

Unit 4: High Resolution Topography for Geomorphic Change Detection – Student Exercise

Assignment design by Katherine Shervais (UNAVCO), Ramon Arrowsmith (Arizona State University), Christopher Crosby (UNAVCO), Nathan Niemi (University of Michigan) and Marin Clark (University of Michigan).

One way to assess a geomorphic system and to understand active processes is to compare repeat topographic data to detect change. TLS is an ideal tool for capturing topographic data for use in geomorphic change detection because it can quickly produce a georeferenced “snap shot” of a system or feature at a certain point in time. As a result, you can easily calculate how far a channel or landslide has moved over the past year, the evolution of a dune crest over a decade, or how much a fault scarp has eroded since it formed.

Introduction:

In this unit, you will apply the skills you have learned working in the program RiScan Pro to prepare TLS data for analysis. In addition, you will learn how to use the program ArcGIS and the LAStools toolbox to transform the data and do basic raster math to calculate change over time for a geomorphologic system. Once you have completed the calculations, summarize the history of the system in a brief report.

Project Description:

Below is a description of the workflow to follow when working on this project. This exercise is expected to take a lab period.

If using TLS data: RiScan Pro

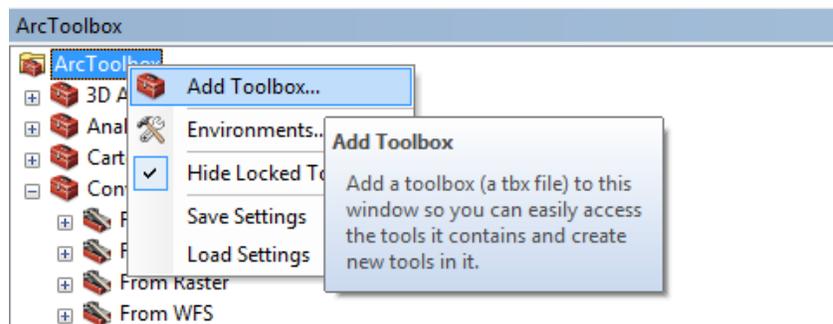
Use the *Data Processing and Exploration Manual* as your guide to clean up the data. This may entail using the filters listed, including the terrain filter. Because TLS data can be quite noisy, thinning the data using the filters makes the data much easier to work with in other programs. After the data have been cleaned, select the area of interest and follow the steps in your manual to export the data. Do this for both point clouds of the feature.

If using SfM data: CloudCompare

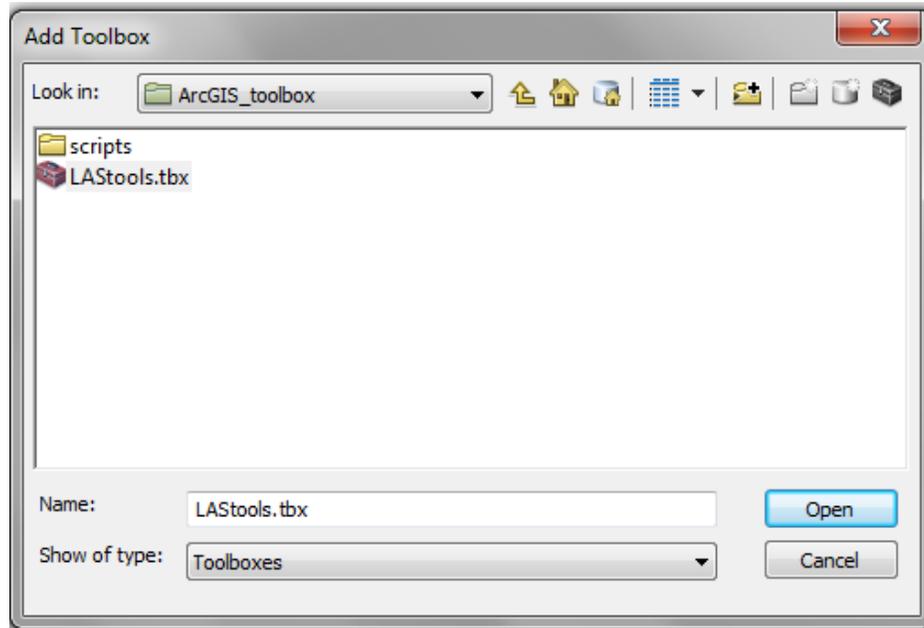
Use the *Data Processing and Exploration Manual* to select a portion of the data you are interested in. You may also use the filters, like the vegetation filter, in Agisoft to further clean the data. This helps reduce the file size to make the data much easier to work with in other programs. After the data have been cleaned, select the area of interest and follow the steps in your manual to export the data. Do this for both point clouds of the feature.

Create the DEM:

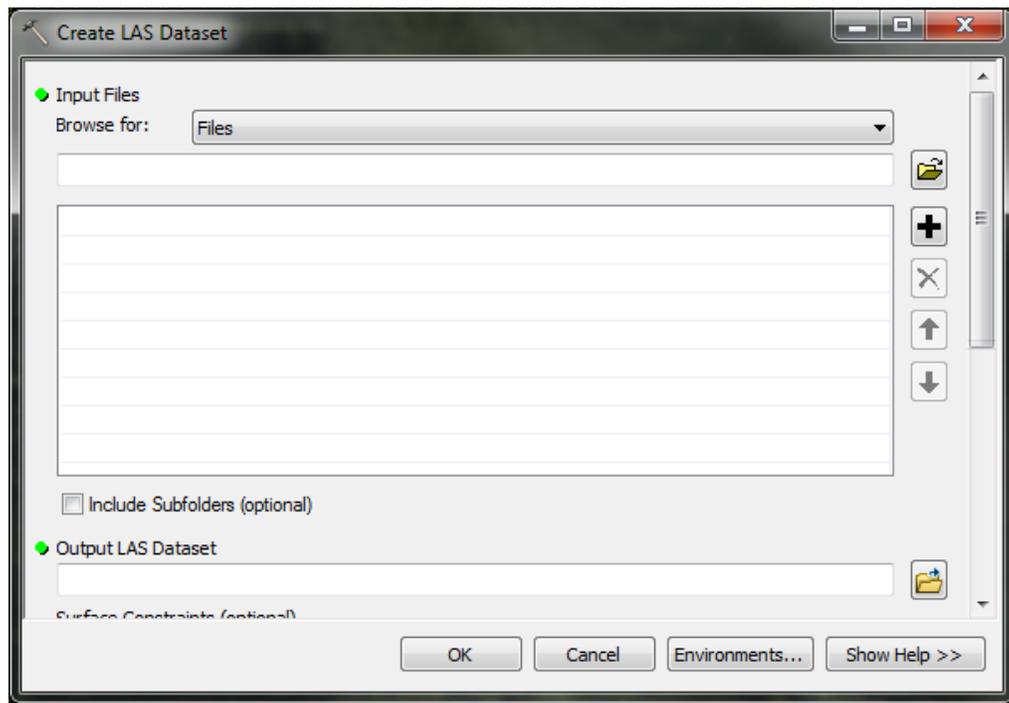
After the data has been exported, open ArcGIS. If LAStools has not been downloaded to your computer, follow this link (<http://rapidlasso.com/lastools/>) and download the folder. Click on the ArcToolbox icon to



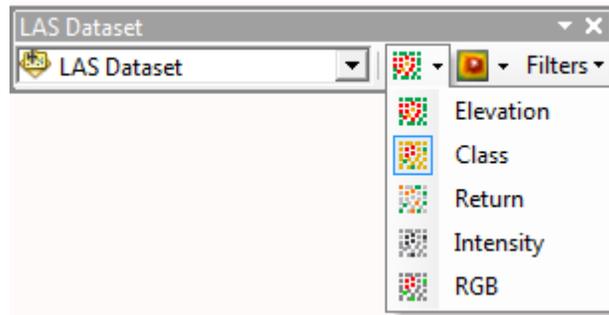
open the Toolbox tab, and right click the heading “ArcToolbox” and select “Add Toolbox.” Click the folder with a plus sign icon and navigate to the LASTools folder to connect to the folder. Then navigate to the LASTools.tbx file like below. Open it.



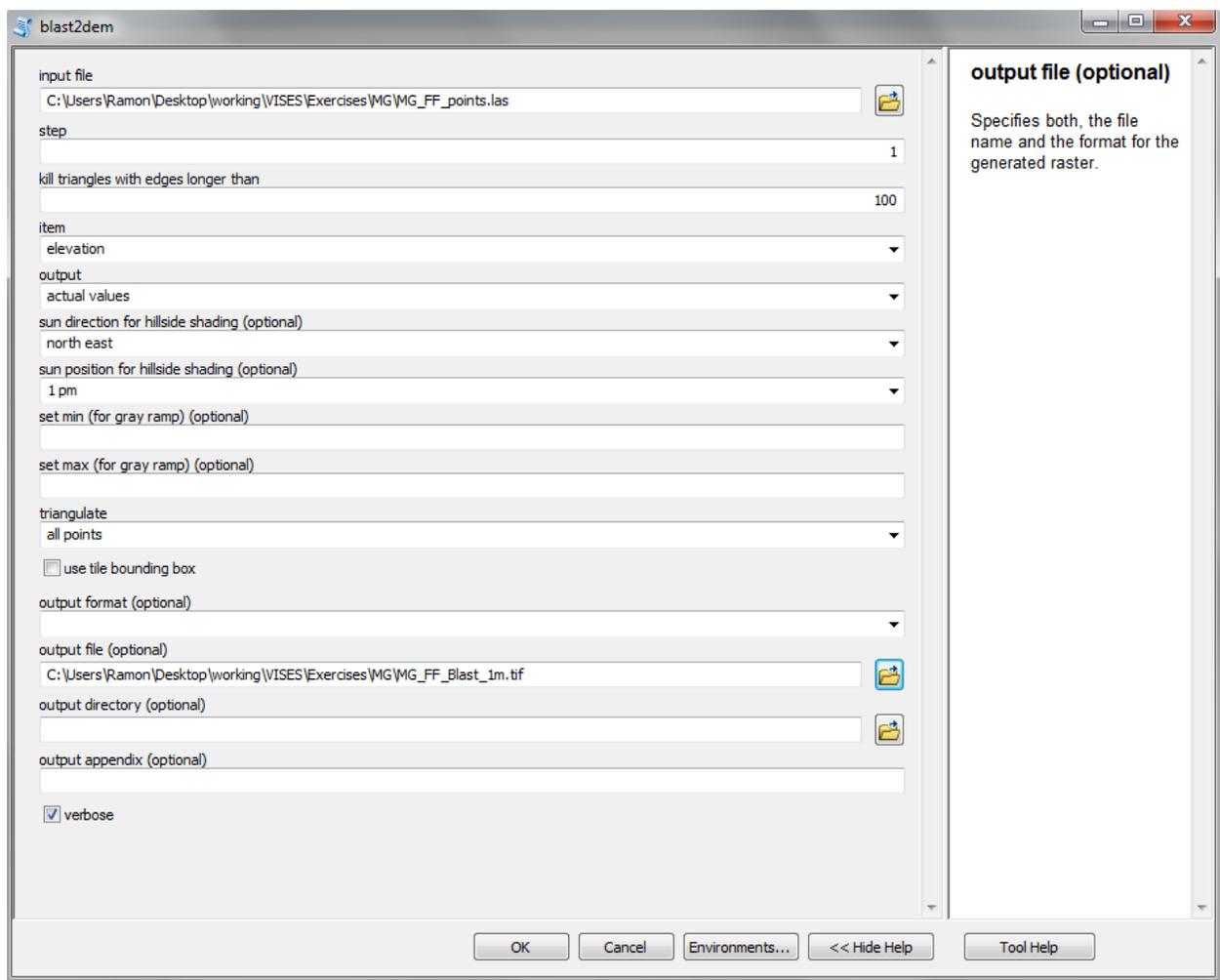
This adds a toolbox to ArcToolbox that has been designed specifically to work with .las data. To visualize your data, go to ArcToolbox—Data Management Tools—LAS Dataset—Create LAS Dataset.



Add the .las file you exported from RiScan Pro. Make sure you ONLY include the .las file for that time; you need to create a separate LAS Dataset if you would like to visualize both. You can use ArcScene to view the LAS Dataset. Add the LAS Dataset toolbar (in the Customize—Toolbars menu). The following toolbar will appear and you can view the data. This toolbar only works when you are zoomed in on the data.



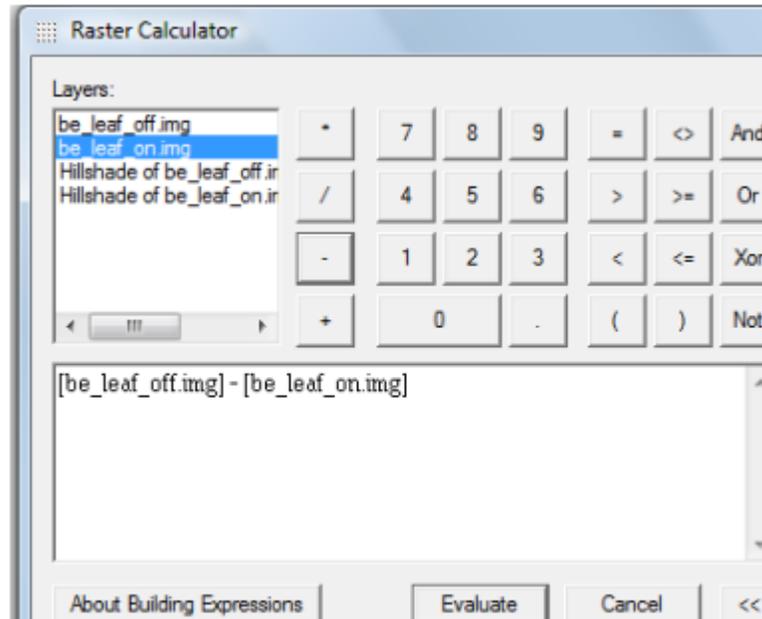
To create the DEM, go to the LASTools Toolbox and select blast2dem. The following window will appear.



Set the parameters above based on your project. Make sure to record the parameters you used to calculate the DEM. You will want to use the same grid resolution (“step”) when gridding the two data sets.

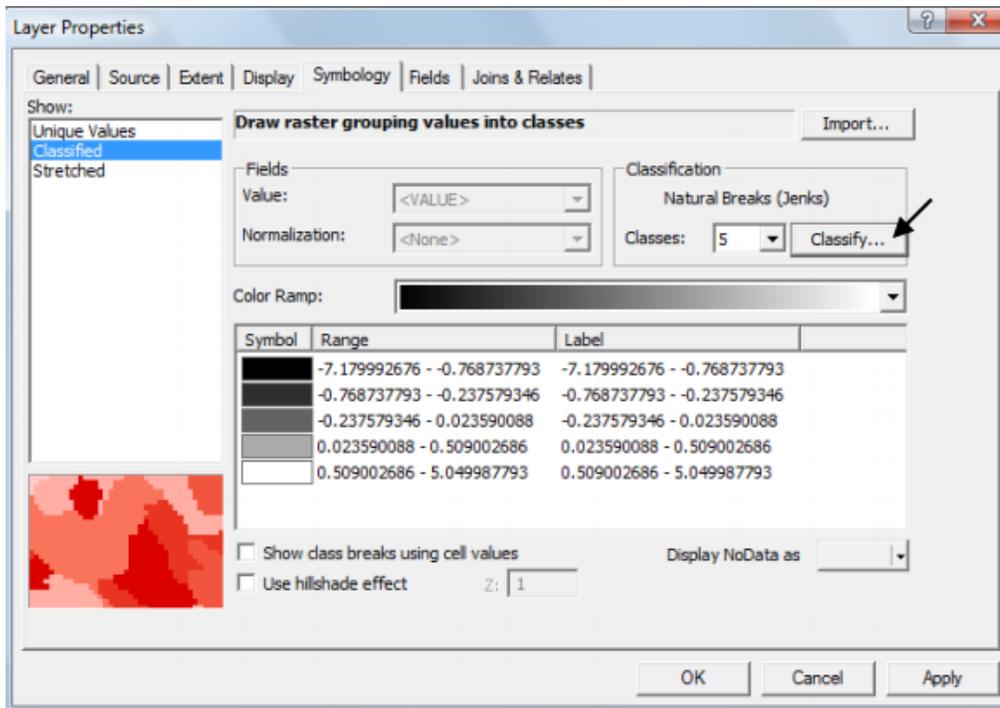
Change detection

Turn on the Spatial Analyst Toolbar (different than the toolboxes) by going to Customize—Toolbars—Spatial Analyst Toolbar. The toolbar will appear in the main window. Click Spatial Analyst and a dropdown menu will appear. Select Raster Calculator.

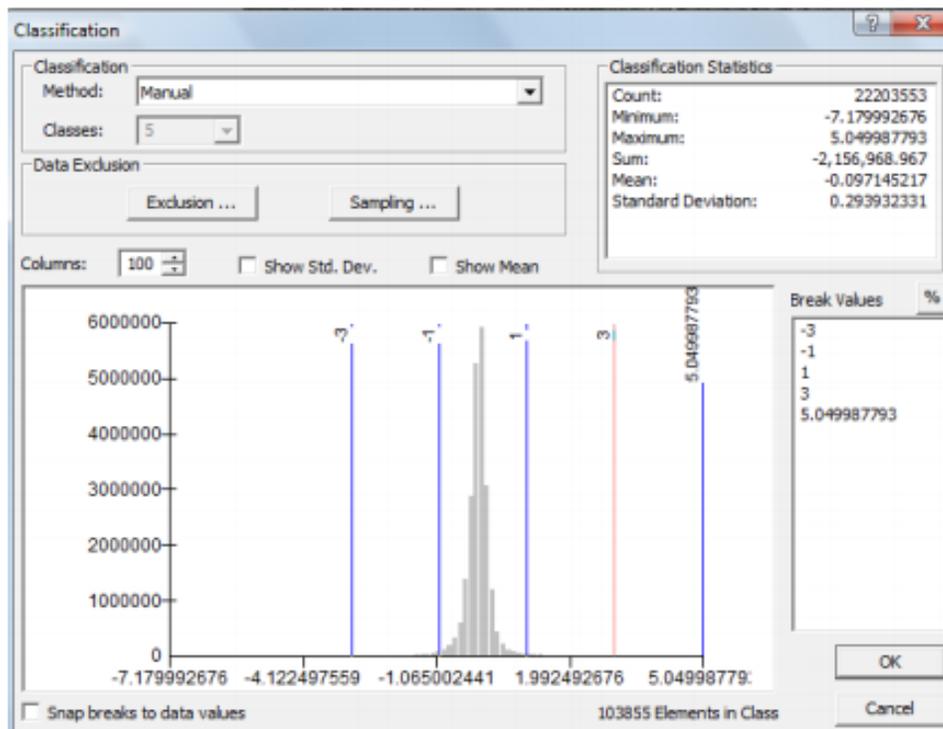


This window will appear. Using syntax such as the one shown above, subtract the older raster data set from the younger raster data set. The resulting calculation will appear in the Layers tab. Right-click the “Calculation” and then go to Data—Make Permanent. Then you can load the saved grid.

Right-click on the grid. The following menu will appear. This is how you can change the display of the calculated grid.

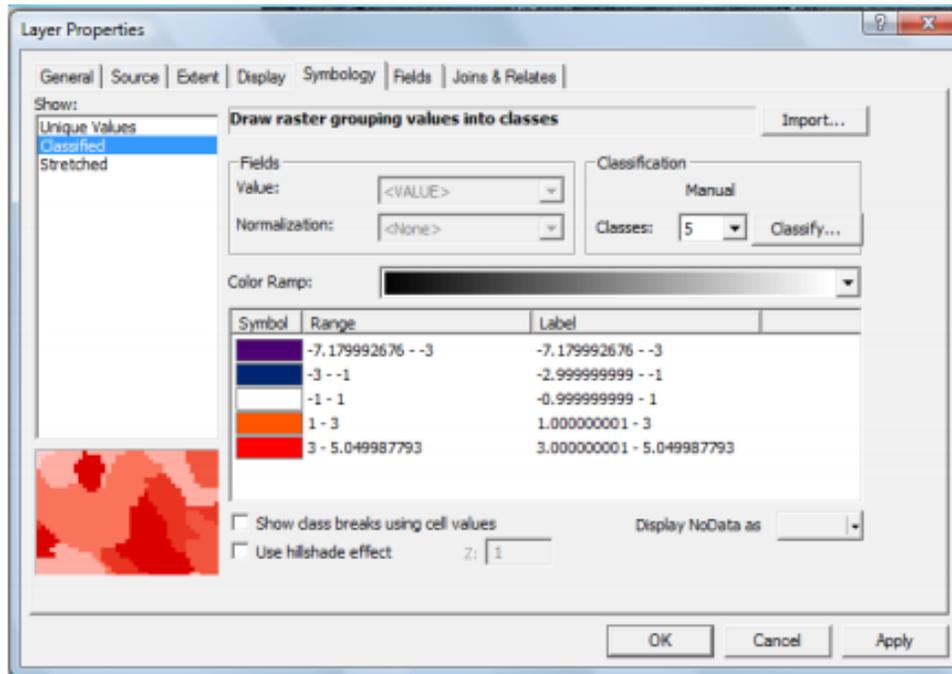


Go to the Symbology and show Classified. Click the classify button. Based on the histogram, select logical Break Values that bin the data into groupings that will highlight the magnitude of change you see in your calculation (example in the figure below). Click OK.



Now you want to change the color map to highlight where there has been erosion and deposition. If you double-click the color box in the symbol column, you can select the color. The figure

below shows a typical color distribution used to show erosion and deposition where positive change (z-values increasing) are cool colors and negative change (z-down) are warm colors.



Project Report:

Part A: Survey Design Description (complete if your class collected geodetic data for this exercise)

If you collected one of the data sets for this exercise, complete this portion of the assignment.

Include the following information in this section of report:

1. Describe the research question and the motivation for using TLS to answer this research question.
2. How did you design this survey to highlight the area of interest?
3. Provide a map of the camera locations / collection path or scan positions, target, and GPS locations with annotations justifying and explaining why those locations were chosen. Include any limitations on camera locations / collection path or scan, target or GPS positions.
4. If doing a TLS survey: Describe the target tie-point verification process, including a plot of the tie-points from RiScan Pro and the degree of correlation of the points. Use this information to discuss the goodness of fit of the merged data sets and what could have been done to increase the goodness of fit.
5. If doing an SfM survey: Provide a map of camera locations. Based on the calculated camera locations from the software, how could you have designed the survey better to highlight the feature of interest? Are any important portions missing or blurry? Use the function in the SfM software to generate a map of photo density. Does this map show you successfully surveyed the feature of interest? Why or why not?

Part B: Data Processing

Describe the input parameters you used in blast2dem to create a DEM from your point cloud data set and the parameters you used in DEM visualization.

1. Why did you select the parameters that you did?
2. What break values did you select when changing the elevation view?

Part C: Change Detection

1. Make a figure that includes the two DEMs you created and the calculated difference grid.
2. Where is erosion occurring? Where is deposition occurring? Where is the most change occurring?
3. Describe the type of change and the geomorphic processes at work. What does this show about the system?

After completing these portions of the write-up, answer the following questions:

1. Research significance: What is the societal impetus to study geomorphologic change?
2. Reflection on learning: What was challenging about working on data processing? What was rewarding?

Unit 4 Rubric – TLS change detection

This rubric covers the material handed in for Unit 4 student exercise and is the summative assessment for the unit.

Component	Exemplary	Basic	Nonperformance
General Considerations	Exemplary work will not just answer all components of the given question but also answer correctly, completely, and thoughtfully. Attention to detail, as well as answers that are logical and make sense, is an important piece of this.	Basic work may answer all components of the given question, but some answers are incorrect, ill-considered, or difficult to interpret given the context of the question. Basic work may also be missing components of a given question.	Nonperformance occurs when students are missing large portions of the assignment, or when the answers simply do not make sense and are incorrect.
Part A: Survey Design Description (10 points) OPTIONAL	<p>9–10 points:</p> <p>Survey design to highlight scarp (3 points)</p> <p>Map with camera locations / collection path or scanner, target, and GPS locations with justifications (3 points)</p> <p>Target tie-point verification, including a figure, degree of correlation, and explanation of the goodness of fit and how it may improve (3 points)</p> <p>OR reflection on collection path / camera locations with figure showing photo overlap and some discussion of how survey design may improve</p> <p>If all of the above in included and the material is presented in a clear, concise and well-written fashion (1 point)</p>	<p>5–8 points:</p> <p>Missing 1–2 of the listed characteristics for an exemplary report and may be poorly written/unclear;</p> <p>AND/OR</p> <p>All characteristics are present but lack detail or are incorrect, showing a lack of comprehension</p>	<p>0–4 points:</p> <p>Missing 2–4 of the characteristics, may be poorly written and unclear;</p> <p>AND/OR</p> <p>Most characteristics are present (1–2 missing) but are incorrect, showing a lack of comprehension</p>

Part B: Data Processing (2 points)	3 points: Report parameters (0.5 point) Why these parameters (1 point) Break values (0.5 point)	2 points: Missing 1 of the characteristics for an exemplary report and may be poorly written or unclear; AND/OR All characteristics are present but lack detail or are incorrect, showing a lack of comprehension.	0–1 points: Missing 2–3 of the characteristics, may be poorly written and unclear; AND/OR Two characteristics are present but are incorrect, showing a lack of comprehension.
Part C: Change Detection (8 points)	6–7 points: Figure of data produced (1 point) Erosion, deposition, and most change locations (2 points) Description of system (2 points) Detailed and thoughtful answer to reflection question about learning experience and societal impetus (2 points) If all of the above is included and the material is presented in a clear, concise and well-written fashion (1 point)	3–5 points: Missing 1–2 of the characteristics for an exemplary report and may be poorly written or unclear; AND/OR All characteristics are present but lack detail or are incorrect, showing a lack of comprehension. AND/OR Answer to reflection question not considered or thoughtful	0–2 points: Missing 3 of the characteristics, may be poorly written and unclear; AND/OR Two characteristics are present but are incorrect, showing a lack of comprehension. AND/OR Did not answer reflection question