MODELING RECLAMATION PRIORITIES OF ABANDONED MINES IN NEW MEXICO

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We are collaborating with state, federal and tribal agencies to inventory and prioritize the reclamation of abandoned coal and legacy uranium mines in New Mexico.
Introduction

New Mexico has a legacy of abandoned or inactive uranium and coal mine sites.

We use the results of ESRI GIS spatial analyses and model building as preliminary decision-making tools in planning site risk assessments and reclamation.
Analysis Approach

Projects
- Legacy Uranium Mine Inventory Project
- Gallup Coal Inventory Project

Two scales of analysis for each project
- State-wide
- Regional site assessments
Legacy Uranium Mine (LUM) Inventory Project

Collapsed shaft

Waste piles
Background

- Over 333 million pounds of $U_3O_8$ mined 1940-2002 in New Mexico.
- Most uranium mines operated and closed with no reclamation requirements or guidelines, leaving a legacy of radiological contamination.
- Inventory purpose: determine the extent & magnitude of the occurrence of LUMS in NM, especially those that have not been previously addressed by a tribal, federal or state entity.
- Goal: determine appropriate means/remedy for rendering sites safe to humans & returning sites to beneficial use, including a self sustaining ecosystem.
LUM Prioritization Model
State Scale (133 sites on non-tribal lands)

Data Sources
- Digital imagery
- Literature Data

Input Variables
- Open Hazards on site
- Stream Proximity
- Wells within 1.5 miles
- Urban Areas within 5 miles
- Agricultural Areas within 5 miles

Model
- ArcINFO 9.3.1 Tools & ModelBuilder

Model Output
- Output Raster & Feature Class

Geoprocessing Flow Involved in the ModelBuilder Creation

- Documents the process.
- Makes analyses more repeatable. Add new variables, modify spatial statistics and rerun the model.
ModelBuilder Final Steps – Weighted Overlay Spatial Analysis Tool
Weighted Overlay Dialog Box

- Overlays all the rasterized variables using common ranking scale.
- Weighted each according to importance (percent influence). Streams and wells received higher weights.
Ambrosia Lake Final Priority Ranking – State-wide Analysis
Priority Ranking – Unprotected Hazards

Final Priorities (LUM Surface Disturbances)
- Low
- Med High
- Med Low
- High
- Wells
- Streams (164 foot buffer)
Priority Ranking – Proximity to Streams
Priority Ranking – Wells within 1.5 miles
Priority Ranking – Urban Areas within 5 miles
Priority Ranking – Agricultural Areas within 5 miles
LUM Prioritization Model – Site Assessment Scale (Pilot Study 2008-09)

Data Sources: Digital imagery, Literature Data, Field Data

Input Variables: Open Hazards, Radiation Readings, Well Locations, Drainages, Dwellings

Model: ArcINFO 9.2 Tools

Model Output: Output Feature Class

Methods

Additions to the State-wide Analysis

- GPS collection of unsafeguarded hazards
- Radiation sampling (Gamma exposure rates [mR/h] at ground contact)
- Delineation of buildings seen in aerial photos
- Delineation of detailed drainage
Methodology: Unsafeguarded Hazards
Located with GPS
## Methodology: Radiation Readings Scoring

<table>
<thead>
<tr>
<th>Radiation reading (µR/hr)</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 15</td>
<td>Background</td>
<td>0</td>
</tr>
<tr>
<td>15 – 20</td>
<td>Background to Low</td>
<td>10</td>
</tr>
<tr>
<td>21 – 100</td>
<td>Low to Moderate</td>
<td>20</td>
</tr>
<tr>
<td>101 – 300</td>
<td>Moderate to High</td>
<td>30</td>
</tr>
<tr>
<td>301 – 450</td>
<td>Moderate to High</td>
<td>40</td>
</tr>
<tr>
<td>&gt; 450</td>
<td>High</td>
<td>Additional weight</td>
</tr>
</tbody>
</table>
Methodology: Radiation Readings
Methodology: Proximity to Nearest Drainage
Methodology: Proximity to Dwellings
Ambrosia Lake Final Priority Ranking

Final Priorities
Rank of scores: 1 = high to 4 = lower priority

- Red: 1 = Domestic Wells
- Yellow: 2 = Solitary Dwellings
- Light Yellow: 3 = Drainage
- Orange: 4 = Domestic Wells

Legend:
- Red Bluff No. 1
- Barbara J No. 1
- Barbara J No. 2
- Barbara J No. 3
- Barbara J No. 3a
- Blue Peak
- Beacon Hill-Gossett
- Beacon Hill
- Davenport
- Malpais
- Dog
- Mesa Top
- Flea
- Piedra Trieste
- Flat Top
- T-20
- Moe No. 4

Scale: 0 - 1.5 miles
NAD83 UTM NM zone 13
Other Top Priority Ranking Sites

Two High Priority Sites
Rank of scores: 1 = high to 4 = lower priority

- Domestic Wells
- Drainage
- Solitary Dwellings
- Dense Dwellings

NAD83 UTM NM zone 13
Gallup Coal Inventory Project

Weaver Mine, Gallup, NM circa 1910
(Courtesy of New Mexico Bureau of Geology & Mineral Resources)
Background

- Estimated more than 15,000 abandoned mines in New Mexico. Much of the state needs to be inventoried.

- The Gallup Coal Field District was the site of underground coal mining in the early 1880’s to late 1950’s.

- Old workings within and outside of Gallup city limits. Subsidence a problem since the 1980’s.

- At this site, reclamation work done by NM AMLP in the 1980-1990’s needed revisiting.
AML Coal Inventory Prioritization Model – State Scale Analysis of Coal Mining Districts

Data Sources

Input Variables

Model

Model Output

Density of

Road Lines

Well Count

Population Centers

Urban Areas

Agricultural Areas

Feature Classes

Data: ESRI, US Geological Service, US Census Bureau, SWReGAP Program, NM Office of State Engineer, NM Bureau of Geology and Mineral Resources

ArcINFO 9.3.1Tools & ModelBuilder

Output Raster & Feature Class
Results – Priority Coal Districts

- Gallup Coal Field District ranked medium-high in priority based on un-weighted sum of model variables.
- Chosen by NM AMLP for mine feature inventory and reclamation prioritization.
- Factors that elevated rank – AMLP previous work locale, the Gallup population and the subsidence issues of old Coal mine workings.
Gallup Coal District and Land Ownership

Surface ownership and percent of the district area.

Federal – 8%
Private – 14%
State – 2%
Tribal – 76%
Landownership Composition of Gallup Coal Field Compared to All Coal Districts (n=30)

- Gallup Coal Field District is one of six coal districts in which Tribal Lands comprise > 75% of its area.
Tetra Tech Albuquerque Contracted to Inventory and Prioritize Gallup Coal Field

Goals are to record location data of mine features with GPS (global positioning system) and prioritize sites for purpose of mitigating hazards.

Tasks:
- Preplan data collection and arrange access to sites
- Locate, GPS, photograph and document
- Create data management system
- Prioritize, rank and report findings
Map of Gallup Area – In-progress Site Assessments


- Features will be revisited and the coal field district inventoried.
Prioritization Criteria Development by Tetra Tech and NM AMLP.

Two tiered prioritization

- Ranking based on Federal (Office of Surface Mining Reclamation and Enforcement) scoring criteria.

- NM AMLP detailed criteria based on geospatial measurements.
Inventory Data Management

- Field forms integrated with the inventory database (MS Access)
- Geodatabase to store GIS features
- Automatic priority ranking system
Future Work

- Expand the regional input variables in the model to include the number and volume of waste rock piles, depth to groundwater, location up/down gradient to wells and radiation at surface contact.
- Investigate and include variables of site accessibility, land ownership and geographic proximity.
- Expand AML Coal Inventory to other districts.
Acknowledgements

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- Our Team of Contractors – Tetra Tech Albuquerque and their GIS Manager, Simon Cardinale (Coal Inventory) and INTERA and their GIS Specialist Chris Park (LUM Inventory).
- All photos were taken by the Ne Mexico Abandoned Mine Land Program.