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LAND INFORMATION *Bulletin*

from the National Consortium for Rural Geospatial Innovations
Chesapeake, Wilkes University and Kings College

Tackling Environmental Clean-up with GIS

Regionally Coordinated GIS Behind Master Plan for Pennsylvania Watershed

The Pennsylvania GIS Consortium is orchestrating an innovative program throughout central and northeastern Pennsylvania—a locally independent and regionally coordinated, multiple-purpose geographic information system (GIS). With support from the National Consortium for Rural Geospatial Innovations (RGIS), the program is designed to serve the diverse needs of local governments for regional planning, environmental protection and economic development. It involves various community leaders and programs, including those of the Upper Susquehanna-Lackawanna American Heritage River Watershed. Here, we follow the evolution of an environmental master plan for the watershed and the role of GIS in reclamation efforts.

The Upper Susquehanna-Lackawanna (US-L) Watershed in northeastern Pennsylvania covers 2000 square miles, incorporating 10 counties and 196 local governments. The Susquehanna River drains the largest basin on the Atlantic coast, contributing over half of all water that flows into the Chesapeake Bay ecosystem. Unfortunately, it is also the Bay's single largest source of industrial pollution.

The US-L Watershed has endured 150 years of ecological abuse—the result of heavy regional anthracite coal mining. Clean-up costs for this environmental legacy are estimated at over \$2 billion. In addition to the acid mine drainage (AMD), more than 200 combined sewer overflows divert wastewater (from a population of over 500,000 people) that mixes with urban runoff into the Susquehanna River during episodic storm events.

In 1998, President Clinton designated the Susquehanna as one of 14 American Heritage Rivers (AHR). As part of the regional AHR program, the Pennsylvania GIS Consortium began working on an environmental master plan. The plan was conceived as being regionally coordinated, while remaining locally independent. The GIS Consortium, a non-profit organization jointly administered by Wilkes University and King's College, has been working on the GIS master plan with the AHR Steering Committee, local community and watershed groups, and various federal, regional, state and local agencies.

The Upper Susquehanna-Lackawanna Watershed empties into Chesapeake Bay



Restoring the watershed to a healthier environmental state is vital to the region's physical and economic health.

Over 60 local communities endorsed the regional AHR proposal that included an environmental master plan. The plan highlights geographic information systems (GIS) and a watershed approach to help solve problems of economic redevelopment and environmental clean-up throughout the region. The environmental plan also recommended ways to address the "digital divide"—a technological gap separating many rural communities from urban centers—with information technologies such as GIS, coupled with outreach and education.

Demise of the Coal Mining Industry

Most of the environmental destruction from past coal mining predated state and federal environmental regulatory agencies, statutes and regulations. Even so, ecological devastation from anthracite coal mining in the US-L river ecosystem is perhaps unprecedented, even by 19th century "industrial-baron" standards.

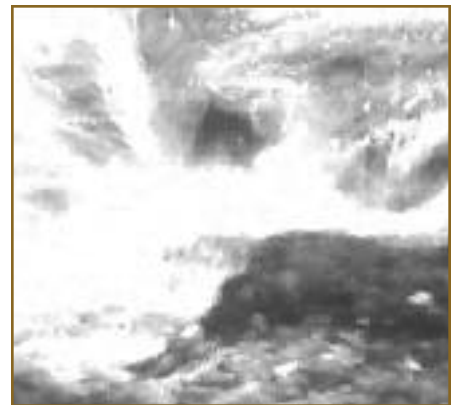
Improper mining techniques underneath the Susquehanna River (up to 900 feet deep beneath the river for over a 60 mile stretch of valley) eventually resulted in a unique disaster: a large "hole" in the river channel with a "runaway whirlpool" that drained 100,000 gallons/minute into the underground mine tunnels (Stranahan, 1993). In 1958, a rail line was diverted in an attempt to plug the giant cataract. More than 200 rail cars along with truckloads of rocks, railroad ties, utility poles and hay were dumped into the hole (see series below), disappearing without a trace. The Susquehanna soon had flooded almost all underground mines in that valley, abruptly halting the anthracite era.

After the demise of the mining industry in the area, limited reclamation efforts have not halted mine-water discharges into the Susquehanna River from the tunnels. In 1991, 100 sites had discharges that, collectively, accounted for 823 cubic feet per second (cfs) of acid mine drainage (AMD) containing heavy concentrations of sulfate, iron, manganese and other metals. (Wood 1996)

Elements of an Environmental Master Plan

In October 1999, the Pennsylvania GIS Consortium and the Army Corps of Engineers invited more than 400 local governments, agencies, and community groups to help map out the master plan for remediation efforts. The resulting plan has rendered a cohesive and coordinated GIS program that addresses issues and concerns of communities throughout the region. The plan focuses on three regional environmental problems—abandoned mine lands, acid mine drainage and combined sewer over-

These frames, captured from a 1958 video clip, show a rail car being swallowed by a "runaway whirlpool" in the Susquehanna River. More than 200 rail cars were dumped there in an attempt to plug the massive hole, which drained into the underlying mine system.



Community leaders, scientists and citizens meet to discuss the goals for the regional GIS program



The 100 largest mining outfalls, (sources of acid mine drainage) in the US-L Watershed.



flows—to be addressed in three phases. The phases do not need to follow a strictly defined timetable. Rather, they are designed to overlap and complement each other. High-priority areas can begin reclamation and redevelopment while data on other areas are being gathered and analyzed.

Gathering data

The first phase includes an inventory of cultural and environmental data in a way that can be integrated into the GIS to address the problems. A number of outreach meetings with the public, scientists, engineers, and community leaders helped to:

- define what data are available and needed for assessment and reclamation;
- identify gaps in information and data that require additional information-gathering and longer-term environmental measurements and monitoring;
- obtain and evaluate relevant ecological and watershed assessment tools; and
- develop a strategy for data acquisition, maintenance, and distribution on a local scale, utilizing concepts and the technology of Web-mapping GIS.

Forty-two tributary watersheds feed into the vast US-L watershed. We used both GIS and regional-scale remote-sensing imagery to assess and evaluate the tributary systems along with the main river corridor. Seven watershed indicators were used to rank selected streams with urban and mining activities relative to four reference streams in the US-L Watershed. Input from a series of public meetings, under the AHR program and the master plan outreach activities, helped identify appropriate regional data, problems of local concern, and the GIS approach to be used.

After locating the 100 largest mining outfalls (acid mine drainage from deep "mine-pool" sources or abandoned mine shafts)(see figure) in the watershed, we incorporated the data into our regional GIS. Further analysis ranked the impacted watersheds based on the amounts and strengths of acidity, iron, and pollutant loading in the river and tributary streams.

The Next Phases

The second phase, now under way, focuses on acquisition of new data needed to conduct a more-thorough analysis to assess accurately the watershed as an entire ecosystem. This information will help engineers plan for the necessary reclamation activities. Information that needs to be updated includes local-scale aerial photography (to provide information for water-flow modeling and ownership of mine lands), satellite imagery (to show land use), soils data, and water-quality and stream-flow monitoring. The cost estimate for this phase is \$30 million.

The third phase will integrate this information with modeling analyses and assessments to establish the most critically needed restoration locations. This phase will also maintain monitoring efforts in the field to track the recovery and success of reclamation activities from a comprehensive ecological approach.

Distributing the Data

Because the watershed is vast and remediation efforts involve many local and regional players, making data easily accessible was a priority. Web-based GIS represents the

About RGIS

The National Consortium for Rural Geospatial Innovations—Chesapeake at Wilkes University and King's College is a USDA program designed to promote the use of geospatial information and technologies by communities in rural America. RGIS is dedicated to helping communities understand the concepts and benefits of using geospatial data as well as assisting them in all aspects of GIS development.

"leading edge" in GIS technologies and allows anyone with a conventional Internet "Web Browser" to access GIS data and maps from various sources. Phase I of the environmental master plan developed a strategy for implementing Web-based GIS in Phases II and III. As part of the master plan, the Consortium has hosted several community meetings of selected GIS users to address the region's GIS data distribution needs.

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