FACT SHEET

Tools to predict the hydrological response and mine pool formation in underground mines

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Project Description and Objectives:

- To derive statistically significant relationships between publicly available geologic, hydrologic, geographic, and mining data and the development of mine pools and potential discharge locations. Data from existing mines were used with the intention of predicting development of mine pools for future mines at the permitting level.
- To use the relationships developed in Objective 1 to produce a set of Geographic Information Systems (GIS)-based tools to predict water levels and discharge locations in coal mines. This set of tools can be used by permit applicants and regulators to determine the feasibility and possible impacts of new and existing mines. These GIS-based tools will improve the efficiency and accuracy of regulatory authorities in evaluating coal mine permits.
- The set of GIS-based tools will help to protect the public interests regarding environmental protection during mining.
- To provide a unique opportunity for undergraduate and graduate students to gain experience and knowledge about underground mining processes and environmental assessment.

Applicability to Mining and Reclamation:

As part of the mining permit review process, there is not a systematic or consistent tool or set of tools used to model the possibility of mine pool development post underground mining. The majority of the time the mining permit process is sufficient to protect water resources; however, occasionally a mine pool develops and produces mine discharges. These discharges are in some cases after the bond has been released and the coal mining company is no longer responsible. In the cases where no responsible party exists for environmental damage to water resources and the cost of environmental clean-up is not fundable, this burden falls on tax payers. Other times the coal mining company is still under bond, creating an expensive and long-term problem for both mine operators and regulators. This tool provides a mechanism for the regulatory agencies and the coal mining industry to predict the occurrence of mine pools and potential for mine discharges.

This empirical statistical model uses publicly available data and is accessible to regulatory agencies, industry personnel, and the public, using data already required for the current permitting process. The range of error on model predictions is 1-3%. The model's ability to predict the likelihood that a mine pool head could peak above ground surface level at points across the proposed mine extent meets a critical need where extensive remediation needs could be averted.

While this model was developed and tested in the eastern coal-bearing region of Ohio, the multivariate analysis and artificial neural networking methodology could easily be followed with data pertinent to other regions. The resulting algorithm could then be inserted into the existing GIS model.

Methodology:

- Data collected from ODNR-MRM coal mining permit applications
- Extraction of data from 28 permits, resulting in usable data for 14 mines
- Analysis - multivariate analysis -Unscrambler X and Artificial Neural Networking -NeuroShell 2
- Selection of appropriate algorithm
- ArcGIS model development and testing
- Reporting and tutorial

Highlights:

- Over 2000 data points included in water level prediction algorithm development
- Algorithm with >0.99 R^2 value
- Testing resulted in 1-3% prediction error for water level
- Data lacks the spatial resolution to interpolate results into a predictive surface
- Method of algorithm development broadly applicable to other mining areas

Results/Findings:

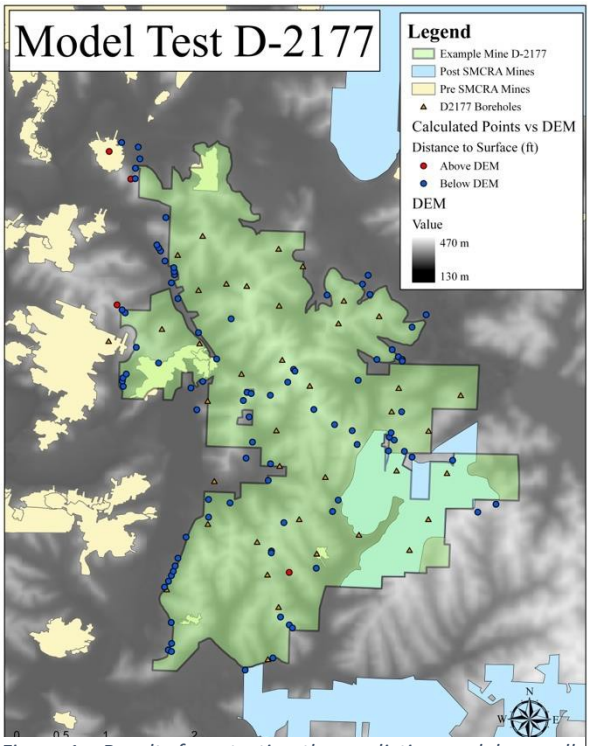

Figure 1 – Results from testing the predictive model on well and borehole data from mine permit D-2177

Multivariate analyses of the of data extracted from the mine permits resulted in an equation to predict post-mining water levels in underground coal mines of Ohio within 1-3% error. The analyses determined 11 significant variables for predicting post-mining water level: surface elevation, bottom elevation (of coal seam), overburden thickness, mined coal seam thickness, clay/shale thickness, sandstone thickness, limestone thickness, total coal thickness, underground mining in a 4-mile buffer, accumulative coal extracted, and average annual precipitation.

An empirical statistical model for applying the equation to predict post-mining water level and provide points at risk of surface discharge was successfully created and implemented in ArcGIS Pro version 2.2. Figure 1 is a test run example outputs of the model on a mine used in this study. The final output provides points of predicted post-mining water level compared to the area digital elevation model (DEM) to provide points of possible surface discharge from underground mine pools.

Website Information: The final project report can be found at http://www.watersheddata.com/MinePool_Study.aspx

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