Alabama Surface Mining Commission Mining Geographic Information System[1]

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Abstract. The Alabama Surface Mining Commission (ASMC), Geographic Information System evolved due to a petition to set Total Maximum Daily Load limits in the Hurricane Creek watershed located in Tuscaloosa County, Alabama. To protect the interests of the State, the ASMC assisted in the characterization and assessment of mining impacts in the watershed by developing a database of digital geographic data. This exercise led to a complete overhaul of the ASMC data information system and the development of a mine related geographic information system. This system integrates GIS capabilities with virtually the entire regulatory program; including permitting, inspection and bond release. The final phase of project development will center on access and utilization of the GIS data in field applications using mobile computing technology.

Additional Key Words: GIS, TMDL, Hurricane Creek

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Introduction

The Alabama Surface Mining Commission (ASMC) is the Title V regulatory authority for coal mining in Alabama. The ASMC has issued over 600 coal mining permits since obtaining primacy under the federal Surface Mining Control and Reclamation Act (SMCRA) in 1982. Prior to that, the state had issued over 2000 mining permits under previous state laws and the federal Interim Regulatory Program. Data management consisted of hard copy filing systems and a dBase computer database of permit related information but no digital repository of mapping data. The ASMC acquired computer software in the early 1990's to assist in the evaluation of pollution abatement facilities but very little use was made of CAD or GIS software. In 1999, a petition was filed with the U.S. Environmental Protection Agency (EPA) requesting that the agency assume jurisdiction of the Alabama impaired waters listed under section 303(d) of the Clean Water Act. The petition also requested that EPA establish Total Maximum Daily Load (TMDL) limitations for impaired waters. One of the streams involved in this process was Hurricane Creek located in Tuscaloosa County, Alabama. This 74,000 acre watershed is located in the heart of the state's leading coal producing county. Both surface and underground coal mining and limited iron ore mining have occurred in the watershed since World War II. Surface coal mining has been most prevalent from 1970 to the present. Pre- SMCRA mining operations left the watershed severely impacted due to siltation and acid mine drainage. In the last decade of the 20th century, the watershed was also the focus of considerable coal bed methane exploration and production. Given the importance to the State in terms of coal and coal bed methane production, Tuscaloosa County government and industrial development authorities, in conjunction with state government agencies, including the ASMC, took a proactive roll in the TMDL petition process from the beginning. The ASMC volunteered to map the watershed and delineate the scope of mining impacts to assist in the evaluation of the TMDL petition. This exercise revealed the importance of building a Geographic Information System (GIS) for coal mining and the inadequacies of the ASMC data management system.

The Hurricane Creek Project

Prior to beginning this project, the ASMC had no digital mapping or geographic data of mining related projects anywhere in the State. The agency did however possess limited CAD and GIS software. Using AutoCad and ArcView software, mine maps dating from the 1960's to present day, were manually digitized and watersheds delineated. Base maps were constructed using data from the EPA BASINS software package. Aerial photographs taken over three decades were scanned and geo-referenced into a base map coordinate system. Additional digital map data were acquired through a variety of public domain sources. NPDES outfall and in-stream water sampling stations were digitally located in the database along with sampling results. Throughout this process, the ASMC staff educated themselves in the basics of GIS design and use. The end product was a GIS dataset which defined the scope and impact of mining in the watershed. EPA used this database to evaluate the Hurricane Creek petition and eventually established TMDL's for the watershed which properly reflected coal mining impacts.

This exercise demonstrated to the ASMC that it must upgrade its data processing hardware and software and develop a GIS for the entire coal producing region of the State.

ASMC GIS Development

Upon completion of the Hurricane Creek project, the ASMC began a five year program to upgrade its entire computer system and develop a coal field GIS. This program had six primary objectives:

1. The digital storage and retrieval of geographic mine data;
2. The integration of the primary (primary or primacy?) mine permit database with the geographic data;
3. Facilitate digital permit applications;
4. Improve the analysis and review of mine permit applications;
5. Facilitate the integrated assessment of mine impacts;
6. Migrate the digital data to field inspectors.

The process began with a complete overhaul of the computer hardware, network, and operating software. Over a six month period, ASMC installed a new server, switched from a Token-Ring network operating Netware to an Ethernet network operating Microsoft NT, and acquired new workstations. The primary (primary or primacy?) permit database system was converted from dBase to Microsoft Access and acquisition of a new GIS and upgraded CAD software. At the same time, two staff engineers began to vectorize the 600 plus maps associated with all primacy permits. Base map GIS data were acquired from various sources covering the entire state and specifically the bituminous coal producing region. Additional data were later acquired for the Lignite bearing regions of the state. Most of the data was public domain; costing the agency nothing although some data was purchased from commercial vendors. Regardless of the source, metadata were acquired or created for every dataset. During the process, the entire GIS was migrated from ArcView to ArcGIS 8.3. This migration allowed integration of the GIS dataset with the primary mine permit database which operates using Microsoft Access. The primary mine permit database was also expanded to include reclamation, bonding, and inspection and enforcement documentation as well as hydrologic monitoring data. ArcGIS Desktop features such as the ability to re-project data in different coordinate systems “on-the-fly” added flexibility; especially data collection from different sources.

An important adjunct to this project was the development of digital permit applications. Lacking the time and resources to accomplish this task, the ASMC encouraged engineering consultants for the mining industry to develop their own e-permit application form and submit for approval. (Only one consultant submitted a customized form but the format was accepted by ASMC; that firm has submitted its applications exclusively since 2001.)

The final objective, migrating the GIS to field applications, has not yet been fulfilled due to questions surrounding the cost and durability of equipment.

Features of the ASMC GIS

Seventeen of 67 counties in Alabama currently produce bituminous coal. Twelve other counties contain lignite deposits that have been explored but not mined. At present, the ASMC GIS consists primarily of data from the bituminous coal counties with additional data collection in the lignite region. In addition to geographic boundaries, man made features, water resources and other statewide data, the system features many mine specific vector data sets unique to the coal region. All mine permit boundaries, mine roads, and sediment control ponds are stored in the system. Abandoned mine land boundaries and AMLIS database locations are also stored in the system. County soil survey data, coal quality sample data and other geo-chemical data are included in the system. National Geodetic Survey points are included in the database and enable the user to access data sheets for all benchmarks in the state of Alabama. State-wide raster data sets include digital orthoquads, 1/24000 topographic maps, and digital elevation models for the entire region.

One of the interesting features of ArcMap is the ability to include hyperlinks in the map, allowing access to websites or documents produced by other programs. The ASMC GIS features several applications of the hyperlink feature to assist the user. For example, all USGS water quality stations are stored in the database. Each is hyperlinked to the USGS WATSTORE web site. A simple mouse click on the point location brings up the website and directs the page to the appropriate sample station data in the WATSTORE database for instant viewing.

Another application of the hyperlink feature is the link to mine inspection reports and performance bond transaction reports stored in the ASMC primary Microsoft Access database. Each mine has a hyperlink for each of these reports. A mouse click on the link activates a Microsoft Access query-driven report for a specific mine. This allows the user to view all mine inspection reports by clicking the hyperlink associated with each point feature.

Another useful feature is the ability to use a hotlink VBA script in ArcMap for instantly loading raster or vector datasets to the map. This feature allows the user to click on a point in an index map and instantly load a raster or vector map into the ArcMap base map. This feature is used in the ASMC GIS to load USGS topographic maps, county wide soil survey maps, digital elevation models and other datasets which would otherwise clutter up the base map if kept permanently loaded. Once loaded by this method for a specific inquiry, the dataset can then be deleted from the map when no longer needed. Examples of this type of hotlink script can be found on the ESRI website and modified to the user's specific needs. This feature may be used to load vector or raster datasets. (The Appendix contains two sample VBA scripts as examples of Hotlink loaders for a raster dataset and a vector dataset.)

The hotlink feature along with the other ASMC GIS features allow our agency to fully utilize the digital data contained within our databases. The ability to integrate spatial and non-spatial data is a valuable asset. The migration of this system to the field inspector in conjunction with GPS will place a valuable tool in the hands of ASMC personnel.

Appendix

Example 1. Hotlink VBA script for a raster dataset.

This script loads a geo-referenced USGS topographic quadrangle map in TIFF format.

```
Sub HotlinkImage(pLink, pLayer)


On Error GoTo eh:

  Dim pHyperlink As IHyperlink
  Set pHyperlink = pLink
  Dim pFLayer As IFeatureLayer
  Set pFLayer = pLayer
  Dim m_pMxDoc As IMxDocument
  Set m_pMxDoc = Application.Document
  Dim pMap As IMap
  Set pMxDocument = Application.Document
  Set pMap = m_pMxDoc.ActiveView.FocusMap
  Dim pRasterLayer As IRasterLayer
  Set pRasterLayer = New RasterLayer
Dim pGroup As IGroupLayer
Set pGroup = New GroupLayer
Dim pmapLayer As ILayer
Set pmapLayer = New RasterLayer
Dim i As Integer

  ' create IRasterLayer
  pRasterLayer.CreateFromFilePath pHyperlink.Link
Set pmapLayer = pRasterLayer


For i = 0 To pMap.LayerCount - 1

       If pMap.Layer(i).Name = "DRG" Then 'Set Group layer
          Set pGroup = pMap.Layer(i)
       End If
Next i

pGroup.Add pRasterLayer

  ' add layer to current view
 ' m_pMxDoc.AddLayer pRasterLayer
```

```
pGroup.Expanded = True
pGroup.Visible = True

 m_pMxDoc.ActiveView.ContentsChanged
 m_pMxDoc.UpdateContents
 m_pMxDoc.ActiveView.Refresh


  Exit Sub

eh:
  Dim sErr$
  sErr = Chr$(34) & pHyperlink.Link & Chr$(34) & " is not a valid raster dataset
filename" & vbNewLine & "Please check the hotlink field"
  MsgBox sErr, vbOKOnly + vbCritical, "Invalid Filename"

End Sub
```

Example 2. Hotlink VBA script for a vector dataset.

This script loads an ArcInfo county wide soil survey coverage.

```
Sub Hyperlink(pLink, pLayer)
' Adds a vector county quad soil coverage and joins the MapUnit table to the Coverage

  Dim pHyperlink As IHyperlink
  Set pHyperlink = pLink
  Dim pFLayer As IFeatureLayer
  Set pFLayer = pLayer
  MsgBox pHyperlink.Link

  Dim pWorkSpace As IArcInfoWorkspace
  Dim pWorkspaceFactory As IWorkspaceFactory
  Set pWorkspaceFactory = New ArcInfoWorkspaceFactory
  Dim pPropertyset As IPropertySet
  Set pPropertyset = New PropertySet
  Dim pCounty As String
  pCounty = Mid(pHyperlink.Link, 13, 25)
  pPropertyset.SetProperty "DATABASE", "k:\Soils\SSURGO\" + pCounty + "\Cov\"
  Dim pname As String
  pname = Left(pHyperlink.Link, 11)


  Set pWorkSpace = pWorkspaceFactory.Open(pPropertyset, 0)
  Dim pFeatureWorkspace As IFeatureWorkspace
  Set pFeatureWorkspace = pWorkSpace
```

```
  Dim pFeatureLayer As IFeatureLayer
  Set pFeatureLayer = New FeatureLayer
  Dim pFeatureClass As IFeatureClass
  Set pFeatureClass = pFeatureWorkspace.OpenFeatureClass(pname + ":polygon")
  Set pFeatureLayer.FeatureClass = pFeatureClass
  pFeatureLayer.Name = pname

  Dim pMxDocument As IMxDocument
  Dim pMap As IMap
  Dim pGroup As IGroupLayer
  Set pGroup = New GroupLayer

'Set soil map name to add

'Dim pFeatureClass As IFeatureClass
  Dim pmapLayer As ILayer

'Set renderer
  Dim pRender As ISimpleRenderer
  Set pRender = New SimpleRenderer
  Dim pcol As IRgbColor
  Dim brown As IColor
  Set pcol = New RgbColor
  Set brown = New RgbColor
  pcol.Blue = 66
  pcol.Red = 192
  pcol.Green = 114
  Dim pfcol As IRgbColor
  Set pfcol = New RgbColor
  Set brown = pcol
  pfcol.Blue = 255
  pfcol.Red = 255
  pfcol.Green = 255
  Dim symd As ISimpleLineSymbol
  'Dim symd As ISimpleFillSymbol
  'Set symd = New SimpleFillSymbol
  Set symd = New SimpleLineSymbol
  'symd.Style = esriSFSHollow
  symd.Style = esriSLSSolid
  symd.Color = pcol
  'symd.Outline.Color = brown
  'symd.Outline.Width = 2
  Set pRender.Symbol = symd

  Set pmapLayer = pFeatureLayer
' Set the current document and view
```

```
  Set pMxDocument = Application.Document
  Set pMap = pMxDocument.ActiveView.FocusMap

'Add the FeatureLayer to the correct group layer in the  focus map

  For i = 0 To pMap.LayerCount - 1

        If pMap.Layer(i).Name = "QuadSoils" Then 'Set Group layer
            Set pGroup = pMap.Layer(i)
        End If
  Next i

  pGroup.Add pmapLayer

  pGroup.Expanded = True
  pGroup.Visible = True

'Render new layer
    Dim nLayer As ILayer

     Set nLayer = pmapLayer

     Dim nFLayer As IFeatureLayer
     Set nFLayer = nLayer
     Dim pLyr As IGeoFeatureLayer
     Set pLyr = nFLayer

 'Join the MapUnit Table

  Dim pFeatLayer As IFeatureLayer
  'Dim pDispTable As IDisplayTable
  Dim pFCLayer As IFeatureClass
  'Dim pTLayer As ITable

  Set pFeatLayer = pLyr
  Set pFCLayer = pFeatLayer.FeatureClass

 ' Getting inside DB and external Table

 ' Set up the output feature class, i.e. the empty GDBTable that exists
  Dim pWSFact As IWorkspaceFactory
  Dim pFeatWS As IFeatureWorkspace
  Dim pFeatDS As IFeatureDataset
  Dim pFields As IFields
  Dim pField As IField
```

```
  Set pWSFact = New ArcInfoWorkspaceFactory

  'Open FeatureWorkspace
  Set pFeatWS = pWSFact.OpenFromFile("k:\soils\ssurgo\" + pCounty + "\cov", 0)
  Dim pGDBTable As ITable
  Set pGDBTable = pFeatWS.OpenTable("MapUnit")

  Dim pMemRelFact As IMemoryRelationshipClassFactory
  Dim pRelClass As IRelationshipClass
  Set pMemRelFact = New MemoryRelationshipClassFactory
  Set pRelClass = pMemRelFact.Open("TabletoLayer", pFCLayer, "MUSYM",
pGDBTable, _
  "MUSYM", "forward", "backward", esriRelCardinalityOneToMany)

  ' use Relate to perform a join
  Dim pDispRC As IDisplayRelationshipClass
  Set pDispRC = pFeatLayer
  pDispRC.DisplayRelationshipClass pRelClass, esriLeftOuterJoin


     Set pLyr.Renderer = pRender
'Refresh the view and TOC
 pMxDocument.ActiveView.ContentsChanged
 pMxDocument.UpdateContents
 pMxDocument.ActiveView.Refresh

End Sub
```