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USDOI Office of Surface Mining Reclamation and Enforcement

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DEVELOPMENT OF A RAPID GEOMORPHIC ASSESSMENT TECHNIQUE TO SUPPORT THE CHIA/PHC PROCESS: A FOCUS ON MODEL IMPROVEMENT FOR ESTIMATING SEDIMENT LOADS

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ABOVE PHOTO: Collecting suspended solids data from an area stream following a precipitation event.

Project Description and Objectives:

This project was designed to develop testing methods, classification techniques, and modeling procedures useful for the evaluation or prediction of impacts resulting from land-use disturbances in large rural watersheds typical of the Appalachian coalfields. The primary objective was to identify tools which could be used by regulators or other resource management groups to assess cumulative sediment loading and changes in stream channel stability resulting from existing or proposed land-use alterations. The study area was located in the New River watershed of Tennessee, a principal water course that drains to the Big South Fork National River and Recreation Area.

Applicability to Mining and Reclamation:

Siltation and habitat alteration have been identified as the principal cause of stream-use impairment in the United States. Change in siltation or sedimentation rates in receiving streams result from multiple land use and resource extraction activities including: logging, mining, oil and gas development, agriculture, recreational vehicle traffic, and runoff from unimproved roadways. The results of this project could be useful to natural resource agencies and/or private companies that extract or manage land, water, and mineral resources. The study identifies a land-use classification system useful for rural landscapes and statistically correlates these land-use activities to stream particle size distributions which can be measured in the field using rapid geomorphic assessment techniques (RGA) described in the document. The (RGA) method is a useful tool for determining when

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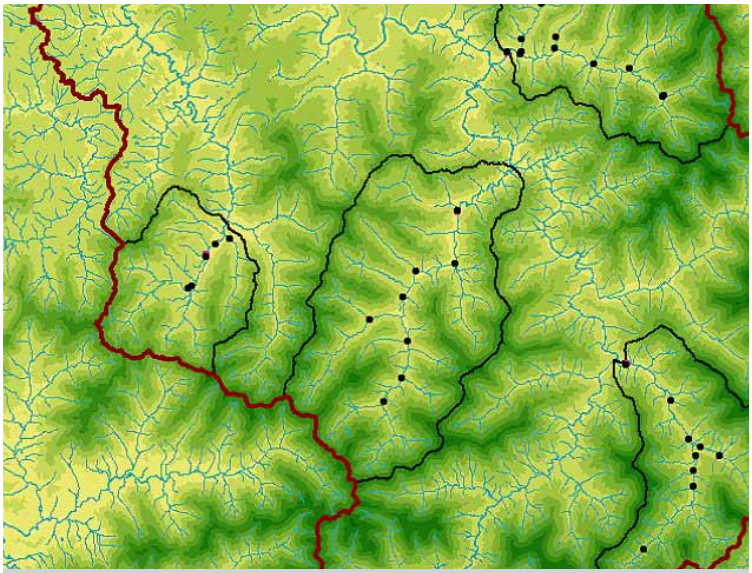

ABOVE PHOTO: Digital elevation grid and hydrologic stream network showing the position of various RGA stations.

channel instability caused by land-use alterations could be an important source of downstream siltation and when such sediments should be accounted for during sediment transport modeling. It concluded that the AnnAGNPS and ConCEPTS models provide a reasonable approach for estimating annual sediment load in larger watersheds commonly needed by state and federal regulators to evaluate the cumulative hydrologic impact assessment (CHIA). It also provides a tool for the evaluation of the probable hydrologic consequences (PHC) of surface coal mining with regards to assessing sediment load or impacts of alternative affects of alternative land-use practices on total sediment yields in a watershed.

Methodology:

Seven subwatersheds (ranging in size from 3 to 33 miles^2) within the New River basin of Tennessee were selected as part of this study. The selection process included three reference watersheds which were relatively undisturbed along with four other watersheds subjected to a variety of recent and historic land-use disturbances. Land use and soils information was then computed using current aerial photography and satellite imagery to develop ArcGIS map and Arcview project files. Once evaluated, a common land-use classification system was developed and used to assess the relationship between streambed sediment composition and land-use disturbance. Streambed sediment was collected as part of the RGA sampling which included assessments at over 50 sites within these subwatersheds. A rapid hillslope assessment (RSA) technique was also evaluated to determine if such a method would provide a relationship between watershed geometry and sediment yield. The RSA used digital elevation models (DEMs) to generate information on watershed characteristics including relief, gradient, and hillslope geometry (concave versus convex slope areas) to determine if any correlation existed between landform and streambed composition. A standardized system of metrics was developed and used to score the watersheds draining to the RGA assessment stations.

Highlights:

Land use/sediment correlations. Land-use classifications and geomorphic field measurements uniquely correlated with subwatersheds by PCA ordination statistical analysis providing evidence that the land-use types identified generate distinct sediment yields. Of the geomorphic metrics, the RGA, reach channel slope, and fine sediment amounts found in lateral stream deposition areas were the most important geomorphic variables.

RGA scores and channel stability. This study found that in most of the headwater areas, stream channels were stable due to geologic controls. However, bank erosion problems were observed in lower subwatershed areas containing floodplains with alluvium. Overall, the RGA is a useful field assessment tool to evaluate whether coal mining operations are having an impact on channel stability downstream of their hydrological influence.

Performance of sediment models. Preliminary results from the use of the AnnAGNPS and ConCEPTS models demonstrated that reasonable estimates of annual sediment yields can be generated for different land-use scenarios, answering questions such as:

1) What would be the sediment yield increase from a new coal mine operation in a subwatershed, and
2) What are the proportional contributions of sediment yields from all possible upland sources and bank erosion sources?

Results/Findings:

The study demonstrates methodologies that can be used by regulatory and resource management personnel in assessing channel stability and sediment loading in large watersheds involved in resource extraction and multiple land-use scenarios. An instruction manual developed to assist users in the input of watershed data and modeling parameters, necessary for the AnnAGNPS model, is available at the website information provided below.

Website Information:

The final project report is available at **http://www.techtransfer.osmre.gov/NTTMainSite/appliedscience/2006appscience/CompletedProjects/UTRapidGeom2006FinRpt.pdf**. A guidance manual to assist users in the AnnAGNPS model for calculating sediment loads in large watersheds is available at **http://www.techtransfer.osmre.gov/NTTMainSite/appliedscience/2006appscience/CompletedProjects/UTRapidGeom2006UserMan.pdf**

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