Soil Erosion Modeling with the Modified Universal Soil Loss Equation

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ForestryImages.org: Photos for Forestry and Natural Resources

By Joe LaForest and Dave Moorhead

Photos are invaluable for use as training aids and for publication, program illustrations, and descriptive and identification purposes. Unfortunately, most of us do not have our own exhaustive collection of images. Even those of us who are prolific photographers often find ourselves missing critical images of a subject for illustrating a particular point. When we can't find a good image from our own collection, we resort to Google searches and hunting on Flickr or other websites to track down an image that will work and one that we might get permission to use. This can be a very time-consuming process and frustrating when we find the perfect image, but can't figure out whose image it is.

However, there is a useful source of images available to foresters and natural resource professionals. ForestryImages.org began as a cooperative project with the US Forest Service Forest Health program and the Center for Invasive Species and Ecosystem Health (CISEH) at the University of Georgia. The latter is also known as the Bugwood Network, which began as a collaborative effort between forestry and entomology faculty who were working on forest health issues. Original slides were collected and scanned from many Forest Service Research stations across the United States. Over the years, the scope of the collections expanded to include forestry practices, with contributions in part from the SAF Silviculture Instructors Group and other forestry contacts. Today, the database contains more than 124,000 images.

The great thing about this resource is that all images are freely available for noncommercial, educational use, as long as users

properly cite the photographer, organization, and Bugwood.org. Doing so recognizes the work of the photographers, the support of their organizations, and the system delivering the images. If individuals wish to use an image in a commercial publication, such as advertising or for sale projects, they can request permission to use them through the image request system on the site, known as the Light Box. This feature contacts the photographer(s) and forwards the details of the image use request.

Bugwood.org is always looking to add quality images to the database and invites you to visit the www.forestryimages.org or www.bugwood.org to browse through the sites and consider submitting images to the system. The first thing people ask when considering posting images is, "What does this mean for my copyright? Do I still own my images?" The answer to this is a resounding, "YES, you still own the images!" By adding them to the system, you do grant permission for them to be used in noncommercial publications, as long as they are properly cited. If someone requests permission to use the image commercially, the Light Box system will forward the request to you. If you ever decide that you want your image removed from the site, all you have to do is ask. The database managers realize how valuable photographs are to each photographer and they do everything they can to respect those rights.

The second question that usually comes up is, "What do I get out of it?" The answer to this boils down to one thing: recognition. Aside from the potential for charging for commercial requests, the center does not claim any rights to the images or charge for access to the website. Photographers are

One of the more than 124,000 images available from ForestryImages.org/Bugwood.org: the fruiting bodies of the *Phaeolus schweinitzii* fungus.

Susan K. Hagle, USDA Forest Service, Bugwood.org

given a profile page where they can post a bio and picture of themselves as well as the logo for their organization and a link to their website. Each organization is also given a profile page on the website to let people know more about the work it does. Because Forestry Images and the other Bugwood image sites receive more than 12 million hits a month, there is a good chance that people will find you and your images through browsing the site as well as searching in Google, Bing, and other search engines. This lets people know that you and your company, agency, or organization value educational resources and are willing to help to improve the access and availability of useful information.

If you are interested in contributing images, you can do so via the contribute images link on www.forestryimages.org. This will take you to a website where you can upload images and provide the information that goes with them. If you still have questions regarding the system, comments on how things are organized, or suggestions for improvement, contact Joe LaForest at laforest@uga.edu or Dave Moorhead at moorhead@uga.edu.

Joe LaForest oversees the Bugwood images database at the University of Georgia. Dave Moorhead is a professor of silviculture and codirector for the Center for Invasive Species and Ecosystem Health at the university.

Soil Erosion Modeling with the Modified Universal Soil Loss Equation

By Yanli Zhang, Jason Grogan, I-Kuai Hung, and Ramanathan Sugumaran

Forests are important not only because of their direct economic contributions, but also because of their soil and water conservation functions. Thus, when planning forest management practices, maintaining soil productivity and minimizing erosion need to be primary considerations. From a watershed-scale management viewpoint, conservation efforts and resources should be focused on the most sensitive areas of soil erosion. This article introduces a GIS (Geographic Information System) method to identify these areas within a small watershed, to assist foresters' conservation efforts.

The Modified Universal Soil Loss Equation (MUSLE) is one of most widely used empirical soil erosion models, because it includes a runoff factor, and it provides better sediment-yield prediction than its predecessor, USLE. In general, MUSLE can be expressed as:

$$Y = 11.8 \times (Q \times q_p)^{0.56} \times K \times LS \times C \times P$$

where Y is the sediment yield to the stream network in metric tons; Q is the runoff volume from a given rainfall event in m³; q_p is the peak flow rate in m³ s⁻¹; K is the soil erodibility factor, which is a soil property available from the Soil Survey

Geographic (SSURGO) database; LS is the slope length and gradient factor; C is the cover management factor, which can be derived from land cover data; and P is the erosion control practice factor, which is a field specific value. The Q, q_p, and LS parameters can be derived from Digital Elevation Model (DEM), land cover, soil, and rainfall data.

MUSLE can be used to evaluate soil erosion risk. However, the spatial data processing for such evaluations within a GIS environment is a sophisticated procedure. ArcMUSLE, a free, user-friendly ArcGIS extension, was designed to assist the application of MUSLE at the small watershed scale.

ArcMUSLE has three user interfaces. The first interface is used to define the watershed boundary, data resolution, and output directory. The second interface is used to specify required input spatial data, which include DEM, land cover, SSURGO, and two-year, 24-hour rainfall data. DEM and land cover data are available from the National Map Seamless Server (http://seamless.usgs.gov/). For land cover, the National Land Cover Dataset (NLCD) may be used. However, land cover data often are available from state GIS data clearinghouses, and these sources may have more detailed classification systems than the NLCD. SSURGO data are available from US Department of Agriculture Natural Resources Conserva-
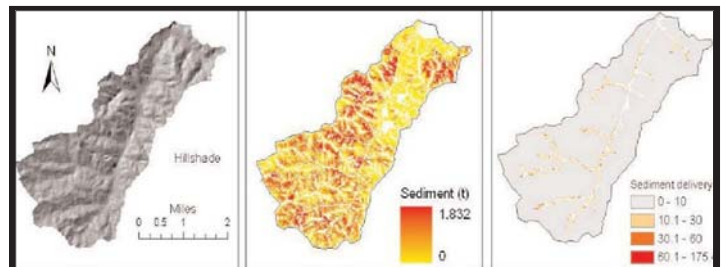
Examples of the output from ArcMUSLE. The sediment map (image 2) shows where soil sediment will be eroded; the darker the red, the larger the amount of sediment (these areas are the most sensitive areas to soil erosion). The sediment delivery map (image 3) shows the amount of sediment entering waterbodies—darker red colors indicate larger amounts of sediment. These two maps clearly demonstrate that ArcMUSLE can serve foresters to evaluate soil erosion risk within a small watershed. After ArcMUSLE's evaluation and field verification, corresponding best management practices may be applied to protect the most sensitive areas.

tion Service website (http://soildatamart.nrcs.usda.gov/). The two-year, 24-hour rainfall data, is a dataset for a typical 24- hour precipitation for two-year return period. *Urban Hydrology for Small Watersheds* (TR-55), published by the US Department of Agriculture, contains rainfall maps for the entire United States. Users can create a constant raster dataset based on the value found from these maps. For land cover data, users need to add two extra attribute fields, C factor and Man-

nings n, to the attribute table and define corresponding values for each land cover category. The third interface is used to define model parameters, such as antecedent moisture condition (dry, average, or wet) and rainfall amount.

ArcMUSLE is a relatively easy to use GIS software that can assist foresters in evaluating soil erosion risk at a small wa-

8 percent, we should do so, as our expected rate of return from the investment will increase. For example, if we can buy bare land for $100/acre and grow a timber crop as described earlier, our return on investment will increase from 8 to 9.9 percent. Further, the economic value of our 12-year-old pre-commercial timber stand will decrease to $676.10/acre (see Professor Straka's Table 1) from $773/acre as shown earlier. This lower stand value largely results from the increase in the interest rate from 8 to 9.9 percent.

Lastly, although not stated in Professor Straka's article, when we use a range of interest rates in our valuation determination, we need to recalculate the optimum stand establishment cost as well as the rotation age that accompanies each interest rate. It is very likely that these input parameters are sensitive to differing interest rates.

B. Bruce Bare is dean emeritus and professor, forest management and quantitative science, School of Forest Resources, University of Washington.

Reference

1. "Calculation of the Value which Forest Land and Immature Stands Possess for Forestry," 1849, Martin Faustmann. Reprinted in *J. of Forest Economics* 1:1 1995.

Thomas J. Straka responds:

Dean Bare does an excellent job of clarifying some valuation issues not addressed in my article. The original article was written for a field forester audience and centered on two problems inherent in the use of simple compounding and discounting of costs and revenues as a method often used to value pre-commercial timber stands. Those two problems were the importance of the interest rate and land opportunity cost. Keeping the examples simple, while "numerically correct," probably increased the number of foresters who actually read the article. So much of the "inherent complexity" associated with the problem was intentionally omitted due to space limitations and intended audience. I am pleased that Dean Bare, a forest valuation expert, took the time to address those complex issues. I am especially pleased that he described the issues in a non-technical manner, well suited to that same field forester audience. As such, his comments are a perfect addendum to the original article. All of his comments were valid considerations in using this method and strengthen the original article in terms of related complex valuation issues.

tershed scale. It is available at www.faculty.sfasu.edu/zhangy2/download.htm. For questions about this tool, please contact the authors.

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Posted: January 4, 2011
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E-mail: szwirble@forestcap.com
Phone: (617) 832-2932

Job ID: 7512133
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E-mail: krutten@masonbruce.com
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Company: Utilimap Corporation
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Contact: Lauren
E-mail: Jobs@Utilimap.com
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Fax: 636-533-4056

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Company: LandVest, Inc.
Location(s): New Hampshire
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E-mail: rcarbonetli @landvest.com
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Company: LandVest, Inc.
Location(s): Tupper Lake, New York
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Contact Person: Richard G. Carbonetli
E-mail: rcarbonetli @landvest.com
To Apply: www.landvest.com

Job ID: 7484015
Position: Forester
Company: Hancock Forest Management
Location(s): Kapowsin, Washington
Posted: December 23, 2010
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Contact: Hancock Natural Resource Group
E-mail: nwpositions@hnrg.com

Job ID: 7480377
Position: Vice President for Institutional Advancement
Company: Paul Smith's College
Location(s): Paul Smith's, New York
Posted: December 21, 2010
Job Type: Full-Time
Contact: Addie Jones and Mark Tarnacki
E-mail: PSC@phillipsoppenheim.com
To Apply: www.paulsmiths.edu

Job ID: 7477091
Position: Land Records Administrator
Company: Hancock Forest Management, Inc.
Job Function: Other
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Posted: December 20, 2010
E-mail: jobs.hfmsd@hnrg.com

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Position: Dean of the College of Forestry and Conservation & Director of the Montana Forest and Conservation Experiment Station
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