

Chapter 10

A GIS Methodology for Assessing the Safety Hazards of Abandoned Mine Lands (AMLs): Application to the State of Pennsylvania

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ABSTRACT

Abandoned mine lands (AMLs) associated with past coal-mining scar Pennsylvania's landscape with environmental and safety hazards. Reclamation projects eliminate and reduce hazards AMLs pose. Due to the large number of AMLs and limited funds, precedence is given to reclaim the most hazardous sites first. These sites are identified through an assessment process that assigns priorities to AMLs. However, priorities are out-dated and do not accurately reflect the current spatial distribution of land use and census data. This article presents a GIS methodology for the prioritization of AMLs using the process of extrapolation and focal statistics. By incorporating current assessment techniques into GIS with current land use and census data, AML priorities were reassigned to accurately reflect the current spatial landscape. Results indicate that current AML priorities assigned by the state do not accurately reflect current land use and census data and underestimate the safety hazards of many sites, including high priority sites.

INTRODUCTION

Pennsylvania is one of 11 states east of the Mississippi River dealing with remnants of past coal mining in the form of abandoned mine lands (AMLs). Their presence is a result of unregulated coal mining from the mid-1700s to the late 1940s. Prior to the 1940's, mine operators would remove

all economically recoverable coal from a mine site and not be required to return the land to its pre-mining condition. Current reclamation law, dating from 1977, requires the mine operator to reclaim the mine site to its pre-mining condition. But there is almost a two-hundred year history of coal mining in which mine reclamation did not occur. Consequently, an estimated 250,000 acres of AMLs mark Pennsylvania's landscape and pose

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a threat to public health and the environmental quality of the state (Rossman, Wytovich, & Seif, 1997). Forty-three (43) of Pennsylvania's sixty-seven (67) counties contain AMLs, more than any other state in the nation (Rossman, Wytovich, & Seif, 1997). Many are located near residential areas, schools, and hospitals; places frequented by the population on a daily basis. Thus, their presence poses a risk to the general population. Many have been the scenes of death due to drowning as unsuspecting individuals attempt to swim in cold, shallow abandoned open water pits that contain old mining equipment. Others perished by falling from dangerous highwalls as they navigate the woods on feet or all terrain vehicles (ATV). Abandoned mining equipment is an attractive playground for young children. These illustrate just a few safety hazards posed by AMLs. From 2000-2008, 250 non-employee mine fatalities occurred nationwide on both active and abandoned mine facilities (MSHA, 2009). Pennsylvania has the most deaths with 23 (Figure 1). Environmentally, the most significant impact of AMLs is the untreated discharge of acid mine drainage (AMD) (Bilek, 2004; Brake, Connors, & Romberger, 2001; Correa, Costa, & Koppe, 2003; Equeenuddin, Tripathy, Sahoo, & Panigrahi, 2010; Hammarstrom, Belkin, & Sibrell, 2003; Hawkins, 1994; Herman & Baumgartner, 1992; Jaynes & Pionke, 1984; Kim & Chon, 2001; Kimmel, 1983; Kumar-Vadapalli et al., 2008; Mayo, Petersen, & Kravits, 2000; O'Bara & Estes, 1985; Rahn, 1992; Rahmatian, 1990; Ramsey & Brannon, 1998; Saria, Shimaoka, & Miyawaki, 2006; Siriwardane, Kannan, & Ziemkiewicz, 2003; Smith & Skema, 2001; Stevens, McCarthy, & Vis, 2001; Wielder, 1993; Wu et al., 2009; Zalack, Smucker, & Vis, 2010). Untreated discharge entering streams can degrade both the habitat and water quality leaving an environment unsuitable for desired uses and void of aquatic life.

As a result of such hazards to the general population and environment, reclamation programs have been enacted to eliminate and restore

AMLs to their natural state. The agency that specifically designs reclamation projects and contracts for their implementation using federal grants and forfeited bonds is the Bureau of Abandoned Mine Reclamation (BAMR); an agency within the Pennsylvania Department of Environmental Protection (DEP). The bureau evaluates AMLs through site-specific visitations to determine their severity according to six major criteria: health, safety, drinking water, water pollution, land resources, and property (Table 1). A priority number from 1-3 is then assigned to each; 1 is the highest priority and 3 the lowest:

- Priority 1 (P1). An AML problem concerning the protection of public health, safety, general welfare, and property from extreme danger or adverse effects of mining practices of a condition that could reasonably be expected to cause substantial physical harm to persons or property and to which persons or improvements on real property are currently exposed.
- Priority 2 (P2). An AML problem concerning the protection of public health, safety and general welfare from adverse effects of mining practices or a condition that is threatening people but is not extreme danger.
- Priority 3 (P3). An AML problem concerning the restoration of land and water resources and the environment previously degraded by adverse effects of mining practices or a condition that is causing degradation of soil, water, woodland, fish, wildlife, recreational resources, or agricultural productivity as opposed to the well-being of people (PA DEP, 1997).

Currently, the bureau inventories 32,038 AMLs; 15.0% have been reclaimed while 85.0% remained abandoned (Table 2). According to the procedures established by United States (U.S.) Congress in Surface Mining Control and Recla-

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