DATA BASE ON WELL DOCUMENTED HISTORIC ROCKFALL EVENTS

ASP 462 – RockTheAlps
WP1 – Activity A.T1.2
Deliverable D.T1.2.1

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ROCKTHEALPS PARTNERSHIP

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SFI – Slovenian Forestry Institute
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DISAFA – Department of Agricultural, Forest and Food Science, University of Turin
ERSAF – Regional Agency for Services in Agriculture and Forest - Lombarida Region
PAT-SFF – Autonomous province of Trento, Forest and Wildlife Department
POLITO – Politecnico di Torino, Department of Territory, Land and Infrastructure Engineering
BFW – Federal Research and Training Centre for Forests, Natural Hazards and Management
BMLFUW – Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management
LWF – Bavarian State Institute of Forestry
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1 INTRODUCTION

In order to develop an efficient rockfall risk assessment methodology, adequate/accurate data for testing, calibrating and validating models are needed to evaluate the performance of the model. Therefore, past historical rockfall data are needed which can be obtained via multiple sources (e.g. newspapers, historical sources, databases of different slope processes, field observations etc.). In the project RockTheAlps (ASP 462) one of the aims of first work package (WP T1) is to collect and analyse well documented data on historic rockfall events and provide a data base on well documented historic rockfall events, which would include data about rockfall occurrence through the Alpine Space.

With that aim a new methodology for collecting historical rockfall events on the field was created by using the application Collector for ArcGIS. The application enables the user to collect crucial information about the rockfall source area and corresponding rockfall deposits. Based on this two locations it is then possible to calculate the rockfall propagation statistics which can be used for development and evaluation of the new rockfall model (ROCK-EU) which is being developed through the project. The collected data by using this application are formalized in the GIS-related database and available through the WEB Mapping Application. The following content is in a form of instructions on how to collect historical rockfall events by using the application, how to calculate energy line angles for individual rockfall site by using a special tool designed for this purpose, and how to access WEB database.

Figure 1: Examples of rockfall source areas that were collected in the process of obtaining the historical rockfall database (Source: RTA project, 2017).
2 COLLECTOR FOR ARCGIS – AN OVERVIEW

Collector for ArcGIS\(^1\) in an application that allows users to collect and update data in the field, log their current location, and put the captured data to work so one can make more informed and timely decision. It allows you to (Collector for ArcGIS, 2017):

- collect and update data using the map or GPS,
- download maps to your device and work offline,
- collect point, lines, areas and related data,
- fill out easy-to-use, map-driven forms,
- attach photos to your features,
- use professional-grade GPS receivers.

**Device requirements:**

**Android:**

- Android 4.1 (Jelly Bean) or later
- ARMv7 or x86 processor
- OpenGL ES 2.0 support
- Precise location (GPS and network based) support

**iOS:**

- iOS 8 or later
- iPhone, iPad, iPod touch

**Windows 10 (tablet and PC):**

- Version 1511 or later
- Long-Term Servicing Branch (LTSB) version 1607 or later

**The application is available for free and it can be download from:**

- App Store ([link](#))
- Google Play ([link](#))
- Amazon ([link](#))
- Windows Store ([link](#))

**Supported languages:** English, French, German, Italian … (Slovenian is not available yet); the whole list of available languages is published on the [website](#) of Collector.

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\(^1\) Source: Collector for ArcGIS. Esri. 2017. All instructions in this chapter are based on this source.
**Signing in into application:** After you downloaded the application open it. The first window that will pop-up is the **Sign In** where you click **Continue**. Next window will pop-up where you have to put in your **username** in **password** and then click **SIGN IN** (Figure 2). Then you will see all the available maps in your application.

![Figure 2: Signing into application.](image)

2.1 **USING THE HIGH-ACCURACY GPS**

If you want to use a high-accuracy receiver you have to configure your Collector. Firstly, you have to connect your receiver to your device and secondly also in Collector, where you have to create a location profile and specify your desired accuracy. GPS averaging can also be used in Collector².

2.1.1 **Connect your receiver to your device**

First verify if your **GPS receiver is compatible with Collector**.

Turn on you receiver – if you are using a Bluetooth receiver, place it near your device.

Connect receiver to your device:

- if using a Bluetooth receiver, select receiver’s name in **Manage Bluetooth devices** and **Pair**;

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² Source: Collector for ArcGIS. Esri. 2017. All instructions in this chapter are based on this source. More detailed instructions are available at this [site](#).
if you are using a serial receiver, connect its cable to your device.

Figure 3: Opening Settings within the application.

2.1.2 Connect your receiver to your device

Once your GPS receiver is connected to your device, specify that you want the receiver to provide GPS locations in Collector. Once the receiver is selected, this is the only source of positions that is used until a new receiver is selected.

After signing in to Collector, select Menu from the Map Gallery and select Settings (Figure 3).

On the Location tab, under Location provider, select the receiver that is listed (Figure 4). The GPS Receivers list display. If it is not displayed take following actions:

- Select Add receiver to display a list of connected receivers.
- Select your receiver and select Continue.
- If you are mounting the receiver to a pole, enter the antenna height.
- If you are using a serial GPS receiver, specify the COM port and baud rate and select Test to check you connection is successful.
- Select Add.
- You are returned to the GPS Receivers list and your receiver is listed.
- Select your receiver and select Switch.
- If you need to change the antenna height, COM port, or baud rate, select your receiver, select Details, enter information, and select Back.
- Select Close to return to Settings.
2.1.3 Create a location profile in Collector

A location profile defines the coordinate system and, if required, datum transformations to apply when locations are received from your GPS receiver. The location applies to both internal and external receivers. It’s recommended to create a location profile when you’re using a correction service.

In the Settings of Collector, on the Location tab, under Location profile, select the name of the location profile currently in use. Select Add profile.

In the Search box, type the name or ID of your receiver’s correction service’s geographic coordinate system (GCS) to filter the results in the list, and then select the correction service’s GCS.

If your map uses a projected coordinate system, select Projected (It is important to make sure that correct filter is selected at the bottom of the screen because some geographic and projected coordinate systems have the same name).

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3 Coordinate system, used for collection of rockfalls, is WGS 1984 Web Mercator (auxiliary sphere).
In the **Search** box, type the name or ID of the map’s coordinate system to filter the results in the list, and then select the map’s coordinate system.

If a datum transformation between the coordinate systems of your receiver’s corrections service and your map is not available, select **Continue**.

If a datum transformation between the coordinate systems of your receiver’s correction service and your map is available, you are prompted to specify the data collection area. To zoom to your location on the map, select **My Location** 📍. Once you have zoomed in to the data collection area, select **Continue** and select the desired datum transformation from the list of available transformations.

![Collector](image)

**Figure 5:** Setting up GPS averaging, Streaming Interval and Number of location.

You can only specify the data collection area on the basemap when your device has access to online data via Wi-Fi or a cellular network.

The datum transformation list is sorted by relevance, with the most relevant transformation based on the data collection area listed first.

Some transformations such as grid-based transformations are not currently supported. Provide a name for location profile and select **Add**. The location profile is added to the **Location Profiles** list.
Select the new location profile from the **Location Profiles** list and select **Switch** to set it as your current profile. Select **Close** to return to **Settings**.

**2.1.4 Specify the required accuracy in Collector**

In Collector you can set the required accuracy of the GPS positions. In the Settings of Collector, on the Location tab, under Location accuracy, enter the required location accuracy for data collection.

Select the units for the required accuracy – **if it is not set to metric please change it to it**. To change units of measurement between metric and imperial, in the app’s **Settings**, select the units you want to use in the **Measurement units** section on the **General** tab.

Select **Menu** and choose either your current map or **Maps** to exit the settings.

**2.1.5 Enable GPS averaging**

In Collector, you can set the required number of points that have to be averaged to get a single location. Any time you use GPS location in your data collection, the required number of points will be collected and averaged for point features, as well as for the individual vertices and polygons.

To use GPS averaging, enable it in the app’s settings. All collections done by using the GPS and without streaming will use averaging if it is enabled.

In the **Settings** of Collector, on the **Collection** tab, enable **GPS Averaging** (Figure 5). Select **Number of locations** and provide the number of GPS positions you’d like to average to determine the location and accuracy for your collection. The default is 5 positions.

Once GPS averaging is enabled, your data collection using the GPS will do averaging on each point collected. When you start a collection, you’ll see a banner showing how many points have been averaged so far, along with the current averaged accuracy. Once a location has been obtained and while averaging is in progress, you’ll see a red dot indicating the current averaged position on the map.
When the number of locations you specified in the settings has been obtained, averaging completes, the banner goes away, and a point is placed on the map. To stop averaging before it completes, select **Stop Averaging**, discarding the averaging you have done so far.

For collection of rockfall data please use Streaming interval 5 seconds and Number of locations 10.

2.1.6 Main point for setting up your Collector settings regarding GPS accuracy

If available please use a high-accuracy GPS device as it will provide more accurate location of collected data.

**WGS 1984 Web Mercator (auxiliary sphere)** is the coordinate system in which the collection data will took place.

Units of measurements need to be set to metric – if default unit is not metric please change it to it.

It is **required to use GPS averaging**: Streaming interval should be set to 5 seconds and Number of Location to 10 locations.

In the settings under General settings set Map Downloads and Sync to **WiFi only**; otherwise you may have additional costs if you don't have enough or none cellular data.
3 PREPARE YOUR WEB-MAP FOR OFFLINE USE

Because lidar hillshade data and other ortophoto images might be too challenging to use for the whole Alps, two web maps are provided for collecting data. One map is topographic and second is imagery. As both are just web maps it is necessary to download them to your device before you go to the field where you won’t have an Internet connection. Both maps for whole Alps may be too large for your device and might also not work properly, it is recommend that you download both maps to your device just for your work area. When you go to the next location of your work area you will remove the previously downloaded maps from your device and download new ones for the new location. It is recommended that you make a good plan where you are going for a particular field day and download map extent for just that area so that the size of maps is not too large.

Unfortunately, both maps cannot be downloaded to your device through just one web map; therefore two versions of web maps are provided from which you can download the needed map:

first version is called RTA_historical_rockfall_database and it contains just topographic map;

second version is called RTA_historical_rockfall_database (Imagery) and it contains world imagery.

To download topographic basemap click on Download under the web map RTA_historical_rockfall_database (Figure 6).

Choose the wanted extent for your map (area where you will do your collection of data). You can change it by zooming in and out. When you are satisfied with your choice, click on Choose Map Detail.

Choose the map detail you require. By zooming in and out of the map you will see how the details on your map change. When you are satisfied with the selection click on Download and the map will start to upload to your device.
To download *imagery basemap* click on Downloads under the web map **RTA_historical_rockfall_database** (Figure 7).

Choose the wanted **extent for your map** (area where you will do your collection of data). You can change it by zooming in and out. When you chose the extent, click on **Choose Map Detail**.

Choose the map detail you require. By zooming in and out of the map you will see how the details on your map change. When you are satisfied with the selection click on **Download** and the map will start to upload on your device.

Now both basemaps area uploaded to your device and ready for offline use. To collect data for rockfalls you can use both web maps as data will be saved to the same source.

When you are offline open **RTA_rockfall_mapping** or **RTA_rockfall_mapping(Imagery)**. By default you will see just the downloaded topographic/imagery basemap; all surrounding area disappears.

To change between topographic and imagery map click on **Options** (dots mark) and select **Basemap** (Figure 8).

In basemaps you will see every map that is downloaded on your device (in this case topographic and imagery). To switch from topographic to imagery map just click on the imagery map and
it will pop-up automatically. To switch it back to topographic go back to basemaps and select topographic map.

Figure 7: Download topographic map to your device by clicking on Download under the web map RTA_rockfalls_mapping (A), choose your work area (B) and the map detail you require (C).

Figure 8: To change between topographic and imagery map select options and choose Basemap (A). In basemaps click on Imagery (B) and that map will automatically be your new basemap (C). To change it back to topographic map repeat the procedure.

To remove the downloaded maps from your device go to the main menu in the Map Gallery and select Manage (Figure 9). Click on Remove next to the maps. In next step you will be
asked if you want to remove features and basemaps or if you want to remove just features. Choose Remove features and Basemap and basemap in your application will be removed. To download new maps for a new work area repeat the procedure, described above.

Figure 9: Go to the main menu in the Map Gallery and select Manage (A). Click on the map you want to delete (B) and choose Remove features and basemap (C). Afterwards the basemap in your application will be deleted.
4 START COLLECTING YOUR DATA

In this application two types of data will be collected:

- **rockfall source area** (point feature) and
- **rockfall deposit area** (point feature).

![Image](image_url)

**Figure 10:** Open map RTA_rockfall_mapping (A). To zoom in to your location click on pointer (B).

To start collecting your data open application and **Map Gallery**. Open map **RTA_rockfall_mapping** (Figure 10).

Dot mark on the map is showing your current location. To zoom to your location on the map, select **My Location (**) (Figure 10).

4.1 ADD NEW ROCKFALL SOURCE AND DEPOSIT AREA

When arriving to your point of data collection at one of the rockfall deposition sites you must first **identify rockfall source area**. As source area can often be inaccessible or hardly accessible you will set the location of source area on the location **where you are standing** and
where you can see the rockfall source area\(^4\). From that point you will measure the angle and azimuth towards the source area (see *Chapter 5*) and based on this feature a location of rockfall source area will be calculated.

To add a new rockfall source area feature select **Collect New**. The Collect New panel displays. The only feature that you can add via Collect New feature is *rockfall source area* as all rockfall deposits will be added through this feature (Figure 11). For full description of all *rockfall source area attributes* that are required see *Chapter 5*.

![Figure 11: Add new Source Area feature by clicking on Collect New (A). Enter all required attributes and save your data by clicking on submit (B). If you want to edit the already saved feature click on pencil icon, if you want to delete it click on trash can icon.](image)

To add the *rockfall deposit features* you have to select corresponding *rockfall source area point* that was *already* added to the map. Open rockfall source area information (Figure 12-A):

- Under **Deposit Area panel** you will see two options: **View** and **New** (Figure 12-B).

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\(^4\) If it is not seen from a standing point of an individual rockfall deposit you will move to location from which it can be seen.
Figure 12: Adding new rockfall Deposit Area. You choose the existing rockfall source area that you want to add new rockfall deposits (A). In the panel Deposit Area you will see two options View and New (B). To add a new rockfall deposit click on New, enter all attributes needed and when you’re finished click Submit (C). To view all the collected deposits at one source area click View (B) – a new window will pop-up showing you a list of all rockfall deposits with their IDs at that site (D).

- In order to add new rockfall deposit to that source area click on New (Figure 12-C):
  - As detailed data collection of each rockfall deposit can be very time consuming, especially in case of many rockfall deposits on one rockfall source area site, you can choose between two types of rockfall deposit data collection when you click on New – SIMPLE, DETAILED or IMPORTED (Figure 13-A):
→ **Choose simple data collection when you want a quick data collection.** If you choose this option, you will already have predefined classes of rockfall deposit dimensions that need to be chosen from drop-down menus for each dimension (A, B, C). All other attributes will already have defined values so you don’t have to add them (but you can always change them if you want). Add Notes and Attachments if necessary and click on submit to save your record (Figure 13-B).

→ **Choose detailed data collection when you want a detailed attributes of individual rockfall deposit.** In this case, you will have to add all attributes that are described in Chapter 5. Enter all attributes, Figures and afterwards click on submit to save that record (Figure 13-C).

→ **Type imported should NEVER be chosen when using the application via the Collector.** This type is intended for other data, not collected with Collector and are imported separately to the GIS database by project partner 5 (UL).

![Figure 13](image1.png)

Figure 13: Choosing between detailed and simple collection of data for rockfall deposit. A) When choosing simple collection of data you only enter all three dimensions of rockfall deposit which you choose from drop-down menu. B) When choosing detailed collection.

- In order to **see all rockfall deposits** that you have already added to that source area click on **View** (Figure 12-B) and you will see the list of all rockfall deposits at that rockfall source area (Figure 12-D). By clicking on individual entry you can see all the attributes that you saved to that deposit (Figure 12-E).
For full description of all rockfall deposit area attributes that are required see Chapter 6. Once you have added all attributes to your feature, you have to save it to actually add it to the map. Click on Submit ✓ and your record will be saved.

Global ID is automatically created for both rockfall source and deposit area so you don’t have to enter any object ID. To see it, open the saved records – click on the point features on the map. One source area GlobalID will be connected to several rockfall deposits GlobalID. Each GlobalID is unique.

Each individual collected source area feature also has an automatic tracking, including information about when the feature was collected, edited and by whom.

4.2 ADDING LOCATION TO YOUR FEATURE

When you add your new feature (either rockfall source or deposit area), your location will automatically be detected based on GPS averaging. You can see the status of your averaging at the top of panel display. When averaging is done the location will be saved (Figure 14).

Figure 14: Location will automatically be retrieved based on the GPS averaging.
4.3 ADDING FIGURES TO YOUR FEATURE

Each feature (both rockfall source and deposit area) can have multiple Figures attached to it. To add a Figure click on the Attachment icon and a new window will pop-up where you can choose to add a Figure via Camera (take new Figure) or Gallery (choose Figure from gallery) (Figure 16). When you take or select your wanted Figure just click on Submit and your Figure will be added to the feature. If you want to add more Figures repeat the procedure.

A location can also be added by choosing a spot on the map – in that case you have to click on Stop averaging or just change location after it is already retrieved from GPS averaging.

By clicking on the Map icon your current basemap will pop-up where you can select your location by clicking on the map. When you are done you click back on the feature panel and you will be back to adding new attribute information to your feature (Figure 15).

Figure 15: A) Select STOP averaging and click on Map icon. B) You will get a warning about stopping averaging (click stop). C) Switch to map view with your current basemap where you can add your location by clicking on the map (dot circled with blue).
SYNCHRONIZE YOUR DATA

When your collection of data is done offline the data is only saved to your device. Therefore you have synchronize it when you retrieve Internet connection so that they are also saved to web map and seen by other people.

When you return to Map Gallery you will see that next to your map under Sync there will be some number. This number indicates all the features that need to be synchronized.

To sync your data **connect to WiFi** and then **click on Sync** (Figure 17).

Synchronization might take a while if there will be a large number of features that need to be synchronized. Afterwards, when all features are synchronized, the number next to Sync will disappear.
Figure 17: To synchronize data click on Sync (A) and synchronization will start (B). When it is done, parentheses and number in it will disappear (C).
5 SOURCE AREA ATTRIBUTES

Next attributes about rockfall source area need to be entered into application:

- Source Type
- Angle
- Azimuth
- Distance
- Equipment_info
- Notes
- Attachments

5.1 SOURCE TYPE

SourceType will carry information about source area type. You can choose between the next options that are displayed in a drop-down menu in the application5:

- rock cliff (potential height of the fall is > 20 m) (Figure 18);
- bare rock (potential height of the fall 20 m > and > 1 m) (Figure 19);
- ground rocks (as part of surface rockiness, deposited rocks) (Figure 20);
- rocks behind trees (rockfalls stopped by trees) (Figure 21).

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5 Categories based on Ancelin et. al. (2006).
Figure 19: Examples of source type – bare rock (Photo: KZG, 2017).

Figure 20: Examples of source type – ground rocks (Photo: KZG, 2017).
5.2 ANGLE AND AZIMUTH

Measured angle (in Degrees - °) is an angle between the users standing point and the source area of rockfalls (Figure 22, Figure 24, and Figure 25). If the detachment location of rockfall is seen on the source area, inclinometer should be pointed to the top-most point of that location. If the detachment point is not possible to determine, you should point inclinometer to the top-most part of cliff/slope and measure that angle. It is crucial that it is pointed to the surface and that it intersects with source area, otherwise it will be impossible to determine the right location.

Figure 22: Measuring angle – pick a spot from which you can see the source area (topmost part of source area / topmost point of detachment location). You should be far enough away from it so that you can see the top of
source area and you should also be on level ground with the base of source area. Use clinometer, point it to your measuring point, look through its straw and read the angle (Photo: KZG, 2017).

**Azimuth** (in Degrees - °) should be measured the same way as described for angle measurement – compass should be faced in direction of source area (Figure 22, Figure 23, Figure 25).

![Diagram of measuring azimuth](Photo: KZG, 2017)

Figure 23: Measuring azimuth – use compass to determine north (0° for azimuth), turn the compass to point towards the direction with azimuth that you want to measure (source area), the degree reading on the compass is wanted azimuth (Photo: KZG, 2017).

For one rockfall deposit area angle and azimuth are measured **only once** as it is possible to determine a location of source area only based one measurement (Figure 22, Figure 24, and Figure 25).

![Diagram illustrating source area location](Photo: KZG, 2017)

Figure 24: Illustration on how the location of source area will be calculated based on measured angle and azimuth (Photo: KZG, 2017).
Figure 25: Example of how measurements of angle and azimuth from different locations should give the same location of source area (left Figure). It is crucial that measurements are correct and precise; otherwise the wrong location of rockfall may be calculated or the location will be impossible to calculate (right figure) (Photo: KZG, 2017).

Figure 26: An example on how to correctly measure Angle and Azimuth for source area based on available information of rockfall detachment point (Photo: KZG, 2017).
5.2.1 Enable GPS averaging

For measuring Angle and Azimuth we recommend you to use the free application Dioptra that is available for Android devices (Download Dioptra).

- This application is easy to use: you point the camera (cross pointer on the camera) to the needed spot and the app gives back immediate value of both Angle and Azimuth. There is also an option to take a Figure of that frame so that one can check the results later but please don’t add that Figure as the attachment (Figure 27).

Similar application, called Theodolite, is also available for iPhone but it is not for free (5 €) (Download Theodolite).

![Figure 27](image_url): Screenshot of application Dioptra which measures Angle (yellow mark) and Azimuth (red mark). Pointing cross is in the middle of the Figure (Photo: KZG, 2017).

5.3 FOREST INFO

Information about whether a rockfall source area is located in the forest or not. You can choose between:

- Yes
- No
5.4 DISTANCE

There is also an option to use devices for measuring distances to the source area (Figure 28). This field is optional and has default value 0 – you should only enter this if using this device. If you are using it, a detailed description of used device and measuring technique is required in field Equipment_info.

![Figure 28: Measuring distance from your standing point to rockfall release area.](image)

5.5 EQUIPMENT INFO

A short description of devices used for measurement. More detailed description is required when using distance devices for measurements.

5.6 NOTES

This field is dedicated for different notes – its use is optional and it can also be left empty. **Your notes should be in English!**

5.7 ATTACHMENTS

For each rockfall source area you can also add Figure (optional) – please limit the amount of Figures to just **one Figure** and save other Figures for your own use. Make sure that Figures are not blurry.
6 DEPOSIT AREA ATTRIBUTES

As one rockfall deposit site may include a large amount of individual rockfalls there is almost impossible to capture all. Especially if part of the rockfall is a scree slope.

Therefore, you should first capture all rockfall deposits that are located at the border of rockfall deposition (maximum runout zone, also lateral spread). This way we will be able to see the spatial distribution of rockfall deposits. Afterwards you can start adding the locations of rockfall deposits within the external borders of deposition (along the surface profile). It’s not necessary to add rockfall deposits (but the more the better) – focus on the **average size of rockfall deposits** on the individual rockfall deposit site. Collect data about bigger rockfall deposits and don’t collect data on scree slopes (you can just mark where the scree slope starts by adding one rockfall deposit with a Note scree slope). Try to capture rockfall deposits from one part of the external border to another – through the whole profile of rockfall site as it is portrayed on Figure 29.

![Figure 29: An example how the collection of location of rockfall deposits should be done.](image)
You have two options for collecting data about rockfall deposits: simple and detailed. At least 10 rockfall deposit sites NEED to be collected with detailed data collection with the whole profile and also lateral spread of rockfall deposits (minimum requirement). Others can be done by using the quicker simple collection of data.

Next attributes about rockfall source area need to be entered into application:

- The size of deposited rock – Dimension A, B, C
- Rock Shape
- Forest
- Stop Cause
- Tree_DBH
- Notes
- Attachments

6.1 DIMENSION A, B, C

Deposited rockfall needs to be measured in all three dimensions (Figure 30), measurement units need to be centimetres (cm) when choosing a detailed data collection. A minimum dimension of at least one dimension (A, B or C) needs to be at least 50 centimetres; otherwise that rockfall deposit should NOT be included into data collection.

When choosing a simple collection of data you will choose the dimensions of rockfall deposits from already pre-defined dimension classes in the drop-down menu. You can choose between following classes (units in centimetres):

- 50-100
- 101-150
- 151-200
- 201-250
- 251-300
- 301-350
- 351-400
- 401-450
- 451-500
- >500

When choosing detailed collection of data you need to measure all three dimensions and enter the exact values in the dimension fields.
6.2 ROCK SHAPE

When choosing a **simple collection of data** a predefined shape of the rockfall deposit will automatically be **undefined** so you don’t have to identify the shape of the rock.

When **choosing a detailed collection of data** a shape of deposited rockfall needs to be identified - you can choose between next options from a drop-down menu:

- **RECTANGLE** – all dimensions can be completely different (Figure 31).
- **ELLIPSOIDAL** – all dimensions can be completely different (Figure 32).
- **SPHERICAL** – all dimensions are more or less identical (Figure 33).
- **DISC** – smallest dimension is max 1/3 of the other two block dimensions, which are rather comparable in size (Figure 34).
- **UNDEFINED** – rock has no known form.

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6 Categories are based on Dorren, 2015.
Figure 31: Examples of rectangle shape of rock (KZG, 2017).

Figure 32: Examples of ellipsoidal shape of rock (KZG, 2017).

Figure 33: Example of spherical shape of rock (KZG, 2017).

Figure 34: Example of disc shape of rock (KZG, 2017).
6.3 STOP CAUSE

When choosing a **simple collection of data** stop cause is automatically set to **other rock**.

When choosing a **detailed collection of data** you must identify the cause why an individual rock stopped at that location. The drop-down menu has next options:

- Other rock
- Tree
- Stump
- Laying log
- Flat area
- Concave area
- Road
- Other infrastructure
- Undefined cause/normal stop

6.4 FOREST INFO

When choosing a **simple collection of data** forest information is automatically set to **no** (meaning that rockfall is not located in the forest).

When choosing a **detailed collection of data** information about whether a deposited rock is located in the forest or not needs to be added. You can choose between:

- Yes
- No

6.5 TREE DBH

In the case that the rock was stopped due to a tree you should also measure DBH (at 1.3 m height) of that tree (**only for detailed collection of data**); otherwise this field has by default a value 0. Measurement units should be in **centimetres** (cm).
6.6 NOTES

This field is dedicated for different notes – its use is optional and it can also be left empty (the same applies for simple and detailed collection of data). **Your notes should be in English!**

6.7 ATTACHMENTS

For each rockfall deposit you can also add Figure (optional) – please limit the amount of Figures to just **one Figure** and save other Figures for your own use. Make sure that Figures are not blurry. The same applies for simple and detailed collection of data.
7 SHORT FIELD INSTRUCTIONS

SOURCE AREA ATTRIBUTES
- **SourceType** - information about source area type:
  - rock cliff (potential height of the fall is > 20 m);
  - bare rock (potential height of the fall 20 m > and > 1 m);
  - ground rocks (as part of surface rockiness, deposited rocks);
  - rocks behind trees (rockfalls stopped by trees).

- **Angle** - an angle between the standing point and the rockfall source area. Allowed values: 0 – 90°.
- **Azimuth** – an azimuth for direction of the rockall source area. Allowed values: 0 – 360°.
- **Distance (optional)**: a measured distance between the standing point and rockfall source area.
- **Equipment info**: a short description of devices used for measuring Angle, Azimuth and Distance (please write in English).
- **Notes (optional)**: a place for notes (please write in English).
- **Attachments (optional)**: add one Figure.

DEPOSIT AREA ATTRIBUTES (description for detailed collection of data)
- **Dimension A, B, C**: a rockfall dimension measurements in three dimensions. Measurement units: centimetres (cm).
- **Rock shape**: a shape of rockfall deposit. Drop-down menu options:
  - Rectangle (all dimensions can be completely different)
  - Ellipsoidal (all dimensions can be completely different)
  - Spherical (all dimensions are more or less identical)
  - Disc (smallest dimension is max 1/3 of the other two block dimensions, which are rather comparable in size)
  - Undefined (rock has no known form)

- **Stop Cause**: the cause why individual rockfall stopped at that location. Drop-down menu options:
  - Other rock
  - Tree
  - Stump
  - Laying log
  - Flat area
  - Concave area

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7 Appropriate as an instruction sheet that one can use directly on the field.
- **Road**
- **Other infrastructure**
- **Undefined cause/normal stop**

- **Forest info:** information about whether a rockfall deposit is situated in a forest. Drop-down menu options:
  - Yes
  - No

- **Tree DBH (optional):** if rockfall was stopped due to a tree you must measure DBH of that tree (at 1.3 m height). Measurement units: **centimetres** (cm).

- **Notes (optional):** a place for notes (please write in English).

- **Attachments:** add one Figure of rockfall deposit.
8 TOOL FOR CALCULATING ACCURATE ROCKFALL SOURCE AREA LOCATION AND ENERGY LINE ANGLES

The tool called Source_Point_ELA is a tool designed for calculating the exact position of rockfall source area based on the field measurements of angle and azimuth towards the actual rockfall source. It is intended especially for data collected via methodology of spatial mapping of rockfalls by using Collector for ArcGIS that is explained in this paper. The use of the tool is limited for a single rockfall, meaning that only one rockfall source area point can be delimited at once, as well as just energy line angles for that rockfall deposits. Tool can be imported and used in ArcMap environment.

To import the tool must the user must firstly go to ArcToolbox and right-click on an empty space in it. Consequently, a new window will pop-up, in which user must choose Add toolbox (Figure 35).

![Figure 35: Importing the tool into ArcMap.](image)

In next step the user must navigate towards the location of the toolbox on the computer. When it is found, the user must select it and click on Open. With that, a new toolbox will appear in ArcToolbox (Figure 36). To use the tool, the user must double-click on script RTASourceELA.
Figure 36: Once the tool is imported it appears in ArcToolbox.

The script has four inputs that need to be entered by the user (Figure 37):

- **WORKSPACE FOLDER** (user must choose a folder to which all outputs will be automatically saved to);
- **ROCKFALL SOURCE POINT** (feature layer – point shapefile – the location that was collected on the field and contains information about the angle and azimuth towards an actual rockfall source area);
- **DIGITAL TERRAIN MODEL** (raster input layer of DTM for that rockfall area);
- **ROCKFALL DEPOSIT POINTS** (feature layer input – point shapefile – of rockfall deposits collected on the field).
- **ANGLE RADIUS**: value for setting up the range of Angles that are used for viewshed analysis. User should start with 0.5° angle and if the analysis cannot be performed (the sightline doesn’t intersect the surface) this value should be incremented by 0.5 until the analysis is performed.
- **COORDINATE SYSTEM**: user can choose in which coordinate system the tool will operate. However, the input layers already have to have predefined the same coordinate system. It is recommended that all data are transformed into a local coordinate system.
The tool provides two main results: **rockfall source area point** (named point_source) (Figure 38), that is automatically added to Table of content, and **energy line angles** for each rockfall deposit, which are found in the attribute table of rockfall deposits shapefile in the field named “ELA” (Figure 39).
WEB MAP OF ROCKFALL DATABASE

All the collected data on historical rockfall via the described methodology and using Collector for ArcGIS is available through an ArcGIS Web App (you need to log in using the same username and password as for Collector) (Figure 40). The goal is that the database would update through the whole duration of the project.

Link to the web app: https://uni-lj.maps.arcgis.com/apps/webappviewer/index.html?id=f0908d087e4f483c8e4b705c4ed4dd51

Figure 39: Calculated energy line angles are found in the attribute table of rockfall deposits.

Figure 40: Web application that is showing the map of collected rockfall source and deposit areas in the Alpine Space.
The map doesn’t just offer the locations of rockfall source and deposit areas but also the general statistics of individual attributes that were collected via the application. Statistics can be shown for next categories:

- rockfall source area data collected by project partner,
- rockfall deposits data collected by project partner,
- rockfall source type,
- rockfall source areas located in the forest,
- the shape of rockfall deposits,
- the average volume of rockfall deposits for different rock shapes,
- the stop cause of individual rock deposit,
- rockfall deposits located in the forest.

The viewer of the map has to options on how to see the statistics data: one can see the statistics for all collected data or one can spatially limit the statistics to the preference area.
REFERENCES

