage, repair of culverts:2; earthworks, removal of soil:2; households, endangered households:2; pavement, all layers:1; pavement, asphalt layers:1	medium investment:1; heavy investment:1	0.27	3	3	3	3
	10518	508312.7	4805284.1	4805122.8	4805122.8	0.69	concrete	Rural - connecting	Observations: 2, landslide:2	bridge, new bridge:2	heavy investment:2	0.22	3	2	2	2
	10606	504567.7	4813585.3	4813735.8	4813735.8	0.19	asphalt	Public transport	Observations: 1, rockfall:1	earthworks, removal of soil:1; pavement, asphalt layers:1; scaling, rock scaling:1	light investment:1	0.14	2		4	4
Vukašina Toskića	10321	504282.1	4811476.7	4811211.5	4811211.5	0.8	asphalt	Urban - other	Observations: 2, landslide:3	drainage, cleaning or repair of light drainage elements:2; earthworks, removal of soil:2; embankment, damage of embankment:2; pavement, all layers:2; pavement, asphalt layers:2	heavy investment:2	0.13	2	2		2

Figure 76 Link data sorted by priority score in English.

Naziv puta	Link puta	Poč. X	Poč. Y	Kraj X	Kraj Y	Dužina (km)	Površina	Funkcija puta	Tip pojave	Ugrožen put	Kategorija investicija	Priorite t-bod	Klasa prioriteta	poz.osn.klasa	Klas Poz.2050	Klasa Poz.210
	10348	503794.20	4811888.03	4811872.29	4811872.29	0.02	asfalt	Urbani - ostali	Opservacije:1, klizište:1	odvodnjavanje, čišćenje ili popravka manjih elemenata odvodnjavanja:1; zemljani radovi, uklanjanje zemljanog materijala:1	male investicije:1	1.00	5	4	5	5
	10286	508678.38	4805010.13	4805122.78	4805122.78	0.14	asfalt	Vangradski - tranzitni	Opservacije:1, bujica:2	ili popravka manjih elemenata odvodnjavanja:1; potporni zid, novi zid (sekcije):1; zemljani radovi, uklanjanje zemljanog materijala:1	velike investicije:1	0.95	5	2	1	1
	10347	503789.24	4811872.29	4811831.68	4811831.68	0.04	asfalt	Urbani - ostali	Opservacije:2, klizište:2	kolovoz, slojevi asfaltnog zastora:1; odvodnjavanje, čišćenje ili popravka manjih elemenata odvodnjavanja:2; zemljani radovi, uklanjanje zemljanog materijala:2	male investicije:2	0.83	5	4	4	4
Rakljanska	10324	503675.24	4811597.71	4811450.97	4811450.97	0.27	asfalt, makadam	Urbani - tranzitni, Vangradski - tranzitni	Opservacije:4, klizište:3, bujica:1	domaćinstva, ugrožena domaćinstva:2; kolovoz, slojevi asfaltnog zastora:1; kolovoz, svi slojevi:3; nasip, oštećenje nasipa:1; odvodnjavanje, čišćenje ili popravka manjih elemenata odvodnjavanja:1; zemljani radovi, uklanjanje zemljanog materijala:4	male investicije:1; velike investicije:3	0.52	4	2	2	2
Doktora Milana Mirkovića	10100	504310.24	4811593.64	4811279.98	4811279.98	0.32	asfalt	Urbani - ostali, Vangradski - tranzitni	Opservacije:2, poplava:1, bujica:1	domaćinstva, ugrožena domaćinstva:2; kolovoz, slojevi asfaltnog zastora:2; komunalne instalacije, prekid postojeće infrastrukture pored puta:2; most, popravka konstruktivnih elemenata mosta:2; most, popravka površinskih elemenata mosta:1; odvodnjavanje, čišćenje ili popravka manjih elemenata odvodnjavanja:2; odvodnjavanje, sanacija propusta:1; zemljani radovi, uklanjanje zemljanog materijala:2	velike investicije:2	0.48	4	2	2	2
	10544	497779.95	4814929.92	4815054.54	4815054.54	0.52	asfalt	Vangradski - vezni	Opservacije:1, bujica:2	domaćinstva, ugrožena domaćinstva:2; kolovoz, slojevi asfaltnog zastora:1; kolovoz, svi slojevi:1; nasip, oštećenje nasipa:1; zemljani radovi, uklanjanje zemljanog materijala:1	velike investicije:1	0.32	3	1	1	1
	10071	507739.63	4811665.15	4811445.39	4811445.39	0.25	asfalt	Vangradski - tranzitni	Opservacije:2, poplava:2	domaćinstva, ugrožena domaćinstva:2; kolovoz, slojevi asfaltnog zastora:1; kolovoz, svi slojevi:1; odvodnjavanje, čišćenje ili popravka manjih elemenata odvodnjavanja:1; odvodnjavanje, sanacija propusta:2; zemljani radovi, uklanjanje zemljanog materijala:2	srednje investicije:1; velike investicije:1	0.27	3	3	3	3
	10518	508312.70	4805284.10	4805122.78	4805122.78	0.69	beton	Vangradski - vezni	Opservacije:2, klizište:2	most, novi most:2	velike investicije:2	0.22	3	2	2	2
	10606	504567.71	4813585.33	4813735.80	4813735.80	0.19	asfalt	Urbani - tranzitni	Opservacije:1, odron:1	kavanje, kavanje stena:1; kolovoz, slojevi asfaltnog zastora:1; zemljani radovi, uklanjanje zemljanog materijala:1	male investicije:1	0.14	2		4	4
Vukašina Toskića	10321	504282.14	4811476.65	4811211.51	4811211.51	0.8	asfalt	Urbani - ostali	Opservacije:2, klizište:3	kolovoz, slojevi asfaltnog zastora:2; kolovoz, svi slojevi:2; nasip, oštećenje nasipa:2; odvodnjavanje, čišćenje ili popravka manjih elemenata odvodnjavanja:2; zemljani radovi, uklanjanje zemljanog materijala:2	velike investicije:2	0.13	2	2		2

Figure 77 Link data sorted by priority score in Serbian.

Figure 78 presents a panel for report preview and export, where Link report is selected for LSG Kraljevo first in Serbian. The columns included in the report are the same as previously explained. Generally, the user can select the type of the report, LSG and language for the report.

NAZIV PUTA	LINK PUTA	POČ. X	POČ. Y	KRAJ X	KRAJ Y	DUŽINA(KM)	POVRŠINA	FUNKCIJA PUTA	TIP POJAVE	UGROŽEN PUT	KATEGORIJA INVESTICIJA	PRIORITET-BOD	KLASA PRIORITETA	POZ.OSN.KLASA	KLAS POZ.2050
	23511	459410,59	4839459,74	4839453,79	4839453,79	0.08	šljunak	Vangradski - vezni	Opservacije:1, poplava:3	most, popravka konstruktivnih elemenata mosta:1; nasip, oštećenje nasipa:1; potporni zid, novi zid (sekcije):1	velike investicije:1	1.00	5	1	1
	22025	462387,85	4835487,52	4835518.15	4835518.15	0.03	asfalt	Vangradski - vezni	Opservacije:1, poplava:1	domaćinstva, ugrožena domaćinstva:1; kolovoz, svi slojevi:1; most, novi most:1	velike investicije:1	0.71	5	1	1
	22023	462399.38	4835460.42	4835487.52	4835487.52	0.03	asfalt	Vangradski - vezni	Opservacije:1, poplava:1	domaćinstva, ugrožena domaćinstva:1; kolovoz, svi slojevi:1; most, novi most:1	velike investicije:1	0.71	5	1	1
	21883	484583.98	4851187.06	4851189.24	4851189.24	0.01	asfalt	Vangradski - vezni	Opservacije:1, poplava:1	kolovoz, svi slojevi:1; nasip, oštećenje nasipa:1; potporni zid, novi zid (sekcije):1; zemljani radovi, uklanjanje zemljanog materijala:1	velike investicije:1	0.53	4	5	5
	22542	487249.67	4848975.12	4849298.58	4849298.58	0.63	asfalt	Vangradski - vezni	Opservacije:2, klizište:2	kolovoz, slojevi asfaltnog zastora:2; kolovoz, svi slojevi:1; zemljani radovi, uklanjanje zemljanog materijala:2	male investicije:1; velike investicije:1	0.10	2	2	2
	22024	462381.54	4835518.15	4835722.57	4835722.57	0.31	asfalt	Vangradski - vezni	Opservacije:1, poplava:1	domaćinstva, ugrožena domaćinstva:1; kolovoz, svi slojevi:1; most, novi most:1	velike investicije:1	0.05	1	1	1
	22084	489529.30	4844953.38	4843376.23	4843376.23	2.6	asfalt	Vangradski - vezni	Opservacije:2, klizište:1, poplava:1	kolovoz, svi slojevi:2; komunalne instalacije, prekid postojeće infrastrukture pored puta:1; most, novi most:1; ugrožen vodok:1; zemljani radovi, uklanjanje zemljanog materijala:1	velike investicije:2	0.01	1	3	3
Cara Lazara	20025	474595.56	4841472.76	4840971.81	4840971.81	0.94	asfalt	Urbani - ostali, Vangradski - tranzitni	Opservacije:5, klizište:6	kolovoz, slojevi asfaltnog zastora:5; komunalne instalacije, prekid postojeće infrastrukture pored puta:4; most, popravka površinskih elemenata mosta:1; potporni zid, novi zid (sekcije):2; potporni zid, popravka zida:2; zemljani radovi, uklanjanje zemljanog materijala:1	srednje investicije:1; velike investicije:4	0.29	3	2	2

Figure 78 Panel for reports with selected Link Report

4.3 Reporting on sub-links

All report available for links are also available for sub-links with similar columns and headers. Figure 79 presents the Sub Link overview report where each sub link is presented in one row, starting with the road name (if available), followed by the link identifier, and coordinates of both end points, length, surface course and road function. All hazards that have been reported on the particular link are listed in the 'hazard type' column. The affected road and investment category are collected from all observed geolocations. Priority score and priority class are calculated according to the given Methodology.

#	ROAD NAME	ROAD LINK	START X	START Y	END X	END Y	LENGTH	SURFACE COURSE	ROAD FUNCTION	HAZARD TYPE	AFFECTED ROAD	INVESTMENT CATEGORY	PRIORITY SCORE	PRIORITY CLASS
1	Svetosavska	21600	469467,42	4841860,59	4841972,49	4841972,49	0,49			:3, :1, :1, poplava:1, :2		:1; :2	1	5
2	Četvrta čibukovačka	20913	470261,09	4842058,31	4841826,46	4841826,46	0,5			:4, :2, :1, poplava:2, :1		:2; :2	0,93	5
3	Svetosavska	25501	469577,37	4841564,85	4841876,91	4841876,91	0,32			:2, :2		:1; :1	0,64	5
4	Gavrila Karapandžića Gaja	20909	470481,6	4842248,05	4842013,21	4842013,21	0,5			:3, :1, :1, poplava:2, :1		:2; :1	0,62	4
5	Osma Čibukovačka	20931	469875,58	4841314,48	4841377,83	4841377,83	0,28			:1, :1, :1, :1		:1	0,57	4
6	Čibukovačka	21605	470059,72	4840880,62	4840658,13	4840658,13	0,5			:2, :1, :2, poplava:1, :1		:2	0,57	4
7	Čibukovačka	21603	470899,32	4841380,84	4841151,34	4841151,34	0,5			:1, :1, :1		:1	0,46	4
8	Gavrila Karapandžića Gaja	23390	470442,38	4842131,3	4841835,74	4841835,74	0,33			:2, :1, :1, poplava:1		:1; :1	0,31	3
9	Četvrta čibukovačka	20914	470565,7	4841826,46	4841455,34	4841455,34	0,5			:2, :1, :1		:1; :1	0,29	3
10		20912	470144,7	4842027,89	4841834,86	4841834,86	0,2			:1, :1, :1		:1	0,26	3

Prikaz 1 do 10 od ukupno 18 elemenata

Prethodna 1 2 Sledeća

Figure 79 Sub link overview report Figure 80 presents more detailed overview with the observation data for sub links for selected LSG.

Figure 80 presents report table with columns:

#	ROAD NAME	ROAD SUBLINK	LENGTH	LOCATION	COOR X	COOR Y	LANDSLIDE	ROCKFALL	FLOOD	FLASHFLOOD	TRAFFIC	INFRASTRUCTURE
1	Светосавска	21600	0,49	loc-6	469578,59	4841861,94					....	
2	Светосавска	21600	0,49	loc-7	469868,67	4841929,67					....	
3	Светосавска	21600	0,49	loc-8	469957,47	4842001,64					....	
4	Четврта шибуковачка	20913	0,5	loc-16	470539,49	4841816,16					....	
5	Четврта шибуковачка	20913	0,5	loc-10	470218,55	4842072,04					....	
6	Четврта шибуковачка	20913	0,5	loc-18	470310,62	4841845,61					....	
7	Четврта шибуковачка	20913	0,5	loc-19	470236,01	4841834,71					....	
8	Светосавска	26501	0,32	loc-6	469578,59	4841861,94					....	
9	Светосавска	26501	0,32	loc-6	469610,85	4841696,64					....	
10	Гаврила Карапанџића Гаја	20809	0,5	loc-12	470392,56	4842101,82					....	

Prikaz 1 do 10 od ukupno 33 elemenata

Figure 80 SubLink for Observation report

Figure 81 presents report for LSG with scores that can further open other, more detailed report for one observation (Figure 82).

OBSERVATIONUUID	TABLE ID	PARAM	VALUE	SCORE	SUM SCORE	SUM SCORES	NORMAL SUM SCORES	PRIORITY CLASS	
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	length	50	3	31,5	32	0,54	0	
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	width	100	4	31,5	32	0,54	0	
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	depth	0	1	31,5	32	0,54	0	
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	visible_scarp	true	5	31,5	32	0,54	0	
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	main_scarp_height	0	1	31,5	32	0,54	0	
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	area	5000	3	31,5	32	0,54	0	
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	volume	10000	3	31,5	32	0,54	0	
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	frequency	21: once_in_a_few_years	1	31,5	32	0,54	0	
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	trigger	31: lslide_rainfall, 32: lslide_earthquake	5	31,5	32	0,54	0	
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	activity	131: active	5	31,5	32	0,54	0	

Prikaz 1 do 10 od ukupno 506 elemenata

Figure 81 Lsg scores report

OBSERVATIONUUID	TABLE ID	PARAM	VALUE	SCORE	SUM SCORE	SUM SCORES	NORMAL SUM SCORES	PRIORITY CLASS
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	length	50	3	31,5	32	0,54	0
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	width	100	4	31,5	32	0,54	0
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	depth	0	1	31,5	32	0,54	0
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	visible_scarp	true	5	31,5	32	0,54	0
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	main_scarp_height	0	1	31,5	32	0,54	0
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	area	5000	3	31,5	32	0,54	0
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	volume	10000	3	31,5	32	0,54	0
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	frequency	21: once_in_a_few_years	1	31,5	32	0,54	0
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	trigger	31: lslide_rainfall, 32: lslide_earthquake	5	31,5	32	0,54	0
408d1efa-9c42-11ed-b507-0015fdea8902	landslide 1	activity	131: active	5	31,5	32	0,54	0

Prikaz 1 do 10 od ukupno 39 elemenata

Figure 82 Form opened from Lsg Scores for detailed data for one observation

4.4   Statistics reporting

Part of web application is dedicated to the statistical overview of data in central database in the form of tables and graphs. Figure 83 presents the statistical overview of observed geolocations grouped by five priority classes and class "other" is for those that are not classified, usually recent or unfinished entries.

Geolocation per LSG (group by priority class)

Aleksandrovac

PRIORITY CLASS	VALUE
■ Very low class < 0.08	0
■ Low class = 0.08 - 0.16	39
■ Moderate class = 0.16 - 0.36	13
■ High class = 0.36 - 0.64	3
■ Very high class > 0.64	0
■ Other	0

Kraljevo

PRIORITY CLASS	VALUE
■ Very low class < 0.08	0
■ Low class = 0.08 - 0.16	20
■ Moderate class = 0.16 - 0.36	13
■ High class = 0.36 - 0.64	3
■ Very high class > 0.64	0
■ Other	0
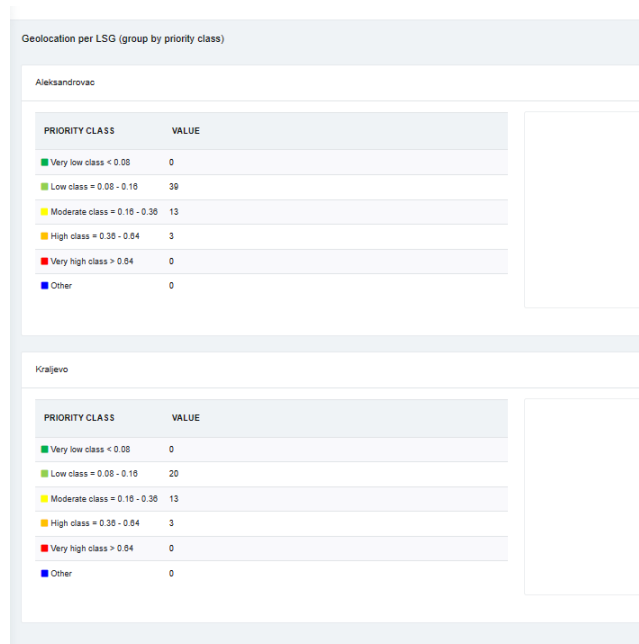
Figure 83 Statistical overview of data in central database by priority classification

Figure 84 presents the statistical overview of a number of observed geolocations per user, classified in columns by priorities. In the last column is a button link for a drill-down more detailed view with a list of geolocations observed by the selected user.

Geolocation per Users (group by priority class)

USER	■ VERY LOW CLASS	■ LOW CLASS	■ MODERATE CLASS	■ HIGH CLASS	■ VERY HIGH CLASS	■ OTHER	
Uroš Đurić	0	3	2	0	0	0	⊞
Test User 4	0	0	1	0	0	0	⊞
Test User 5	0	0	1	0	0	0	⊞
Test User 6	0	12	7	3	0	0	⊞
Ranka Stankovic	0	0	0	0	0	0	⊞
Miloš Marjanović	0	0	0	0	0	0	⊞
Test User 1	0	13	3	0	0	0	⊞
Test Guest	0	0	0	0	0	0	⊞
Jelena Jovkovic	0	1	0	1	0	0	⊞
Test FieldSpecialist	0	0	0	0	0	0	⊞
Test User 2	0	7	4	0	0	0	⊞
Test User 3	0	0	0	0	0	0	⊞
test fs kr	0	0	0	0	0	0	⊞

Figure 84 Statistical overview of number of observed geolocations per user

Figure 85 presents list of observed geolocations for selected user.

Column visibility

Search

| UUID	LOKACIJA	OPSTINA	XCOORD	YCOORD	PRIORITY CLASS
00000000-0000-0000-0000-000000000000	Pribojevac	Aleksandrovac	503782.62115	4810493.22733	1
00000000-0000-0000-0000-000000000000	Drenča Crkva	Aleksandrovac	504667.44115	4813616.70752	1
00000000-0000-0000-0000-000000000000	Drenča Velja Glava	Aleksandrovac	503194.17731	4814600.56598	1
00000000-0000-0000-0000-000000000000	lokacija 7- Bolnička ulica	Aleksandrovac	504232.81094	4811296.62312	1
00000000-0000-0000-0000-000000000000	lokacija 8 Kožetin Nade Milutinović	Aleksandrovac	503306.17859	4812123.11125	1
00000000-0000-0000-0000-000000000000	lokacija 9 Kožetin Nade Milutinović	Aleksandrovac	503779.92182	4811838.7871	1
00000000-0000-0000-0000-000000000000	Lokacija 10 Vitkovo Pumpa	Aleksandrovac	507709.29949	4811650.08899	1
00000000-0000-0000-0000-000000000000	brvnara	Kraljevo	473284.6883	4843183.53862	1
00000000-0000-0000-0000-000000000000	Lokacija 11 Vitkovo, kod škole	Aleksandrovac	507647.60261	4811503.56197	2
00000000-0000-0000-0000-000000000000	Lokacija 12, Ac, ul. Vukašina Toskića	Aleksandrovac	504360.82094	4811434.97097	1

Showing 1 to 10 of 16 entries

Previous 1 2 Next

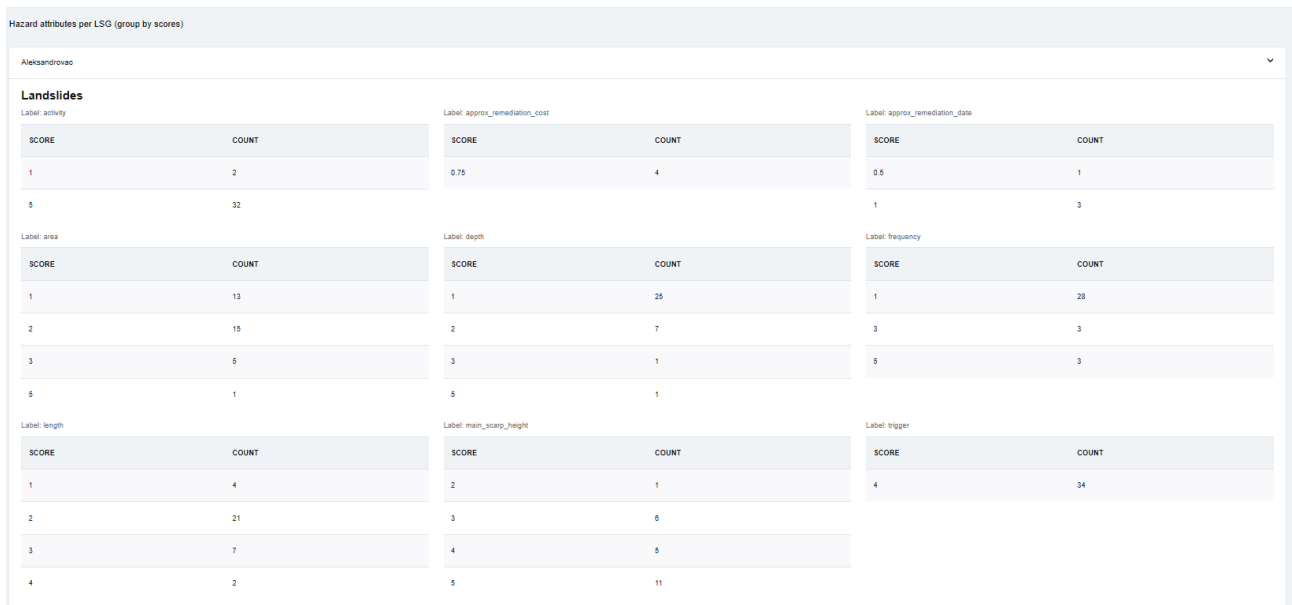**Figure 85 List of geolocations observed by user**

Figure 86 presents graphical overview of hazards, where each hazard type (landslide, rockfall, flood, flash flood) is presented in one class and each LSG has separate graph.
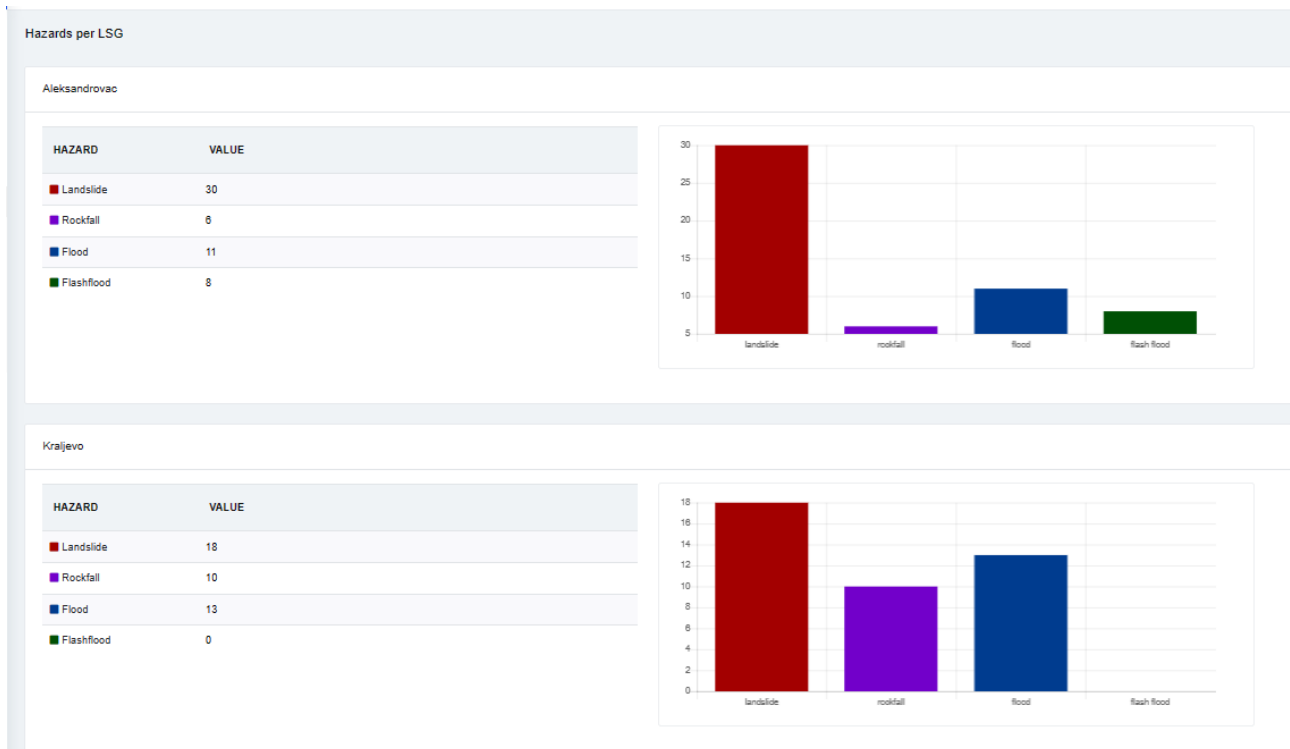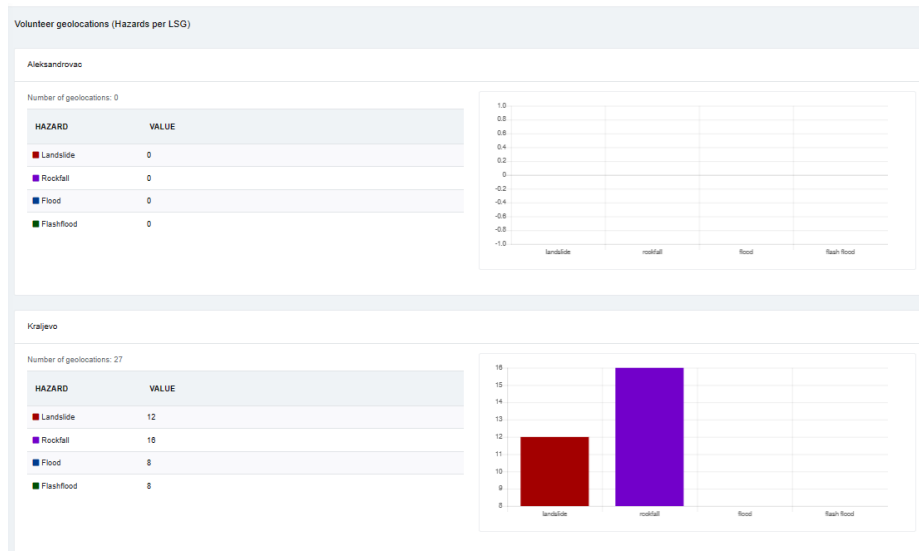

Figure 86 Statistical overview of hazards per LSG

Figure 87 presents more detailed presentation of recorded data with hazard and vulnerability parameters grouped by score classes 1 to 5.

Hazard attributes per LSG (group by scores)

Aleksandrovac

Landslides

Label: activity

SCORE	COUNT
1	2
5	32

Label: approx_remediation_cost

SCORE	COUNT
0.75	4

Label: approx_remediation_date

SCORE	COUNT
0.5	1
1	3

Label: area

SCORE	COUNT
1	13
2	15
3	5
5	1

Label: depth

SCORE	COUNT
1	25
2	7
3	1
5	1

Label: frequency

SCORE	COUNT
1	28
3	3
5	3

Label: length

SCORE	COUNT
1	4
2	21
3	7
4	2

Label: main_scarp_height

SCORE	COUNT
2	1
3	6
4	5
5	11

Label: trigger

SCORE	COUNT
4	34

Figure 87 Statistical overview of hazard and vulnerability parameters by score classification

Figure 88 presents graph that will present statistics of crowdsourced data – current data is recorded by project team members for testing purpose.

Volunteer geolocations (Hazards per LSG)

Aleksandrovac

Number of geolocations: 0

HAZARD	VALUE
Landslide	0
Rockfall	0
Flood	0
Flashflood	0

Kraljevo

Number of geolocations: 27

HAZARD	VALUE
Landslide	12
Rockfall	16
Flood	8
Flashflood	8

Figure 88 Statistics of crowdsourced (volunteer) geolocation observations