

Feasibility Analysis of Abandoned Mine Reclamation Projects in the United States

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Outline

- Problem Statement
- Proposed Solution
- Pilot Program
- GIS Application
- Results
- Conclusions

Problem Statement: Abandoned Mines

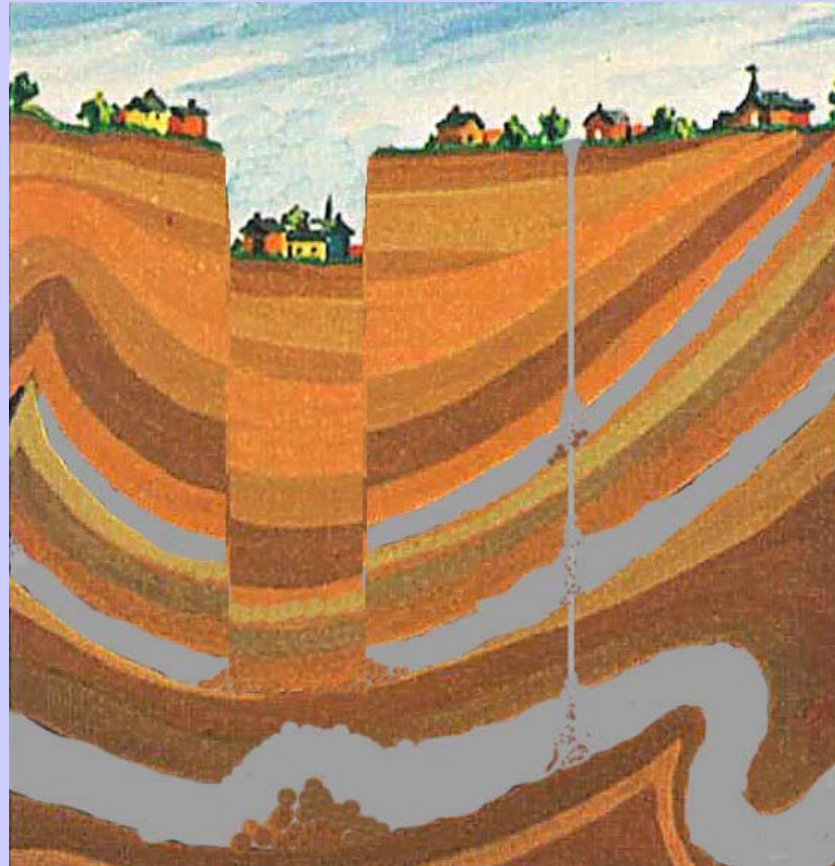
- Acid Mine Drainage (AMD)
- Subsidence
- Mine Fires
- Tailings
- Alteration of Physical Landscape

Problem Statement: Abandoned Mines



Acid Mine Drainage (AMD)

Problem Statement: Abandoned Mines



Subsidence of Terrain

Problem Statement: Abandoned Mines



Mine Fires

Problem Statement: Abandoned Mines



Tailings

Problem Statement: Abandoned Mines



Alteration of Physical Landscape

Problem Statement: Dredge Material Disposal

- High Volumes
- Ecological Impacts
- Transportation



Problem Statement: Coal Fly Ash

Problems:

- High Volume
- Transportation

Characteristics:

- Coal Combustion Product (CCP)
- Cementitious
- Alkaline (High pH)

Proposed Solution

Problem Summary: Fly ash and dredged material have to be disposed in high volumes.

Solution: Mix dredged material and fly ash and dispose of them in abandoned mines

Benefits:

- Alkalinity of fly ash suppresses the acidity of drained waters from mines.
- Weak cementitious product with low permeability.
- Railroads provide cost-effective transportation
- Filled mines provide basis for the reclamation projects on restoring land cover.

Pilot Program: Bark Camp, Pa



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- Cooperative effort among:
 - Pennsylvania DEP
 - Columbia University's Lamont-Doherty Earth Observatory
 - NY/NJ COAST

Ramifications of Bark Camp Experience

The experience at Bark Camp provides model for other sites in USA where abandoned mines, dredging and fly ash materials can be utilized for mine reclamation.

These sites can be found using Geographic Information System (GIS). The project requires the choice of GIS and spatial analytical function. The following methodology describes project components and results.

GIS Application: What is GIS?

Geographic Information System – computerized system for storing, displaying and analyzing geographically referenced data.

GIS Data Formats:

- Vector Data vs. • Raster Data
 - Lines
 - Polygons
 - Points
 - Grid (Pixel)

GIS Application: Choice of GIS Data Format

Raster data format provides background for the discretization of space while vector data can represent only separate or contiguous objects in space.

Advantage: Raster GIS covers space completely in specified order (i.e. # of rows, # of columns, cell size).

Disadvantage: Redundancy of pixels with the same values and large data sets.

GIS Application: Analytical Functions for Raster Data

- Local
 - Functions applied to one cell or pixel
- Global
 - Functions applied to the whole grid
- Focal
 - Functions applied to the cell neighborhood

GIS Application: Local Functions

Grid 1

73	79	76	72	76	79
77	78	73	69	71	75
79	75	70	66	67	70
76	72	67	63	62	66
73	69	64	60	58	62
70	66	61	57	54	57

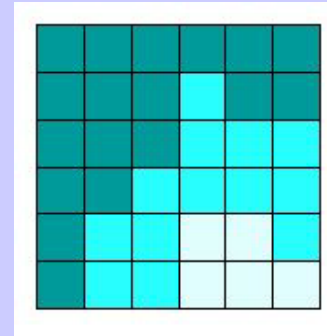
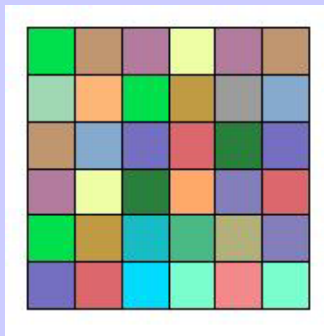
If Value,... New Value...

Grid 1,	Grid 2
50 – 60,	1
61 – 70,	2
71 - 80,	3

Grid 2

3	3	3	3	3	3
3	3	3	2	3	3
3	3	3	2	2	2
3	3	2	2	2	2
3	2	2	1	1	2
3	2	2	1	1	1

Unique
Values



Classes

GIS Application: Global Functions

“Input” grid

73			72		79
77				71	
	75	70			
76		67		62	66
	69				62
	66		57	54	

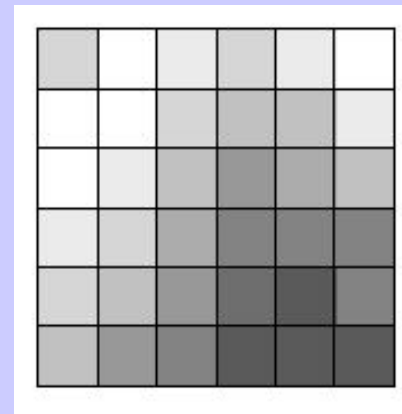
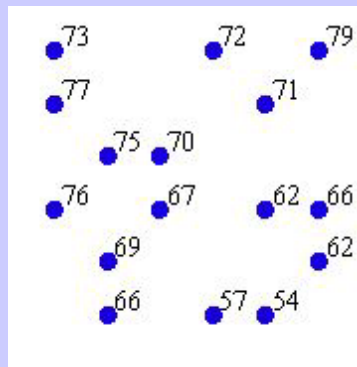
Spline function creates the surface while preserving original “input” values.

It uses mathematical function that “fit” surface through all “input” points.

“Output” grid

73	79	76	72	76	79
77	78	73	69	71	75
79	75	70	66	67	70
76	72	67	63	62	66
73	69	64	60	58	62
70	66	61	57	54	57

Discrete values



Surface

GIS Application: Focal Functions

“Input” grid

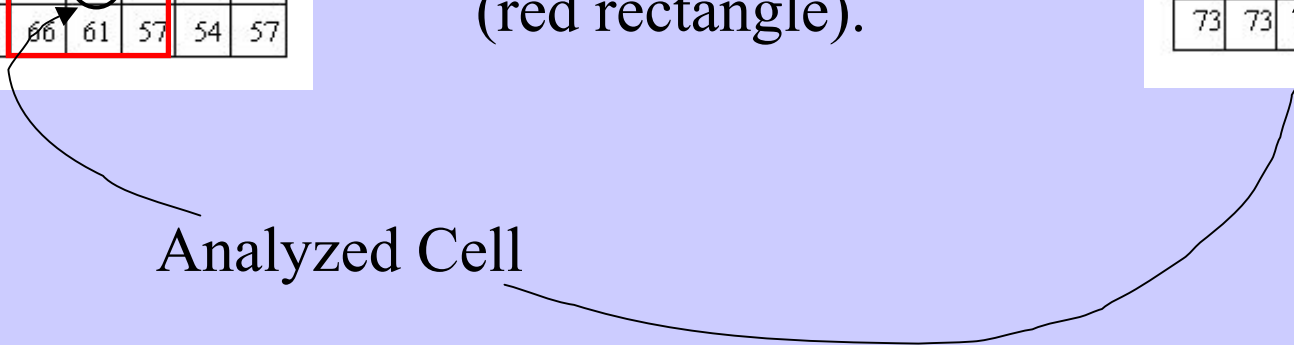
73	79	76	72	76	79
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76	72	67	63	62	66
73	69	64	60	58	62
70	66	61	57	54	57

Neighborhood consists of number of surrounding cells. (red rectangle).

“Output” grid

79	79	79	76	79	79
79	79	79	76	79	79
79	79	78	73	75	75
79	79	75	70	70	70
76	76	72	67	66	66
73	73	69	64	62	62

Analyzed Cell



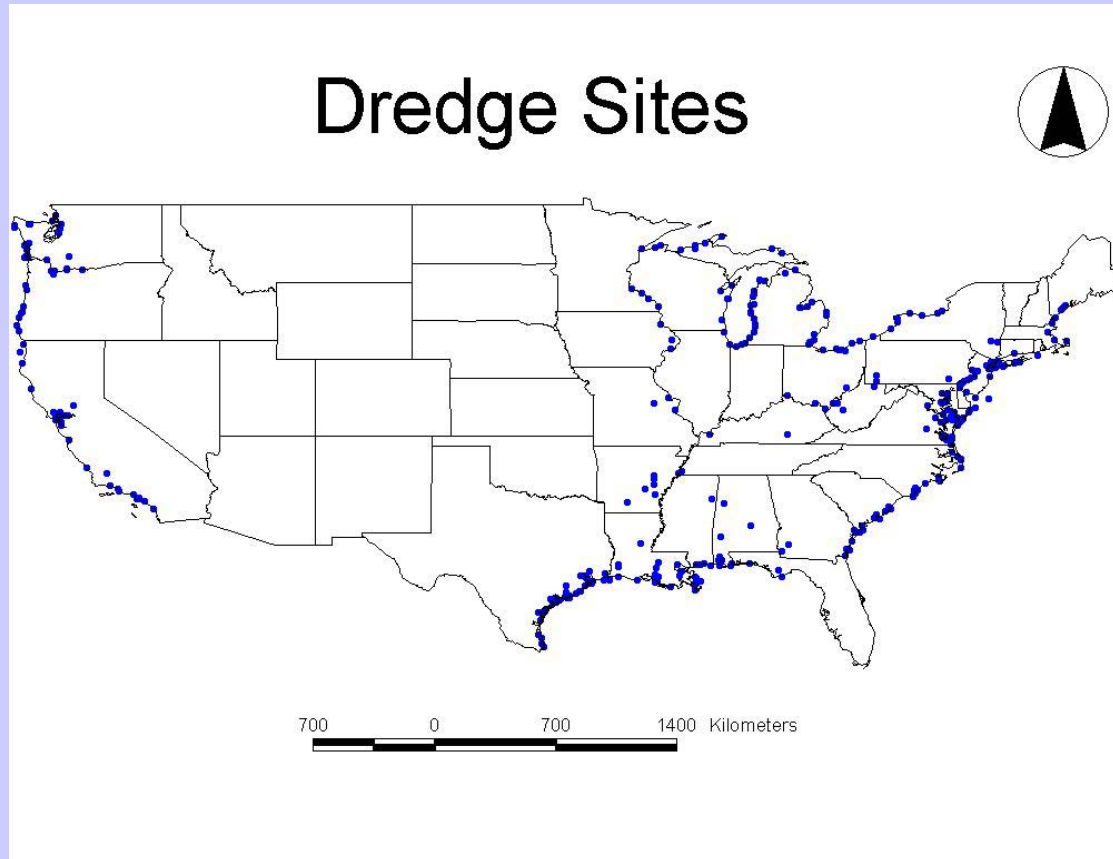
GIS Application: Selection of Analytical Function

Focal Function: FOCALVARIETY (looks for unique occurrences of grid values)

Main Idea:

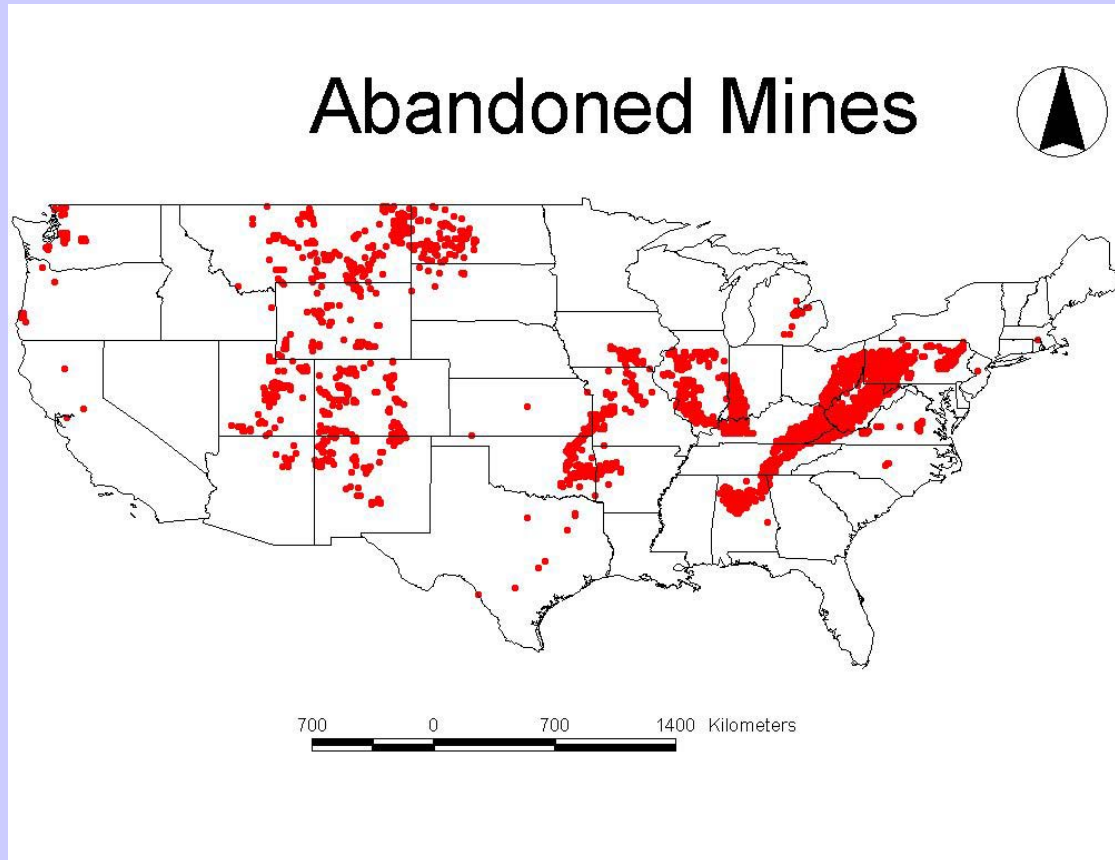
1. Break USA into grid (1x1 km)
2. Search for unique occurrences of GIS data coded (within radii of 20, 40, 60, 80, 100 km. around abandoned mines locations)

GIS Application: Data Collection



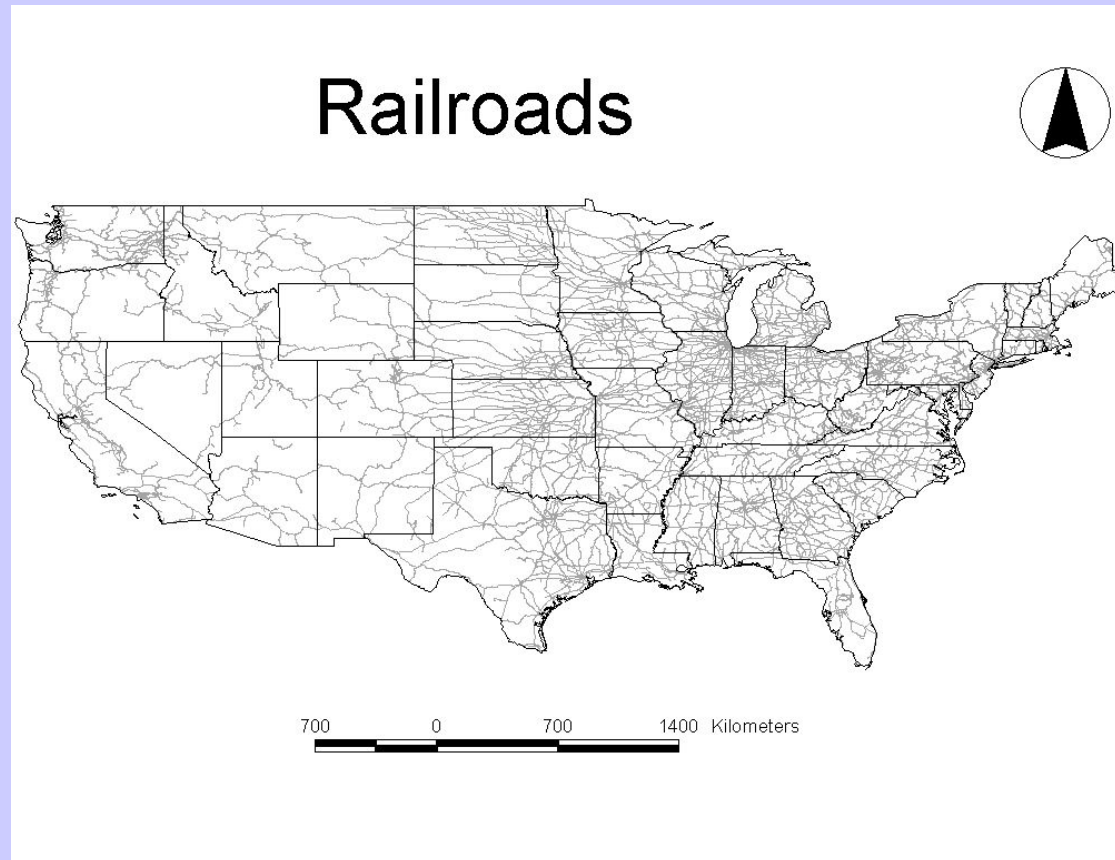
Data Source: U.S. Army Corps of Engineers

GIS Application: Data Collection



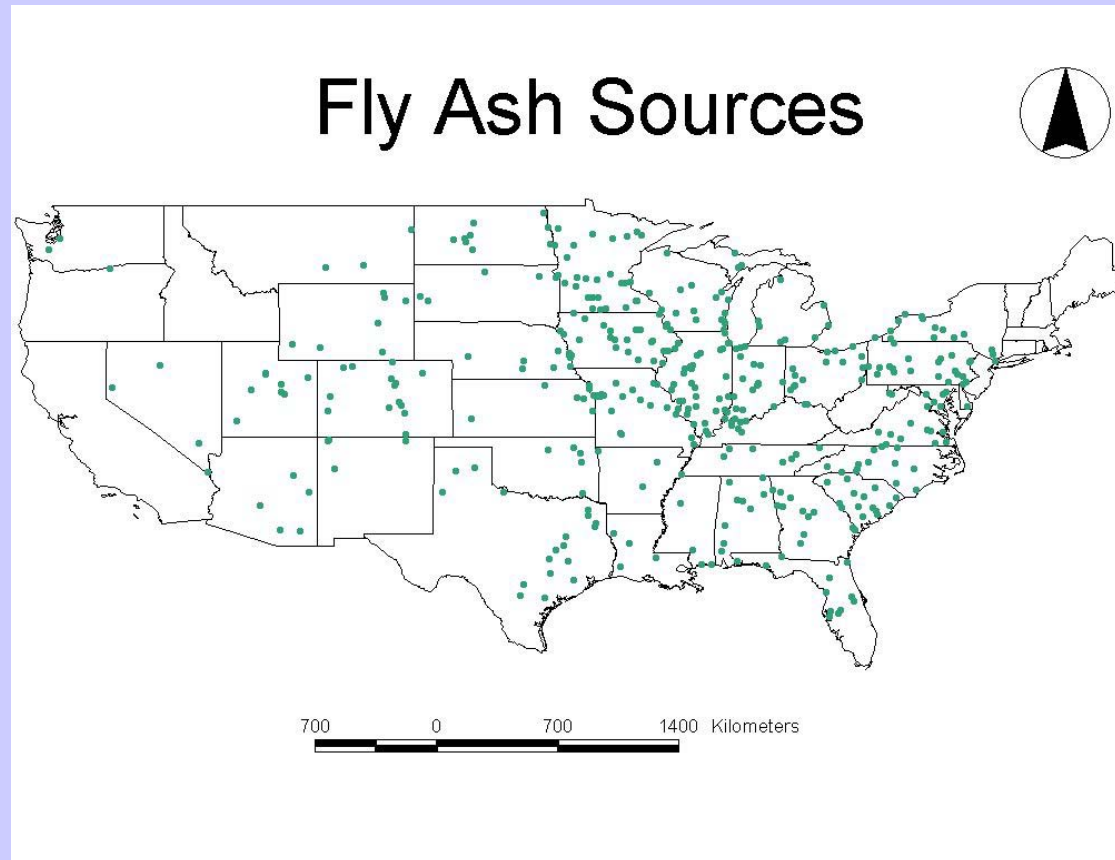
Data Source: U.S. Geological Survey

GIS Application: Data Collection



Data Source: U.S. Geological Survey

GIS Application: Data Collection

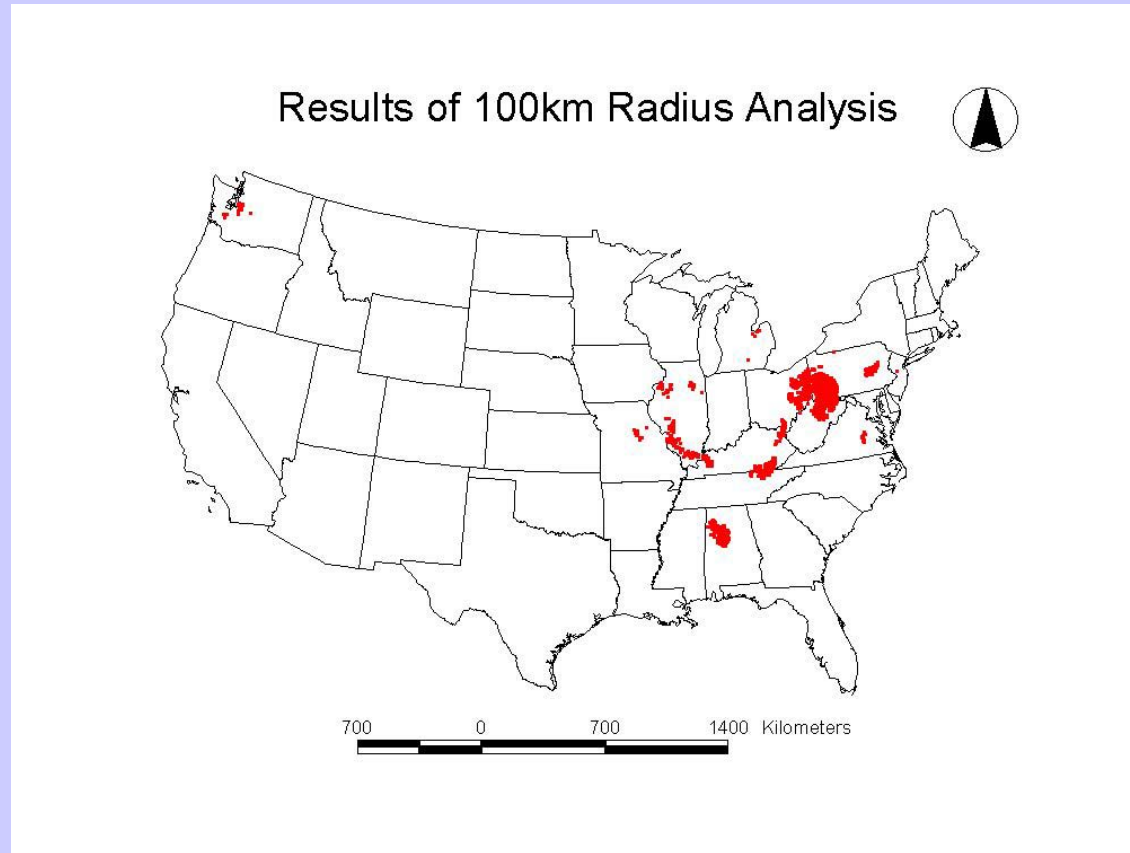


Data Source: Environmental Protection Agency/ESRI Zip Codes

GIS Application: GIS Procedures

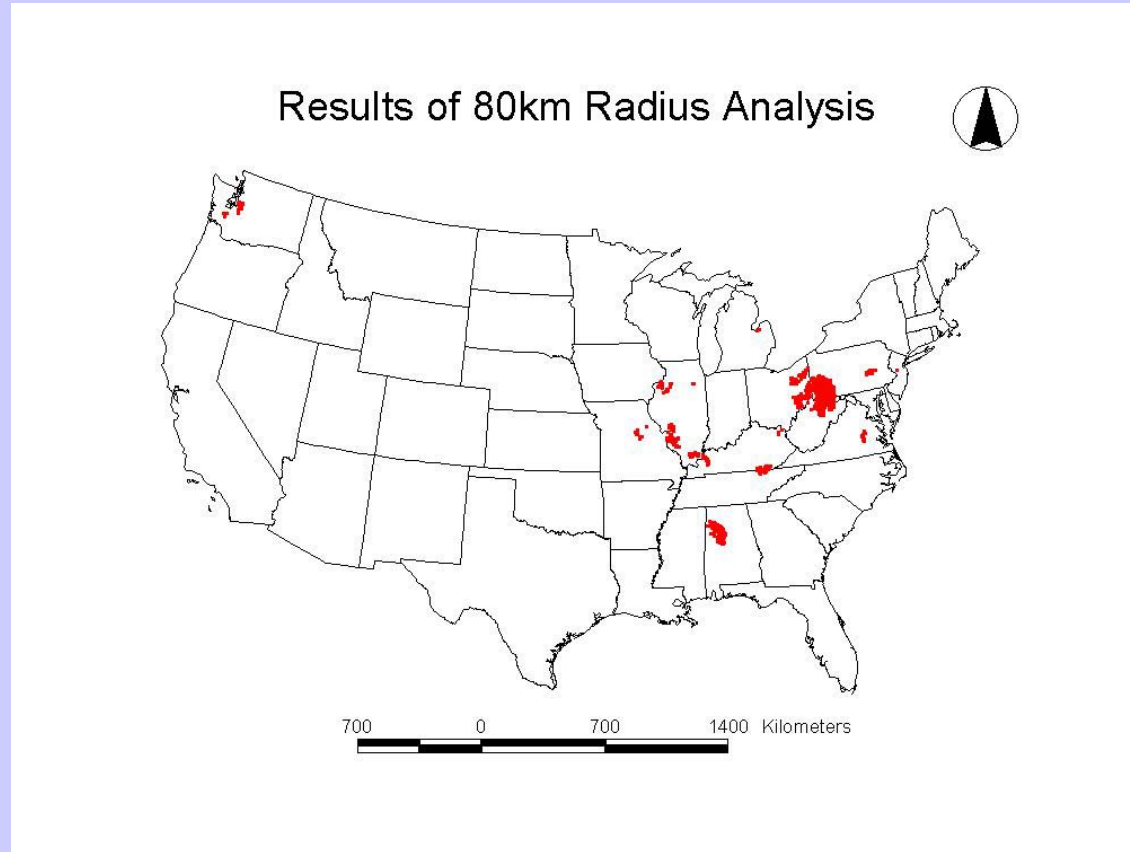
- Vector to Raster Data Conversion
- Re-projection
- Building data sets: setting pixel size and merging data
- Run the **FOCALVARIETY** function: setting search radii
- Visualization of results

Results



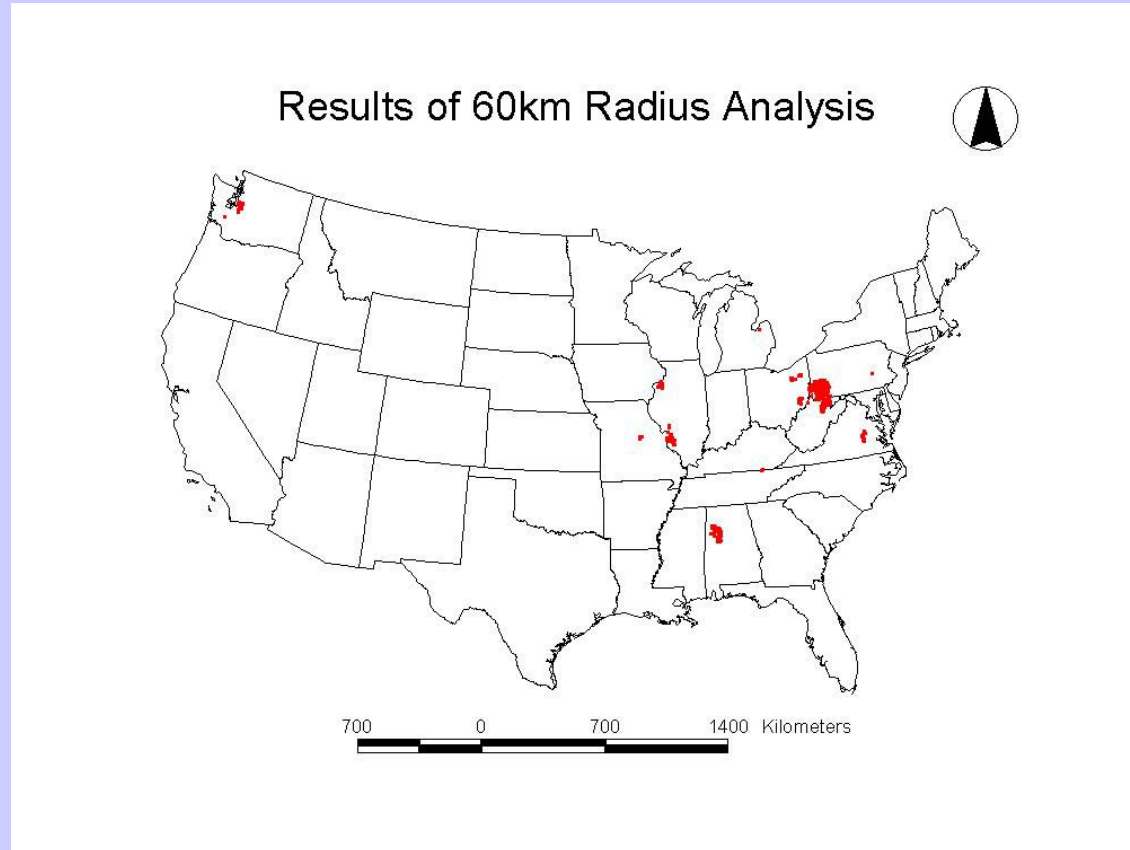
There are 6941 Abandoned Mines meeting the analysis criteria of 100km.

Results



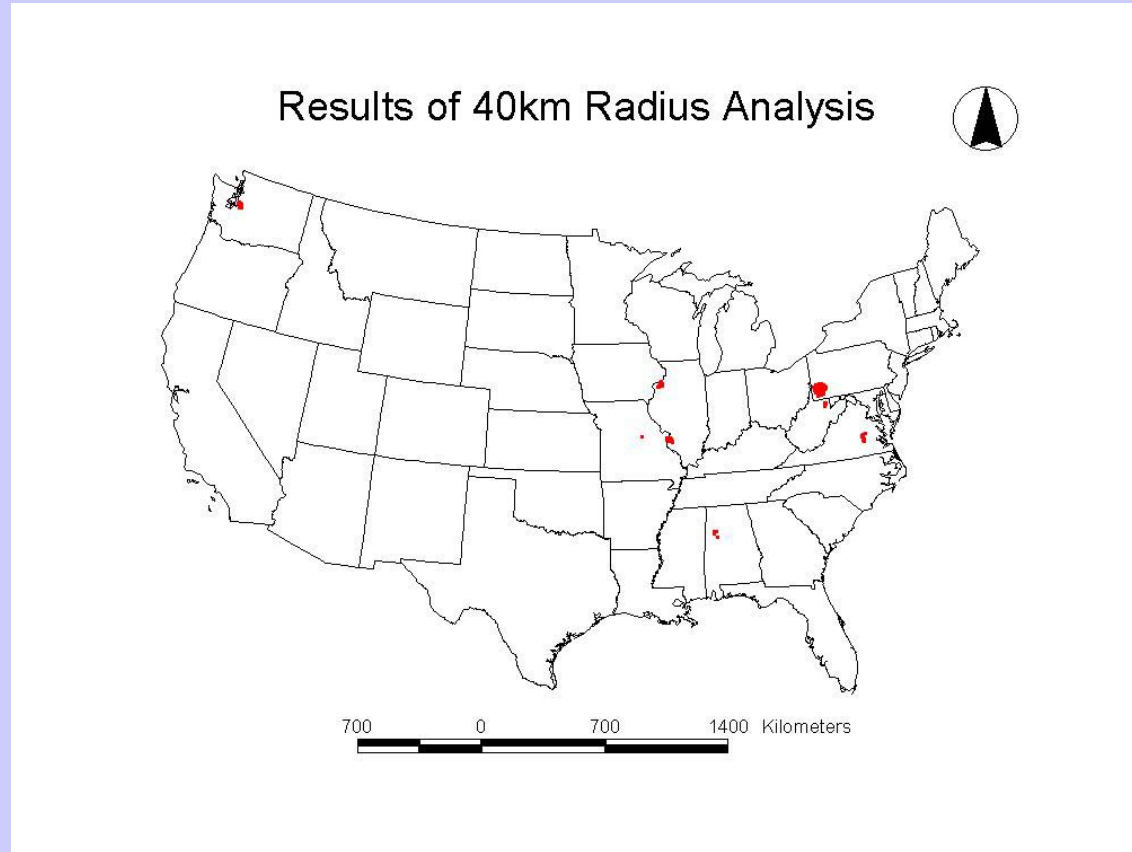
There are 4408 Abandoned Mines meeting the analysis criteria of 80km.

Results



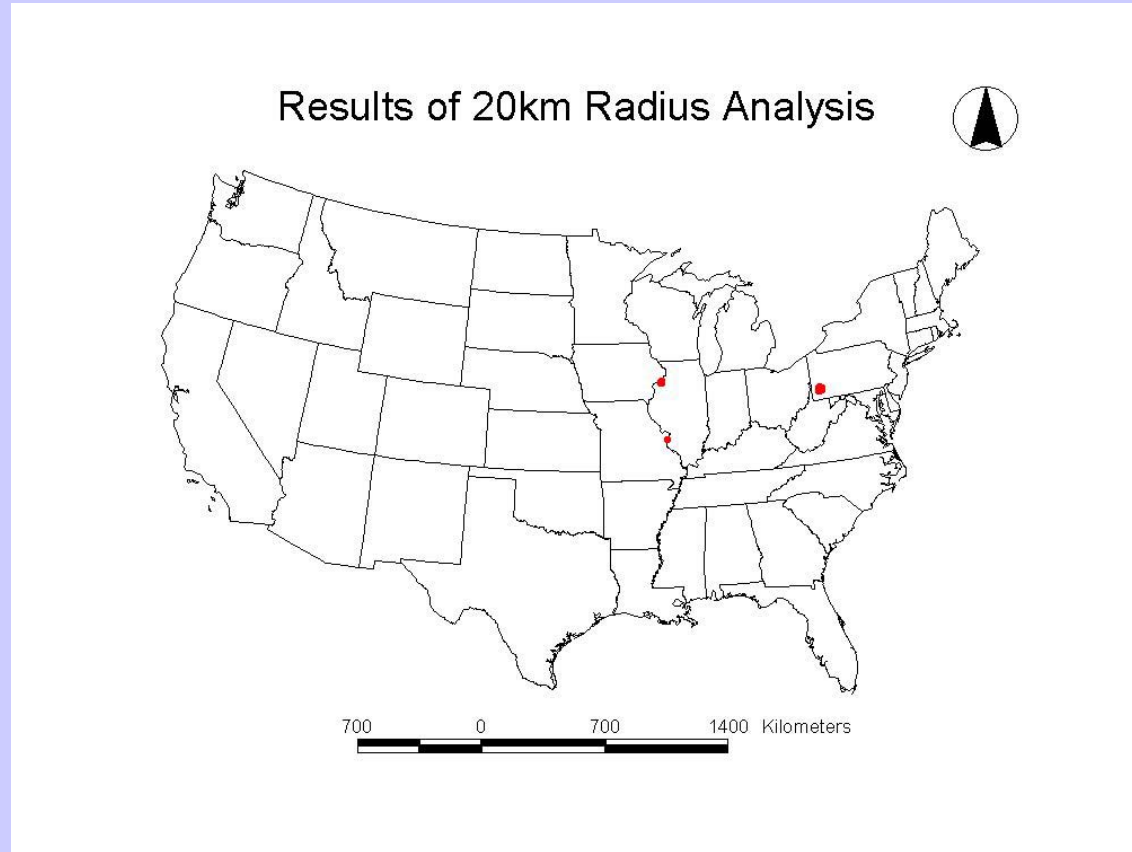
There are 1543 Abandoned Mines meeting the analysis criteria of 60km.

Results



There are 537 Abandoned Mines meeting the analysis criteria of 40km.

Results



There are 94 Abandoned Mines meeting the analysis criteria of 20km.

Conclusions

- GIS raster data format offers efficient analytical technique that allows to find occurrences of unique values over large areas.
- Increase in radius causes increase of number of occurrences of data combination
- Primary states for the mine reclamation project are: West Virginia and Pennsylvania
- Other states are: Alabama, Illinois, Ohio and Kentucky

Acknowledgements

- NY/NJ COAST
- U.S. Army Corp. of Engineers
- United States Geological Survey
- Environmental Protection Agency
- ESRI