

Appendix C. TOOL/SCRIPT SUMMARY

This project aims to automate the process of creating rockfall shadow zone maps using a shadow angle of 27.5 degrees (determined by S.G. Evans & O. Hungr in 1993¹⁵) in Global Mapper. The Global Mapper script tool is utilized to automate this process, and the code language reference can be found in the “Global Mapper Scripting Reference V 24.0” Book/PDF¹⁷. The full automation code is shown in Appendix D. The general process involves the following steps (for full details on each step, please see the comments in Appendix D):

- Load Orthophotos and DEM Files from respective folders. (Only 1 DEM file can be processed at a time.)
- Reclassification of DEM based on slope values. (Need to set default shader as “Slope Shader” first) (See Figure 50 for slope values) (See Figure 52 and Figure 53 for result output)
- Creating equal-value areas based on the color palette to create polygons around the talus slope and the edge of the rock. (Smoothing, Simplification, and Island Deletion are applied) (See Figure 54 for the result output)
- Creating buffer zones around the talus slope and the edge of rock polygons. (Smoothing and Simplification are applied) (See Figure 55 for the result output)
- Using intersection spatial operation on the two buffer zones. (Smoothing and Simplification are applied) (See Figure 56 for the result output)
- Create skeleton lines on the resulting polygon from the intersection of the two buffer zones. The skeleton line created maps out the top of the talus slope. It is important to note that buffer zones are created in a way to shift the top of the talus slope 10 to 15 metres below its actual location to avoid problems in slope direction values for the viewshed analysis step. (See Figure 57 & Figure 59 for result output)
- Combine all skeleton lines to carry out smoothing and simplification. (See Figure 57 & Figure 59 for result output)
- Create points every 100 metres along the skeleton line and calculate elevation & slope values for all points. (See Figure 58 & Figure 60 for result output)
- Create a new attribute “SDN” (Slope Direction Numerical), by copying the values from the “SLOPE_DIR” attribute.
- Remove all non-numerical values from attribute “SDN” and use attribute “SDN” to calculate and store the value of the start angle (taken by subtracting SDN value by 30 and if the value is less than 0 then use SDN value minus 30 plus 360) to be used in viewshed analysis as an attribute “Start Angle”.

- Split layer which contains all the points (in this case “THE CHOSEN ONES”) by SDN number resulting in all points with same SDN value (& Start Angle value as SDN was used to calculate it) to be grouped into one layer. This will allow us to run a loop on the layers using a “VAR_LOOP” Command.
- Apply viewshed analysis on the points created (See Appendix D for more details on VAR_LOOP Command)

Step 12 in the full automation code takes a long processing time; hence, step 12 has not been run yet but all other step’s code work properly. However, there are currently two main drawbacks of the full automation code: the inaccuracy of mapping the top of the talus slope in certain topography (See Figure 51) and the lack of choice of selecting your points of interest to carry out the viewshed analysis in Step 12. Therefore, two more tools are created which are the “Raster Reclassification Tool” and “Semi-Automation of Mapping Rockfall Shadow Zones in Global Mapper Tool” and their code and instructions on how to use are shown in Appendix E and Appendix F, respectively. “Raster Reclassification Tool” basically carries out step 2. The purpose of this tool is to help visualize the top of the talus slopes and edge of the rocks which can be helpful in addition to the orthophotos. “Semi-Automation of Mapping Rockfall Shadow Zones in Global Mapper Tool” basically carries out steps 9 to 12. The purpose of this tool is to allow the user to choose their points of interest to map out the rockfall shadow zones (shown in Figure 61 to Figure 63) and in the process reduce the inaccuracy and the lack of choice in the points of interest. The result of this tool is shown in Figure 64. If the full automation code runs the 12th step the results will be quite similar to the results shown in Figure 64.

In short, the results shown in Figure 64 are quite accurate. The full automation code has its limitation but the semi-automatic tool works correctly. Hence, this project has successfully automated the process of creating rockfall shadow zone maps in Global Mapper.

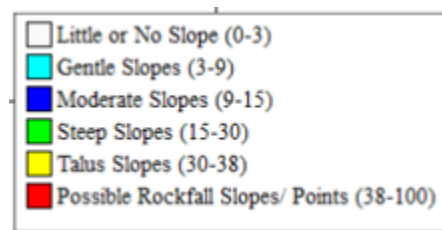


Figure 50. Key to the slope values for the raster reclassification.

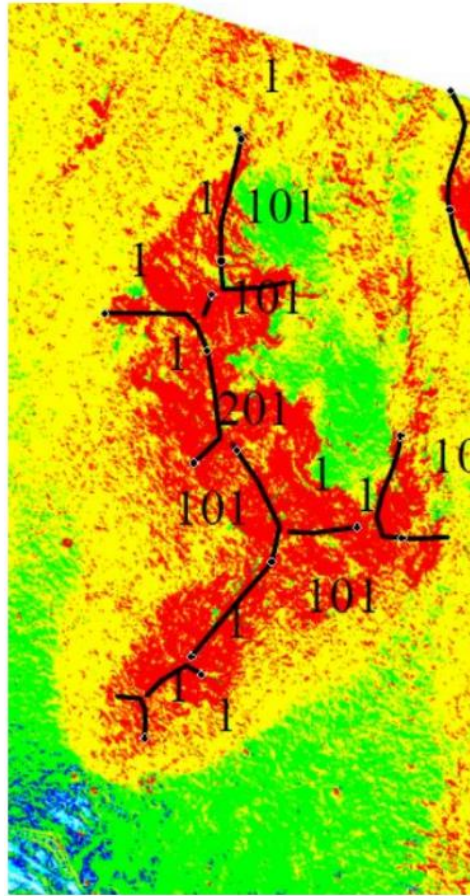


Figure 51. Example of inaccurate mapping of the top of the talus slope.

Appendix D. FULL AUTOMATION OF MAPPING ROCKFALL SHADOW ZONES IN GLOBAL MAPPER CODE

```
GLOBAL_MAPPER_SCRIPT VERSION=1.00
```

```
UNLOAD_ALL
```

```
// The following script/code is suited to only one DEM file at the moment. Batch processing is a  
//work in progress. So please keep only one DEM file in the folder which will be used to import  
//the DEM file. In addition, please name the DEM file as "DEM".
```

```
// Anything written after "//" is a comment and will not be processed. In addition, you will  
//notice that there is a "\" at the end of few lines this means that the code is continuing in the  
//next line.
```

```
// In Global Mapper Script there is usually a command given which is followed by parameters.
```

```
//When stating the value of a parameter, it is important to put the value in quotation.
```

```
// IMPORT_DIR_TREE is a command that allows you to import files into global mapper from a  
//certain directory/folder. DIRECTORY is a parameter. Hence, change the directory to the folder  
//where your files are located for the DIRECTORY parameter.
```

```
// The first folder being uploaded contains the orthophoto files
```

```
IMPORT_DIR_TREE DIRECTORY="H:\Project\ORTHOPHOTOS_DATA\" FILENAME_MASKS="*"
```

```
RECURSE_DIR="YES" \
```

```
LAYER_GROUP="ORTHOPHOTOS"
```

```
// The second folder being uploaded contains the DEM file.
```

```
IMPORT_DIR_TREE DIRECTORY="H:\Project\DEM_DATA\" FILENAME_MASKS="*"
```

```
RECURSE_DIR="YES" \
```

```
LAYER_GROUP= "DEM"
```

```
// You can change the initial shader as required using the command "SET_VERT_DISP_OPTS". In  
//this case, Slope Shader is selected as we are going to use raster //reclassification on the DEM  
//file based on slope values.
```

```
SET_VERT_DISP_OPTS SHADER_NAME= "SLOPE SHADER"
```

```
// The following code of line runs a command to carry out raster reclassification on the DEM
```

```
//file. In addition, this command requires you to set the rules using a gmr file. The rules are
```

```
//basically how do you want to carry out the raster reclassification. For this code, the gmr file
```

```
//has been created and will be shared with the code. Please update the parameter
```

```
//"RULES_FILENAME" with the directory of the gmr file where you have placed it. To know the
```

```
//details of what rules have been set, you can open global mapper then go to raster
```

```
//reclassification tool and then load the already created gmr file to see the rules. In case
```

```
//anyone wants to create a new set of rules from scratch, you can create one by scratch by
```

```
//going to global mapper then go to raster reclassification tool and then defining the rules that
```

```
//you want and save the rules as a gmr file.
```

```
RASTER_RECLASSIFY LAYER_DESC="DEM RECLASSIFIED" FILENAME="DEM" \
```

```

OUTPUT_LAYER_TYPE="PALETTE" RULES_FILENAME="H:\Project\RASTER RECLASIFICATION FOR
SCRIPTING DATA\RRS_2.gmr"
// "GENERATE_EQUAL_VAL_AREAS" command is being used to create polygons around the
//talus slope and edge of rocks using the colors defined in the gmr //file in the previous
//command.
GENERATE_EQUAL_VAL_AREAS FILENAME="DEM RECLASSIFIED" LAYER_DESC="TALUS"
ATTR_NAME="COLOR" \
AREA_TYPE= "Unknown Area Type" \
COLOR_DIST="0" ELEV_DIST="0" SLOPE_DIST="1" FORCE_RGB="NO" FIX_INVALID="NO"
EQUAL_COLORS="RGB(255,255,0)"
GENERATE_EQUAL_VAL_AREAS FILENAME="DEM RECLASSIFIED" LAYER_DESC="POSSIBLE
ROCKFALL EDGE" ATTR_NAME="COLOR" \
AREA_TYPE="Unknown Area Type" COLOR_DIST="0" ELEV_DIST="0" SLOPE_DIST="1"
FORCE_RGB="NO" \
FIX_INVALID="NO" EQUAL_COLORS="RGB(255,0,0)"
//The following command is setting the units of area and distance for this global mapper file.
ADD_MEASURE_ATTRS FILENAME="TALUS" AREA_UNITS="SQUARE METERS"
DISTANCE_UNITS="METRIC" \
MEASURE_UNIT_TYPE= "BASE"
ADD_MEASURE_ATTRS FILENAME="POSSIBLE ROCKFALL EDGE" AREA_UNITS="SQUARE
METERS" DISTANCE_UNITS="METRIC" \
MEASURE_UNIT_TYPE= "BASE"
// "EDIT_VECTOR" command is an important command to edit vector features such as
//polygons. The following line of code, selects all polygons greater than //5000 meters squared
//and copies them to a new layer.
EDIT_VECTOR FILENAME="TALUS" COMPARE_NUM="YES" SHAPE_TYPE="AREA"
COMPARE_STR="ENCLOSED_AREA>5000" \ COPY_TO_NEW_LAYER="YES"
NEW_LAYER_NAME="TALUS > 0.5 Hectares"
EDIT_VECTOR FILENAME="POSSIBLE ROCKFALL EDGE" COMPARE_NUM="YES"
SHAPE_TYPE="AREA" \ COMPARE_STR="ENCLOSED_AREA>5000" COPY_TO_NEW_LAYER="YES"
NEW_LAYER_NAME="POSSIBLE ROCKFALL EDGE > 0.5 Hectares"
// The following line of code is smoothing and simplifying the features. USE DELETE_ISLAND=
//"YES", If you want to remove holes/islands from the polygons
EDIT_VECTOR FILENAME="TALUS > 0.5 Hectares" DELETE_ISLANDS="YES"
SMOOTH_FEATURES="YES" \ COVERAGE_SMOOTHING_FACTOR="200" SIMPLIFICATION="3"
EDIT_VECTOR FILENAME="POSSIBLE ROCKFALL EDGE > 0.5 Hectares" DELETE_ISLANDS="YES"
SMOOTH_FEATURES="YES" \ COVERAGE_SMOOTHING_FACTOR="200" SIMPLIFICATION="3"

```

```

EDIT_VECTOR FILENAME="TALUS > 0.5 Hectares" DELETE_ISLANDS="YES"
SMOOTH_FEATURES="YES" \ COVERAGE_SMOOTHING_FACTOR="200" SIMPLIFICATION="2"
EDIT_VECTOR FILENAME="POSSIBLE ROCKFALL EDGE > 0.5 Hectares" DELETE_ISLANDS="YES"
SMOOTH_FEATURES="YES" \ COVERAGE_SMOOTHING_FACTOR="200" SIMPLIFICATION="2"
EDIT_VECTOR FILENAME="TALUS > 0.5 Hectares" DELETE_ISLANDS="YES"
SMOOTH_FEATURES="YES" \ COVERAGE_SMOOTHING_FACTOR="200" SIMPLIFICATION="1"
EDIT_VECTOR FILENAME="POSSIBLE ROCKFALL EDGE > 0.5 Hectares" DELETE_ISLANDS="YES"
SMOOTH_FEATURES="YES" \ COVERAGE_SMOOTHING_FACTOR="200" SIMPLIFICATION="1"
// Creating a buffer zone around the polygons created for the talus slope and edge of rock. This
//is done to shift the edge of the talus slope around 5 to 10 meters //below its actual position
//to avoid any problems related to getting slope values for the viewshed analysis
EDIT_VECTOR FILENAME="POSSIBLE ROCKFALL EDGE > 0.5 Hectares" BUFFER_DIST="45 m" \
NEW_LAYER_NAME= "POSSIBLE ROCKFALL EDGE > 0.5 Hectares with 40 Meters Buffer Zone"
EDIT_VECTOR FILENAME="TALUS > 0.5 Hectares" BUFFER_DIST="5 m"
NEW_LAYER_NAME="TALUS > 0.5 Hectares with 20 Meters Buffer Zone"
// Smoothing and simplifying the features.
EDIT_VECTOR FILENAME="TALUS > 0.5 Hectares with 20 Meters Buffer Zone"
SMOOTH_FEATURES="YES" \ COVERAGE_SMOOTHING_FACTOR="100" SIMPLIFICATION="1"
EDIT_VECTOR FILENAME="POSSIBLE ROCKFALL EDGE > 0.5 Hectares with 40 Meters Buffer
Zone" SMOOTH_FEATURES="YES" \ COVERAGE_SMOOTHING_FACTOR="100"
SIMPLIFICATION="1"
// "DEFINE_SPATIAL_OPERATION" command helps you to define spatial operations such as
//intersection between polygons. In this case, we are going to find the intersection between the
//two buffer zones created previously.
DEFINE_SPATIAL_OPERATION
SPATIAL_OPERATION_NAME= "INTERSECTION OF TALUS > 0.5 Hectares with 20 Meters Buffer
Zone AND POSSIBLE ROCKFALL EDGE > 0.5 Hectares with 40 Meters Buffer Zone"
LAYER "INTERSECTION OF TALUS > 0.5 Hectares with 20 Meters Buffer Zone AND POSSIBLE
ROCKFALL EDGE > 0.5 Hectares with 40 Meters Buffer Zone" = INTERSECTION("POSSIBLE
ROCKFALL EDGE > 0.5 Hectares with 40 Meters Buffer Zone", "TALUS > 0.5 Hectares with 20
Meters Buffer Zone")
END_DEFINE_SPATIAL_OPERATION
// Running the spatial operation
RUN_SPATIAL_OPERATION SPATIAL_OPERATION_NAME=" INTERSECTION OF TALUS > 0.5
Hectares with 20 Meters Buffer Zone AND POSSIBLE ROCKFALL EDGE > 0.5 Hectares with 40
Meters Buffer Zone"
// Smoothing and simplifying the features.

```

```

EDIT_VECTOR FILENAME= "INTERSECTION OF TALUS > 0.5 Hectares with 20 Meters Buffer Zone
AND POSSIBLE ROCKFALL EDGE > 0.5 Hectares with 40 Meters Buffer Zone"
SMOOTH_FEATURES= "YES" COVERAGE_SMOOTHING_FACTOR= "200" SIMPLIFICATION=" 1"
// CREATE_SKELETON_LINES parameter is used to create a line in the middle of the polygon
//created by the intersection of the two buffer zones. This line will be roughly at the top of the
//talus slope (roughly 10 to 15 m below it).
EDIT_VECTOR \
FILENAME= "INTERSECTION OF TALUS > 0.5 Hectares with 20 Meters Buffer Zone AND POSSIBLE
ROCKFALL EDGE > 0.5 Hectares with 40 Meters Buffer Zone" \ CREATE_SKELETON_LINES= "YES"
// It is important to combine the lines created from the previous command so that we can
//smooth and simplify the top of the talus line.
COMBINE_LINES \
FILENAME= "INTERSECTION OF TALUS > 0.5 Hectares with 20 Meters Buffer Zone AND POSSIBLE
ROCKFALL EDGE > 0.5 Hectares with 40 Meters Buffer Zone Skeleton Lines" \ LAYER_DESC=
"ONE LINE THAT RULES THEM ALL" MAX_DIST=" 2"
// Smoothing and simplifying the features.
EDIT_VECTOR FILENAME="ONE LINE THAT RULES THEM ALL" SMOOTH_FEATURES="YES"
COVERAGE_SMOOTHING_FACTOR="200" SIMPLIFICATION="1"
// Creating points along the top of the talus line at a distance of 100 m so that we can apply the
//viewshed analysis on those points (viewshed analysis works only on points)
EDIT_VECTOR FILENAME="ONE LINE THAT RULES THEM ALL"
CREATE_POINTS_ALONG_FEATURES="100" \ KEEP_ORIGINAL_VERTICES="NO"
// Calculating elevation and slope values at all the points that were created.
EDIT_VECTOR FILENAME= "THE CHOSEN ONES"
CALC_ELEV_SLOPE_STATS IGNORE_LINE_VERTICES
// Copying the slope direction values created from previous command to a new attribute
//named as SDN which stands for "Slope Direction Numerical". Important to note that for this
//DEM when slope stats are calculated the slope direction attribute is named as SLOPE_DIR and
//this might differ for another DEM hence you may face an error for this and may have to edit
//the "SLOPE_DIR" in the "ATTR_TO_COPY" parameter.
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_TO_COPY="SDN=SLOPE_DIR"
// Removing non-numerical values from the SDN attribute (this code is removing the non-
//numerical values based on what I saw are being generated). You may have to add another
//line of code if any non-numerical values are not removed which can simply be done by copy
//pasting one line of the code below and changing the following part "SDN=*Input the non
//numerical value*="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=(="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=)="

```

```

EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN= ="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=°="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=N="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=S="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=W="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=E="
// "CALC_ATTR_FORMULA" command allows carrying out calculation on attributes. In this case I
//am creating a new attribute called "Start Angle" (which is going to be used as an input for
//the viewshed analysis) using the SDN attribute. I want the start angle of the viewshed analysis
//to be less than 30 degrees than the slope direction at the point feature. If you do not wish
//to use 30 then simply just replace 30 with number you want in the "FORMULA" parameter.
CALC_ATTR_FORMULA FILENAME="THE CHOSEN ONES" NEW_ATTR="START ANGLE"
CALC_MODE="NUMERIC" \
FORMULA=IF(SDN-30<0,SDN-30+360,SDN-30)
// Splitting the layer by the value of the SDN attribute so that we can run a loop. Important to
//note that, all points with same SDN value will be in one layer and will also have the same
//start angle as start angle is calculated based on SDN value
SPLIT_LAYER FILENAME="THE CHOSEN ONES" SPLIT_BY_ATTR="SDN" LAYER_DESC_ATTR_ONLY
// Running a loop using a variable loop. %Counter% is a predefined variable that counts which
//loop step is ongoing and we are using it to run the view shed analysis on the layers created
//in the previous command. All the layers created are based on the SDN values which are
//basically numbers. So, we are using the counter variable in the filename parameter which
//will go from 0 to 360 to run the viewshed analysis on the layers created based on the SDN
//number. In addition, we also defined an additional variable named Start Angle which will
//have the value of the attribute named start angle for each layer and all points in each layer
//will have the same start angle since each layer was created based on the SDN values
//(meaning all points which have same SDN value are in one layer and hence have same start
//angle as well). In short, going to go layer by layer (from 0 to 360) and carry out view shed
//analysis for all points for each layer

VAR_LOOP_START VAL_START="0" VAL_STOP="360" VAL_STEP="1"
DEFINE_VAR NAME="START ANGLE" VALUE_ATTR="START ANGLE" FILENAME="%COUNTER%"
GENERATE_VIEWSHED LAYER_DESC="%COUNTER%" FILENAME="%COUNTER%" \
XMIT_HEIGHT="10.4886004748 m" XMIT_HEIGHT_ABOVE_SEA_LEVEL="NO"
RECEIVER_ELEV_TYPE="XMIT_ANGLE_RANGE" \
RECEIVER_ANGLE="-28.5" RECEIVER_ANGLE_END="-26.5" RECEIVER_HEIGHT_ANGLE="0"
RECEIVER_HEIGHT_ABOVE_SEA_LEVEL="NO" \

```



```
RADIUS="5 km" RADIUS_MIN="0 km" START_ANGLE="%START ANGLE%" SWEPT_ANGLE="60"  
USE_EARTH_CURVATURE="YES" \  
ATMOSPHERIC_CORRECTION="1.33333" CREATE_COVERAGE_AREAS="YES"  
SHOW_HIDDEN_AREAS="NO" \  
TREAT_INVALID_AS_ZERO="YES" COLOR="RGB(255,0,0)" GEN_POWER_GRID="NO"  
USE_VECTOR_HEIGHTS="NO" \  
FIX_INVALID="NO" SPATIAL_RES="1.528785126,1.5331757"  
VAR_LOOP_END
```

Appendix E. RASTER RECLASSIFICATION TOOL

```
// This code will generate a map where the talus slope is colored using yellow and rocks as red.
//In addition to the orthophotos, the map generated from this tool helps visualize the top of
//the talus slope and potential points of interest where you would like to know the rockfall
//shadow zone.
// You can change the initial shader as required using the command "SET_VERT_DISP_OPTS". In
//this case, Slope Shader is selected as we are going to use raster reclassification on the DEM
//file based on slope values.
SET_VERT_DISP_OPTS SHADER_NAME= "SLOPE SHADER"
// The following code of line runs a command to carry out raster reclassification on the DEM
//file. In addition, this command requires you to set the rules using a gmr file. The rules are
//basically how do you want to carry out the raster reclassification. For this code, the gmr file
//has been created and will be shared with the code. Please update the parameter
//"RULES_FILENAME" with the directory of the gmr file where you have placed it. To know the
//details of what rules have been set, you can open global mapper then go to raster
//reclassification tool and then load the already created gmr file to see the rules. In case
//anyone wants to create a new set of rules from scratch, you can create one by scratch by
//going to global mapper then go to raster reclassification tool and then defining the rules
//that you want and save the rules as a gmr file.
RASTER_RECLASSIFY LAYER_DESC="DEM RECLASSIFIED" FILENAME="DEM" \
OUTPUT_LAYER_TYPE="PALETTE" RULES_FILENAME="H:\Project\RASTER RECLASSIFICATION
FOR SCRIPTING DATA\RRS_2.gmr"
```

Appendix F. SEMI-AUTOMATION OF MAPPING ROCKFALL SHADOW ZONES IN GLOBAL MAPPER TOOL

```
//INSTRUCTIONS ON HOW TO USE THIS. LOAD YOUR ORTHOPHOTO AND DEM FILE ONTO
//GLOBAL MAPPER. SELECT THE CREATE POINT/TEXT FEATURE AND CREATE ONE POINT
//FEATURE AT THE POINT OF INTEREST. WHEN CREATING THE FIRST POINT FEATURE A POP-
//UP BOX WILL APPEAR WHERE YOU HAVE TO NAME THE LAYER AS "THE CHOSEN ONES",
//SPECIFY THE STYLE OF THE POINT AS //YOU WANT (E.G, ORANGE DOT) AND, MOST
//IMPORTANTLY, TICK THE BOX NEAR "AUTOMATICALLY APPLY THESE SETTINGS TO NEW
//FEATURES OF THE SAME TYPE" THIS WILL SAVE THE SETTINGS FOR THIS LAYER AND WILL
//ALLOW YOU TO CREATE MULTIPLE POINT FEATURES AT MULTIPLE POINT OF INTERESTS
//EASILY WITHOUT THE POP-UP BOX POPPING UP.
// Use the orthophoto or (DEM RECLASSIFIED if generated from the code in Appendix E) to
//identify the point of interests
// Calculating elevation and slope values at all the points that were created.
EDIT_VECTOR FILENAME= "THE CHOSEN ONES"
CALC_ELEV_SLOPE_STATS IGNORE_LINE_VERTICES
// Copying the slope direction values created from previous command to a new attribute
//named as SDN which stands for "Slope Direction Numerical". Important to note that for this
//DEM when slope stats are calculated the slope direction attribute is named as SLOPE_DIR and
//this might differ for another DEM hence you may face an error for this and may have to edit
//the "SLOPE_DIR" in the "ATTR_TO_COPY" parameter.
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_TO_COPY="SDN=SLOPE_DIR"
// Removing non-numerical values from the SDN attribute (this code is removing the non-
//numerical values based on what I saw are being generated). You may //have to add another
//line of code if any non-numerical values are not removed which can simply be done by copy
//pasting one line of the code below and changing the following part "SDN=*Input the non
//numerical value*="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=(="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=)="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN= ="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=°="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=N="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=S="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=W="
EDIT_VECTOR FILENAME="THE CHOSEN ONES" ATTR_REPLACE_STR="SDN=E="
// "CALC_ATTR_FORMULA" command allows carrying out calculation on attributes. In this case I
//am creating a new attribute called "Start Angle" (which is going to be used as an input for the
//viewshed analysis) using the SDN attribute. I want the start angle of the viewshed analysis to
```

```

//be less than 30 degrees than the slope direction at the point feature. If you do not wish to
//use 30 then simply just replace 30 with number you want in the "FORMULA" parameter.
CALC_ATTR_FORMULA FILENAME="THE CHOSEN ONES" NEW_ATTR="START ANGLE"
CALC_MODE="NUMERIC" \
FORMULA=IF(SDN-30<0,SDN-30+360,SDN-30)
// Splitting the layer by the value of the SDN attribute so that we can run a loop. Important to
//note that, all points with same SDN value will be in one layer and will also have the same
//start angle as start angle is calculated based on SDN value
SPLIT_LAYER FILENAME="THE CHOSEN ONES" SPLIT_BY_ATTR="SDN" LAYER_DESC_ATTR_ONLY
// Running a loop using a variable loop. %Counter% is a predefined variable that counts which
//loop step is ongoing and we are using it to run the view shed analysis on the layers created
//in the previous command. All the layers created are based on the SDN values which are
//basically numbers. So, we are using the counter variable in the filename parameter which
//will go from 0 to 360 to run the viewshed analysis on the layers created based on the SDN
//number. In addition, we also defined an additional variable named Start Angle which will
//have the value of the attribute named start angle for each layer and all points in each layer
//will have the same start angle since each layer was created based on the SDN values
//(meaning all points which have same SDN value are in one layer and hence have same start
//angle as well). In short, going to go layer by layer (from 0 to 360) and carry out view shed
//analysis for all points for each layer
VAR_LOOP_START VAL_START="0" VAL_STOP="360" VAL_STEP="1"
DEFINE_VAR NAME="START ANGLE" VALUE_ATTR="START ANGLE" FILENAME="%COUNTER%"
GENERATE_VIEWSHED LAYER_DESC="%COUNTER%" FILENAME="%COUNTER%" \
XMIT_HEIGHT="10.4886004748 m" XMIT_HEIGHT_ABOVE_SEA_LEVEL="NO"
RECEIVER_ELEV_TYPE="XMIT_ANGLE_RANGE" \
RECEIVER_ANGLE="-28.5" RECEIVER_ANGLE_END="-26.5" RECEIVER_HEIGHT_ANGLE="0"
RECEIVER_HEIGHT_ABOVE_SEA_LEVEL="NO" \
RADIUS="5 km" RADIUS_MIN="0 km" START_ANGLE="%START ANGLE%" SWEPT_ANGLE="60"
USE_EARTH_CURVATURE="YES" \
ATMOSPHERIC_CORRECTION="1.33333" CREATE_COVERAGE_AREAS="YES"
SHOW_HIDDEN_AREAS="NO" \
TREAT_INVALID_AS_ZERO="YES" COLOR="RGB(255,0,0)" GEN_POWER_GRID="NO"
USE_VECTOR_HEIGHTS="NO" \
FIX_INVALID="NO" SPATIAL_RES="1.528785126,1.5331757"
VAR_LOOP_END

```

Appendix G. CODE RESULT IMAGE REFERENCE

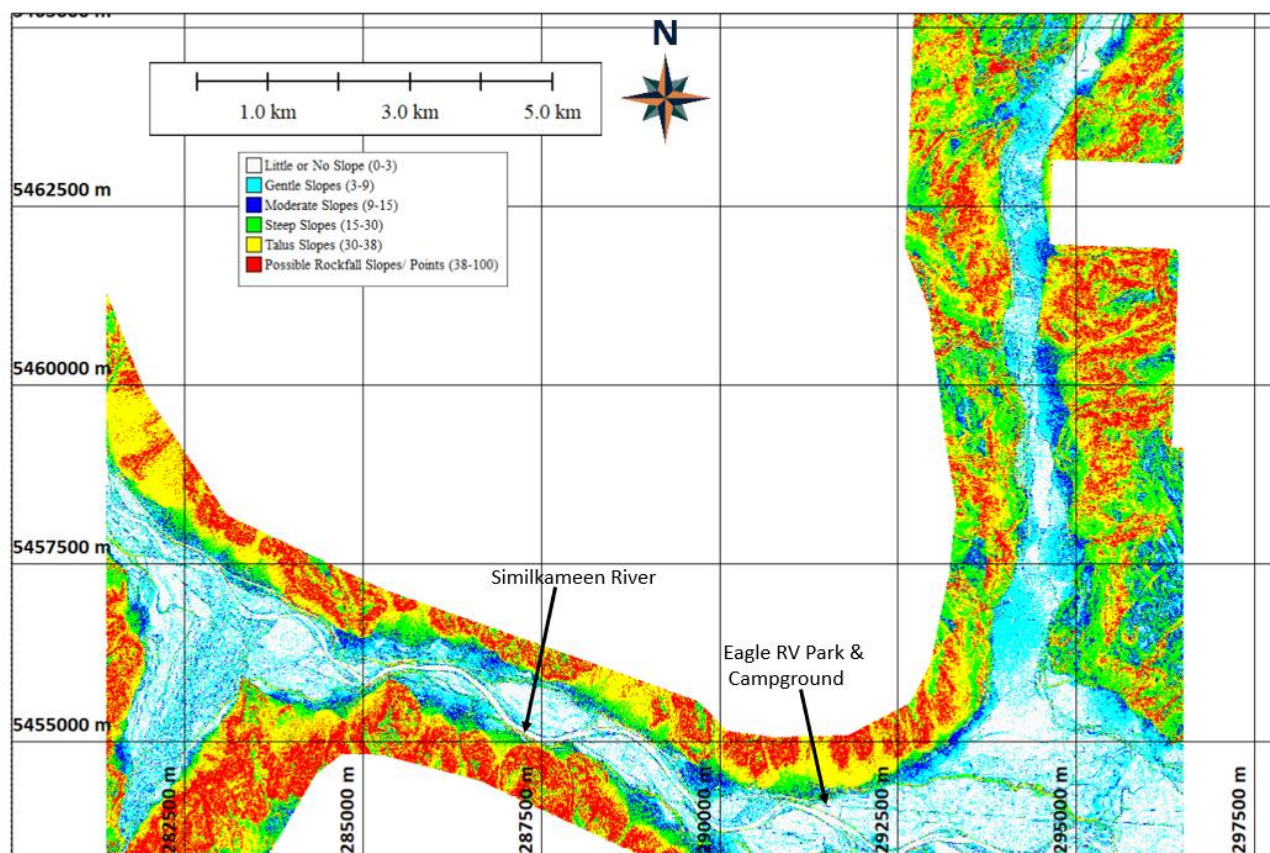


Figure 52. DEM reclassified based on slope values.

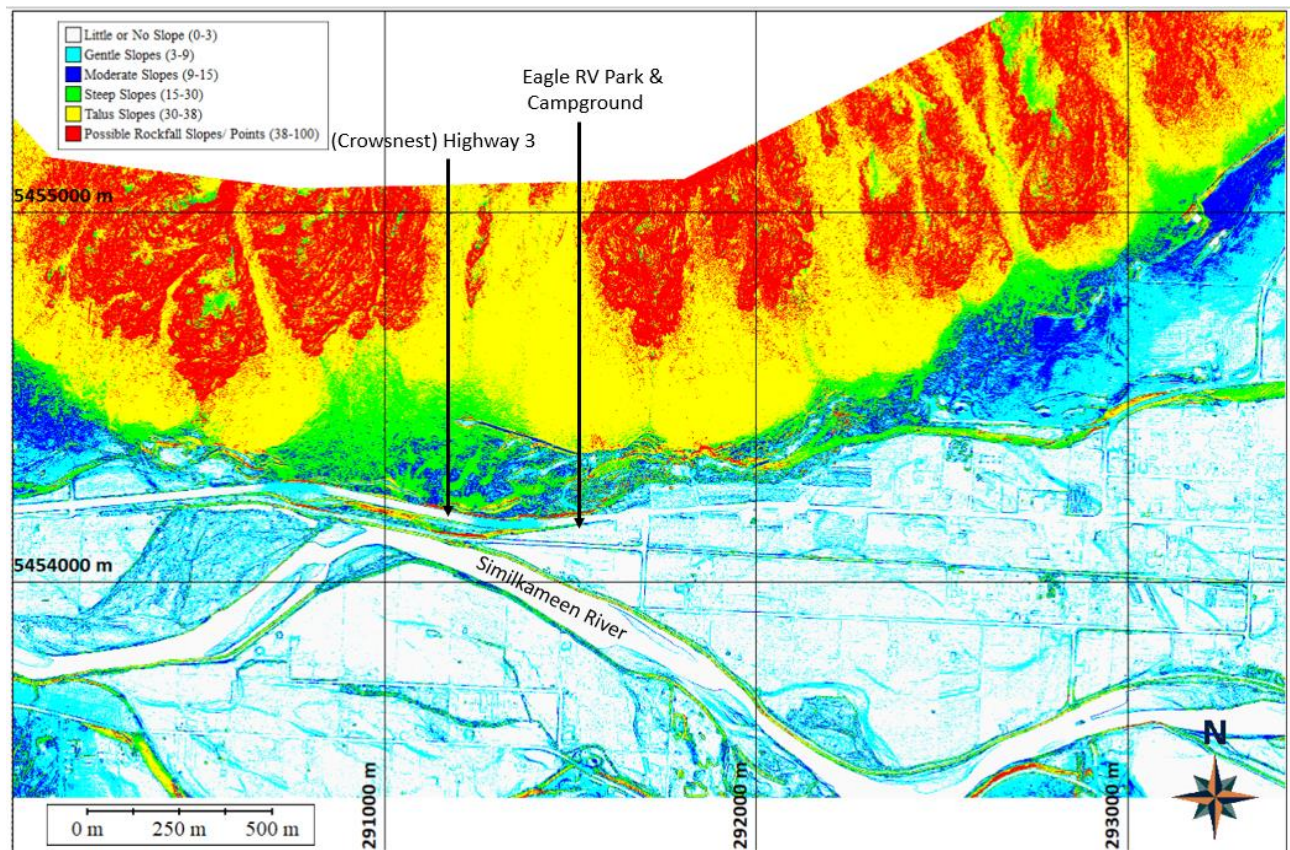


Figure 53. DEM reclassified based on slope values (near Eagle RV Park and Campground).

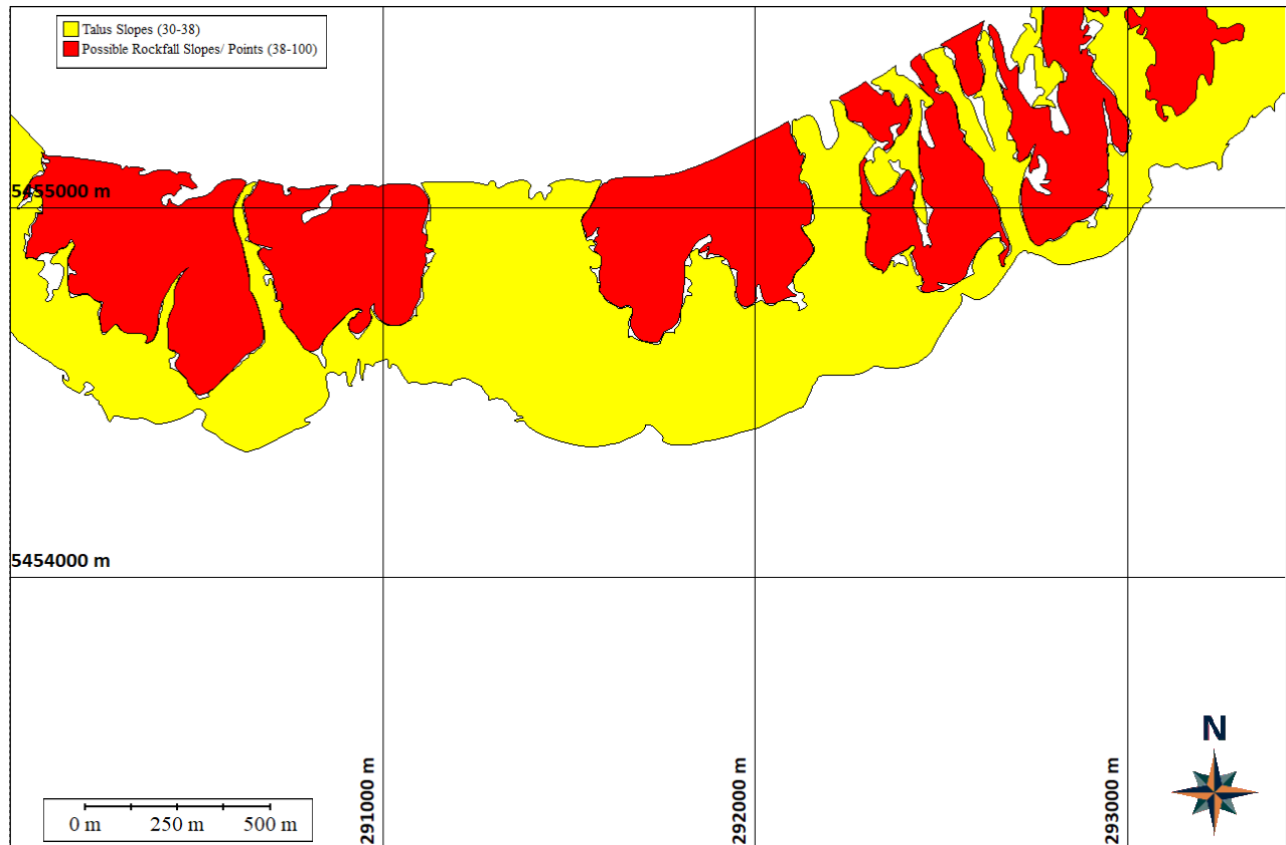


Figure 54. Using the generate equal value areas tool to generate polygons based on the colour palette (smoothing, simplification, and islands deleted).

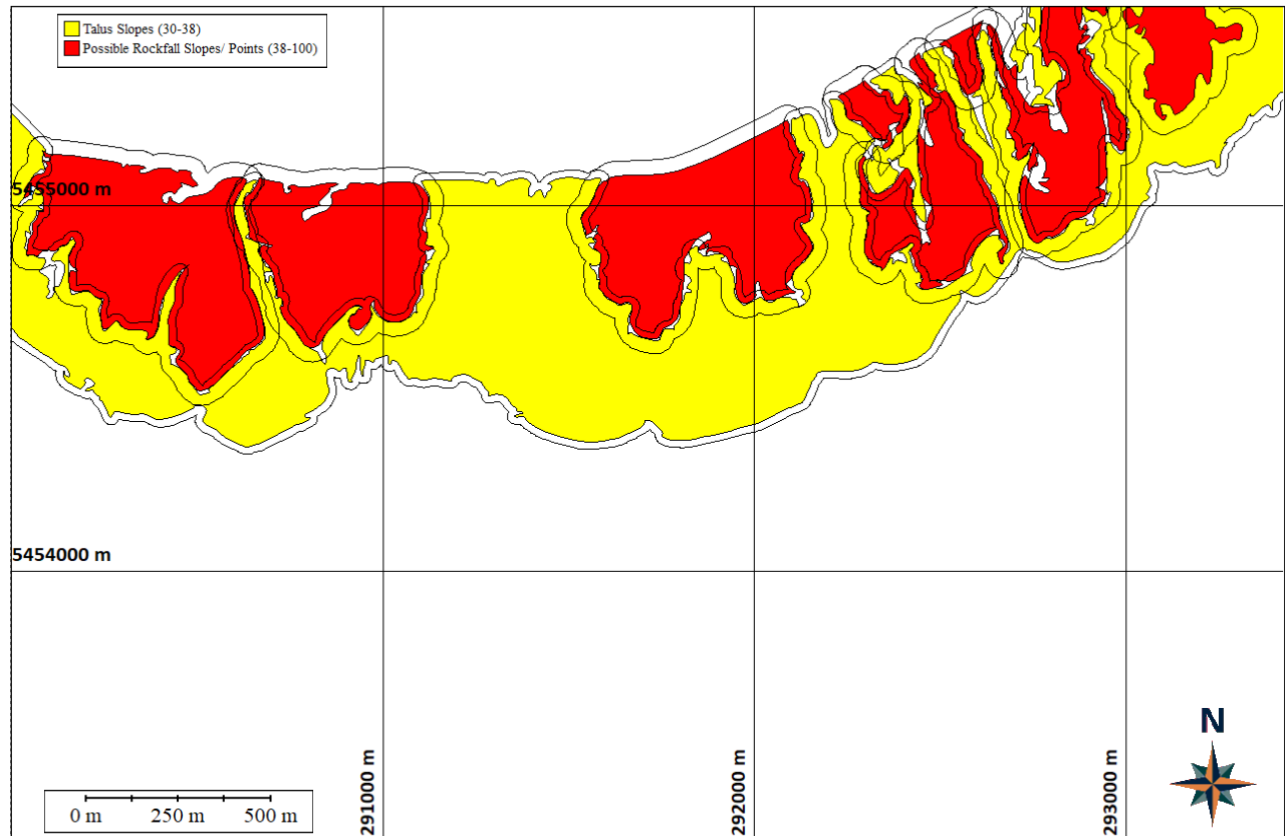


Figure 55. Buffer zones created around the talus slope and the edge of the bedrock.

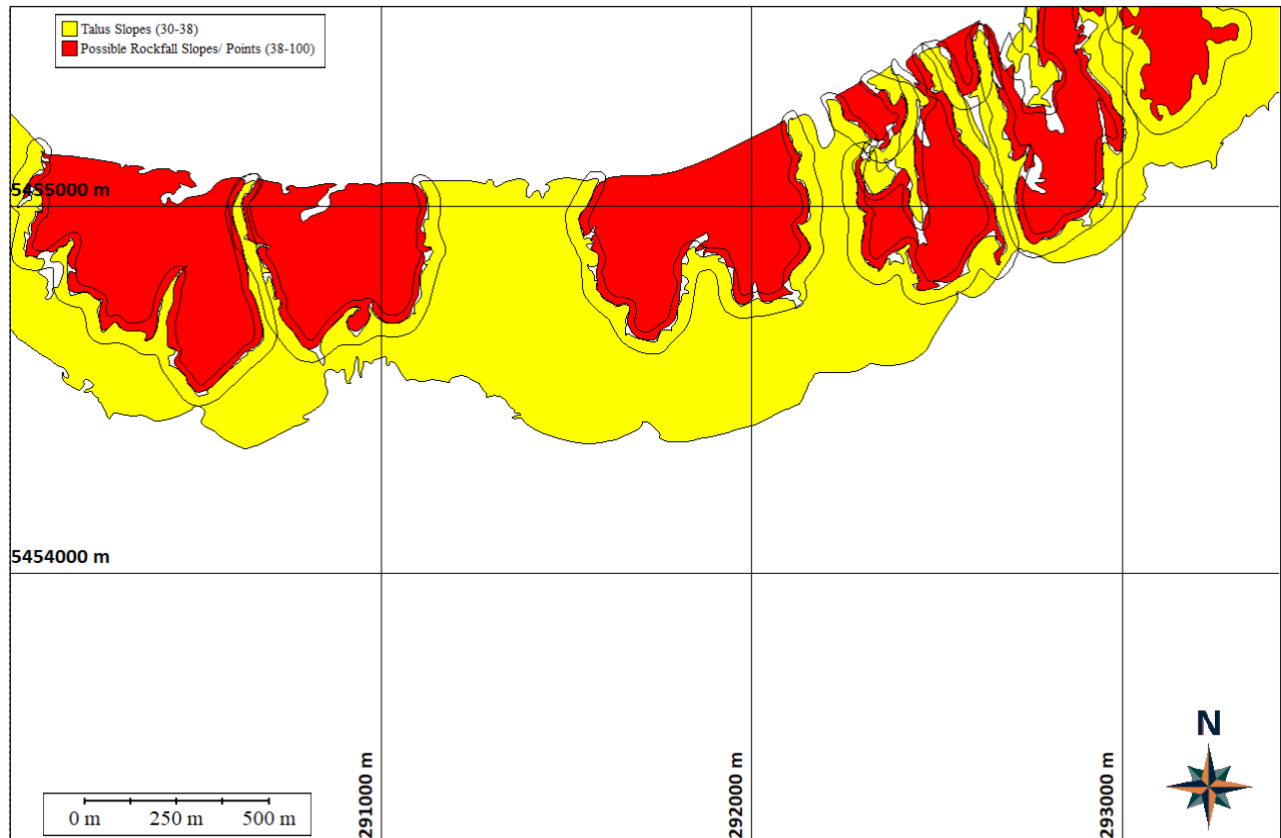


Figure 56. Intersection between the buffer zones created around the talus slope and the edge of bedrock.

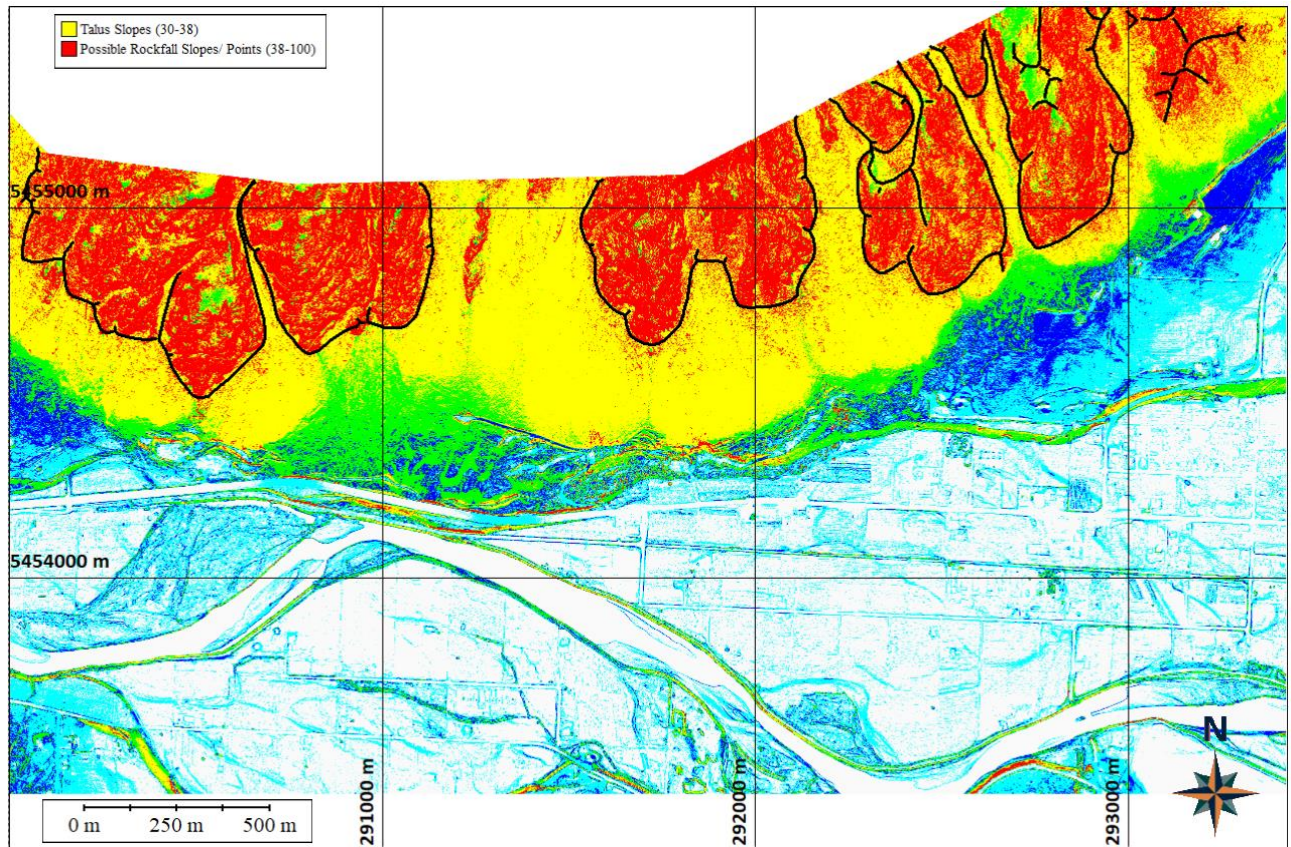


Figure 57. Line created which maps out the top of the talus slope.

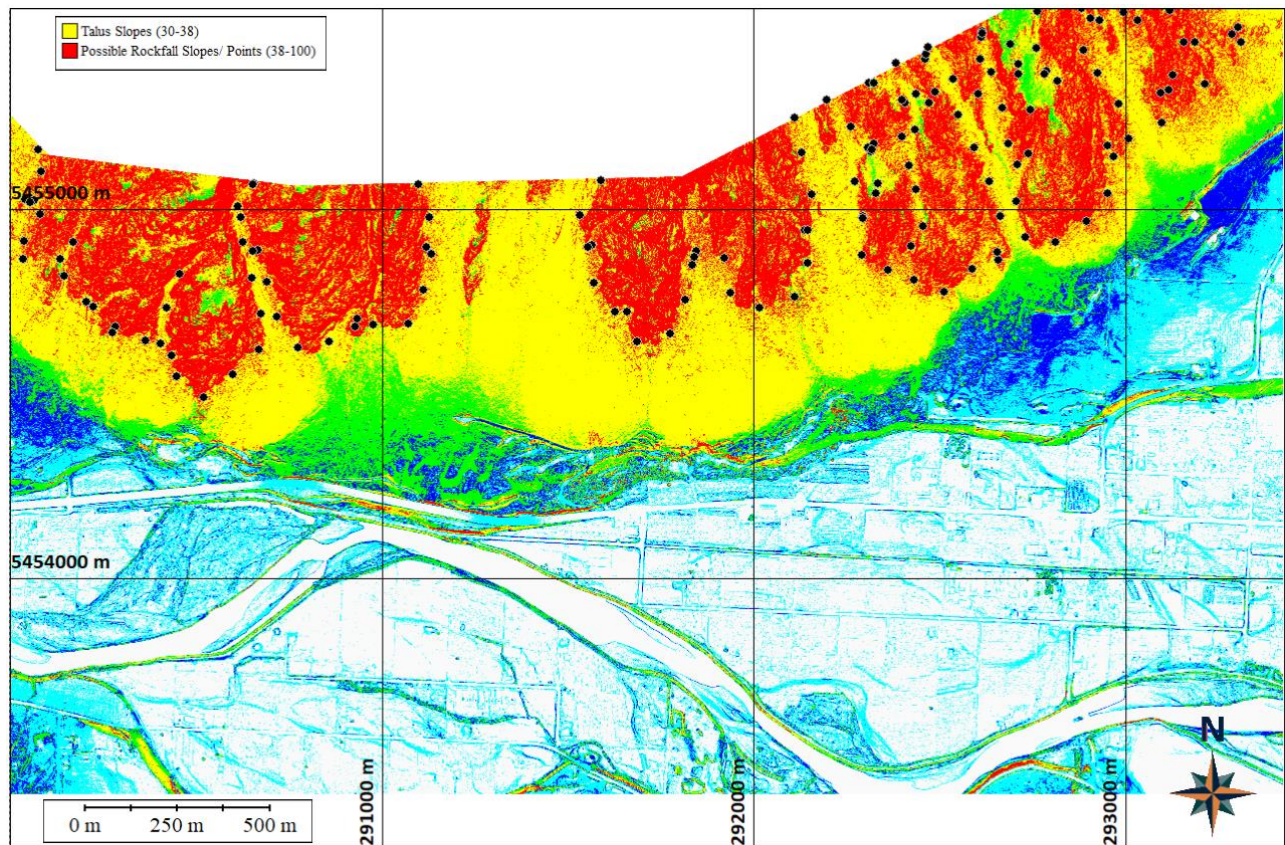


Figure 58. Points created every 100 metres along the line that maps out the top of the talus slope.

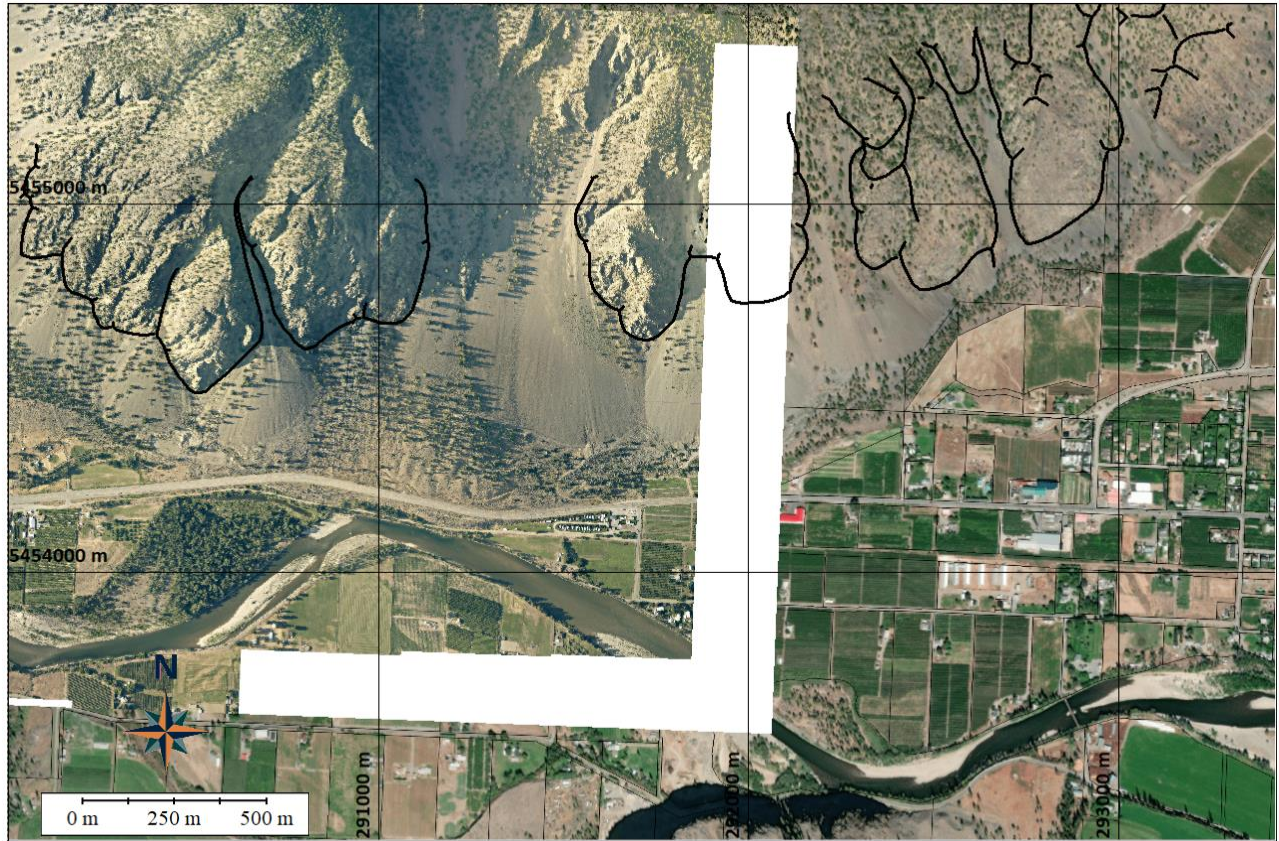


Figure 59. Line for the top of the talus slope shown on the orthophoto¹.

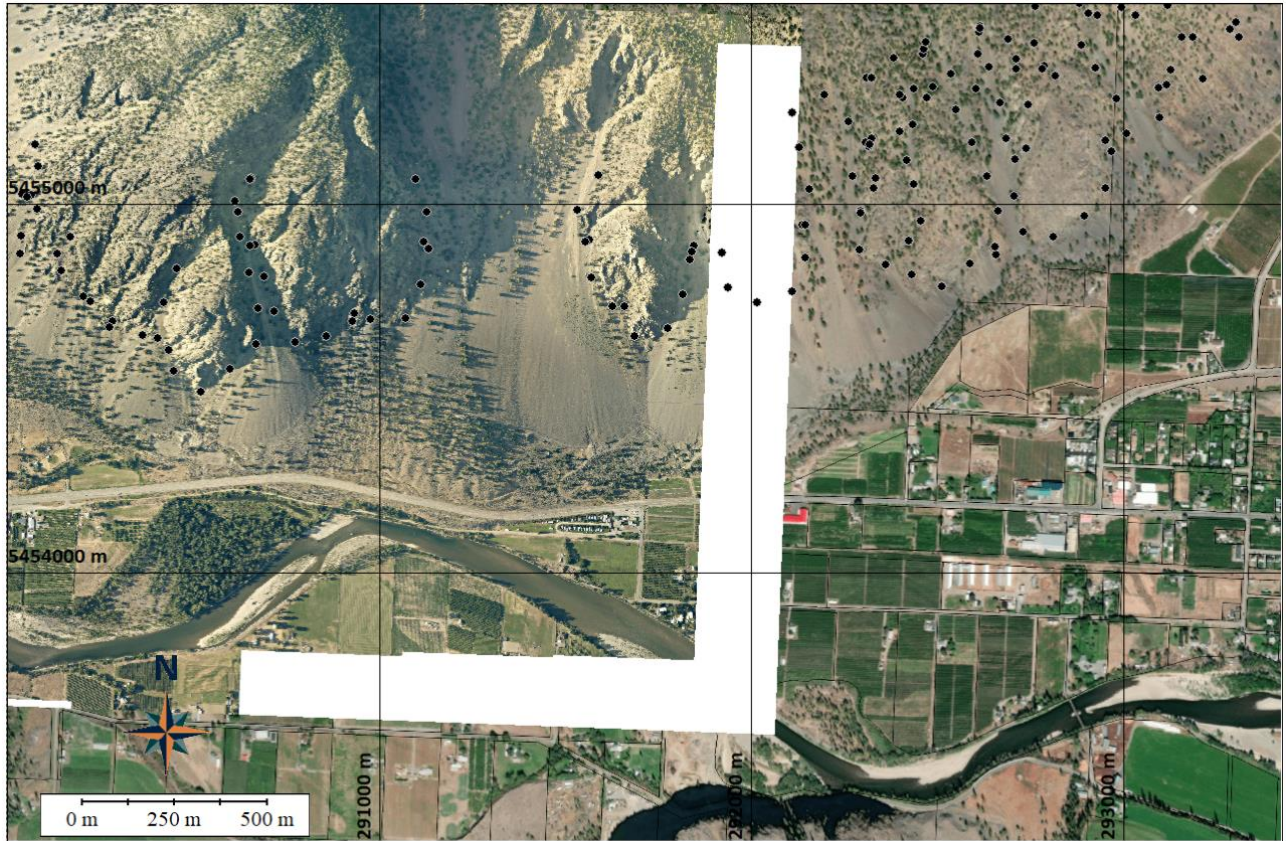


Figure 60. Points created every 100 metres along the line for the top of the talus slope shown on the orthophoto¹.

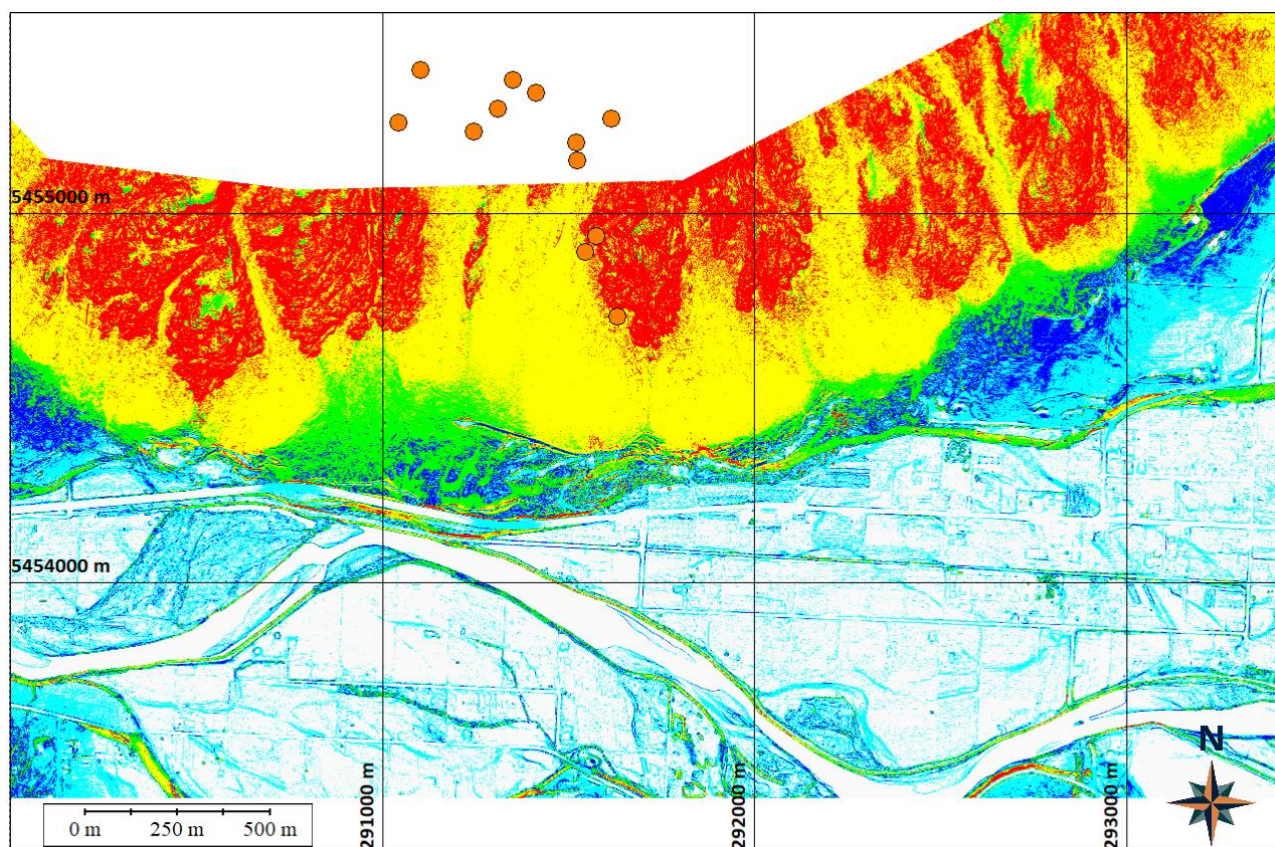


Figure 61. Points created manually shown on the DEM (fine) reclassified based on the slope values.

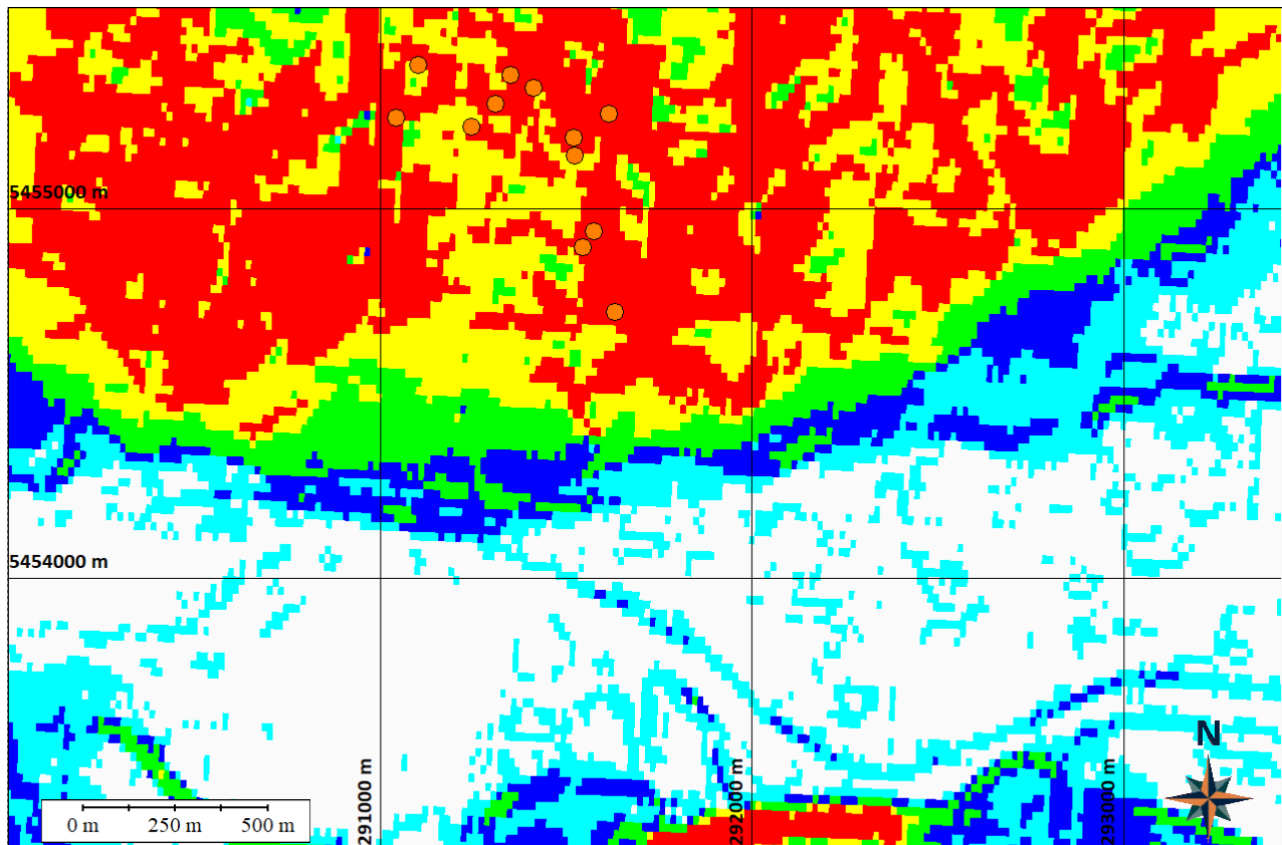


Figure 62. Points created manually shown on the DEM (coarse) reclassified based on the slope values (used for points that are not on the fine DEM).

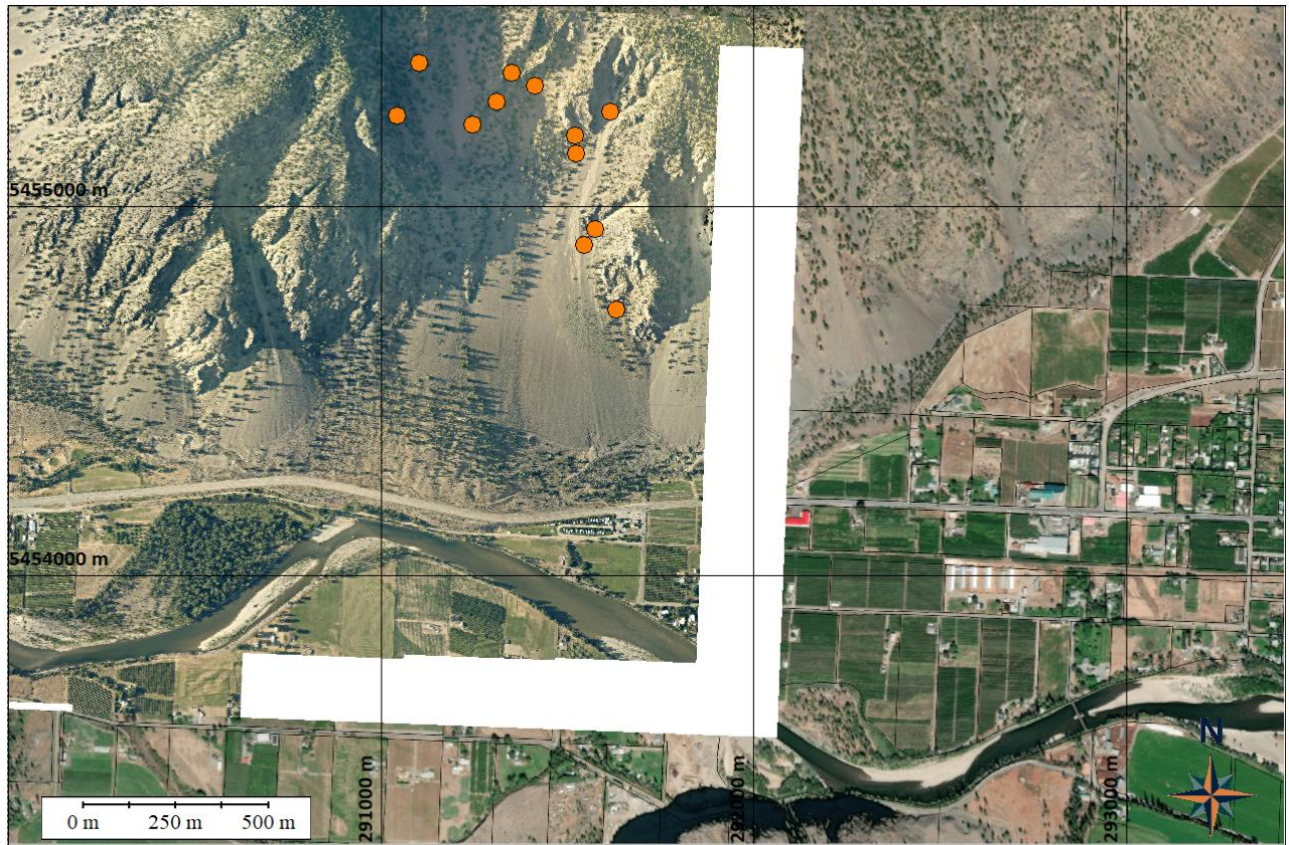


Figure 63. Points of interest created manually are shown on the orthophoto¹.

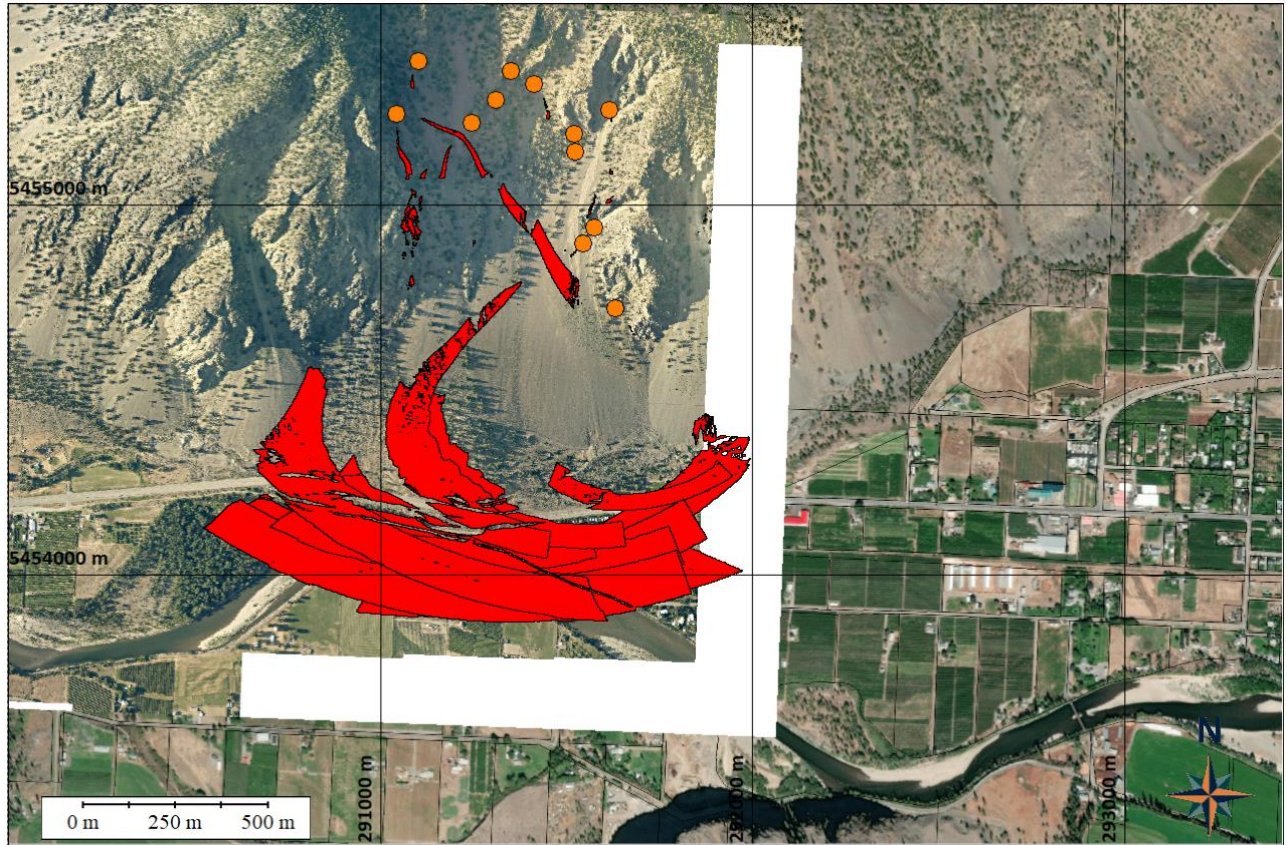


Figure 64. Viewshed analysis results for points of interest created manually¹.