Determining annual erosion rates associated with BeHi and NBS methods

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Introduction

Erosion is a type of weathering in which surface soil and surface rock are worn away by the natural processes of wind and water. The rate at which erosion occurs should concern everyone. Soil erosion in the United States alone costs the nation around 37.6 billion dollars in crop productivity losses each year (Lang, 2006). Most of this costly erosion occurs on streams running through farms, and as the population of the Piedmont region continues to grow, the need for farmland does not diminish, as over 99 percent of human food is sourced by cropland (Lang, 2006). Given the number of farms in the Chesapeake Bay watershed, streambank erosion has become a major concern of environmental restoration companies such as Ecotone. This project was intended to quantify the erosion rates associated with qualitative BeHi (Bank Erosion Hazard Index) and NBS (Near Bank Stress) analyses referred to in the River Stability Field Guide (Rosgen, 2008). A BeHi analysis involves studying variables such as bank height, root depth, surface protection, root density percentage, bank angle, and less common variables such as evidence of stratification. These variables are used to calculate an adjective rating, signifying potential for erosion, ranging from very low to extreme. Along the streams in this study, an NBS analysis most often involved measuring variables such as radius of curvature, bankful width, and maximum and average depth. These variables were also used to determine an NBS adjective rating ranging from very low to extreme potential for erosion. The results of this project will enable companies like Ecotone to predict erosion rates and encourage landowners and grant makers to allow, and fund stream restoration projects.

Methods and Materials

Thirty five sites along eight streams in the Piedmont region were selected for this project. At each of the sites, three ½ inch rebar pins were installed in the bank until they were flush. Immediately after the pin installation (as shown in figure 1), BeHi and NBS erosion potential analyses were conducted. After measuring the variables discussed in the introduction, they were entered into the appropriate worksheets which assisted in determining an adjective ranging from very low to extreme EPR (erosion potential rating). The bank pin installation and BeHi and NBS analyses were conducted in the first 12 weeks of the study, so that the pins could remain in the bank for the remaining 20 to 30 weeks and allow plenty of time for the process of erosion to occur. In the final weeks of the study, stream sites were revisited to measure the bank pin exposure. The average exposure of the three pins was extrapolated to an annual rate, and assigned to that particular stream site so that erosion rates would not differ depending on the erosion potential method.

Methods and Materials (cont.)

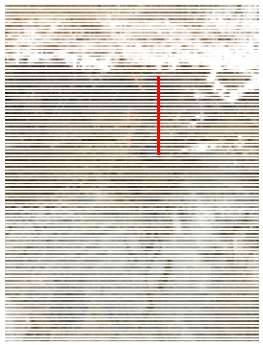


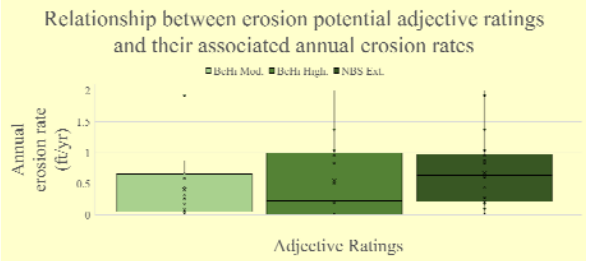
Figure 1 (above left): The photograph displays three bank pins immediately after installation. The pins are installed flush with the stream bank, in a vertical line perpendicular to the stream bed. The red scale bar represents 41 inches.
Figure 2 (above right): Displays a close up of an individual bank pin installed flush with the bank. The diameter of the rebar pin is ½ inch.

After all of the bank pins were measured (as shown in figure 4) and analyzed, we related thirty five BeHi and NBS ratings to thirty-five annual erosion rates. A box plot was created that displayed the differences between moderate BeHi, high BeHi, and extreme NBS because they had sample sizes significant enough to display meaningful results.

Results

Figure 3 (above left): Displays three bank pins after 28 weeks of exposure at site six of the First Mine Run Game Reserve in White Hall, Maryland. The average exposure of these three pins was 14 inches. The yellow scale bar in the image represents 15 inches.
Figure 4 (above right): Displays a researcher measuring the bank pin exposure of the middle pin at site seven of the Beetree property in Freeland, Maryland. This particular pin was exposed 5 ¾ inches 12 weeks after it was installed.

Results (cont.)



Graph 1 (above): Displays the ranges and median values of the erosion rates that occurred at moderate and high BeHi, and extreme NBS sites.

The box plot uses moderate and high BeHi, and extreme NBS data because they had sample sizes of 19, 13, and 22, respectively. All other adjective ratings had sample sizes smaller than five. The values associated with extreme NBS ratings varied from 0.0 ft/yr to 2.0 ft/yr. The values associated with moderate and high BeHi ranged from 0.0 to 1.9 ft/yr and 0.0 to 2.0 ft/yr, respectively.

Conclusion

The purpose of this project was to determine what quantitative annual erosion rates could be associated with the qualitative adjective ratings provided by BeHi and NBS erosion potential analyses. The three data sets that resulted from this study show considerable overlap that does not display any significant differences between the adjective ratings. The overlap of erosion rates related to the moderate and high BeHi and the large range of values in all three samples does not allow us to assume any association between annual erosion rates and adjective ratings, and we cannot draw any conclusions from this data. The study needs to be continued, and further samples need to be collected for the other adjective ratings in both BeHi and NBS to determine if there are significant differences between the erosion rates associated with the adjective ratings used in each method. Box plots with more appropriate medians and ranges will allow Ecotone to predict the amount of sediment travelling downstream after completing an analysis in only a few minutes, as opposed to studying the stream site for months to determine an annual erosion rate that would be presentable to grant makers.

References

Lang, S. (2006, March 20). Slow, insidious soil erosion threatens human health and welfare as well as the environment, Cornell study asserts. *Cornell Chronicle*. Retrieved from http://www.news.cornell.edu/stories

Rosgen, D. L. (2008). *River Stability Field Guide*. D. F. Geenen (Ed.) (2nd ed.). Fort Collins, CO: Wildland Hydrology.