Solutions Network Formulation Report

Landsat Data Continuity Mission Simulated Data Products for Bureau of Land Management and Environmental Protection Agency Abandoned Mine Lands Decision Support

February 1, 2007

1. Candidate Solution Constituents

a. Title: Landsat Data Continuity Mission Simulated Data Products for Bureau of Land Management and Environmental Protection Agency Abandoned Mine Lands Decision Support

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c. Identified Partners: BLM (Bureau of Land Management), USDA (U.S. Department of Agriculture) Forest Service, and EPA (U.S. Environmental Protection Agency

d. Specific DST/DSS: BLM and USFS – GeoCommunicator Web-based DST, EPA – SMARTe DST

e. Alignment with National Application: Public Health, Water Management, and Ecological Forcasting

f. NASA Research Results – Table 1:

Missions	Sensors/Models	Data Product
Landsat Data Continuity Mission	ETM+ type	Terrestrial MSS 30 m VNIR bands, Pan 15 m

g. Benefit to Society: Monitoring abandoned mine land areas, protecting watersheds, monitoring impacted ecological systems

2. Abstract

Presently, the BLM (Bureau of Land Management) has identified a multitude of abandoned mine sites in primarily Western states for cleanup. These sites are prioritized and appropriate cleanup has been called in to reclaim the sites. The task is great in needing considerable amounts of agency resources. For instance, in Colorado alone there exists an estimated 23,000 abandoned mines. The problem is not limited to Colorado or to the United States. Cooperation for reclamation is sought at local, state, and federal agency level to aid in identification, inventory, and cleanup efforts.

Dangers posed by abandoned mines are recognized widely and will tend to increase with time because some of these areas are increasingly used for recreation and, in some cases, have been or are in the process of development. In some cases, mines are often vandalized once they are closed. The perpetrators leave them open, so others can then access the mines without realizing the danger posed. Abandoned mine workings often fill with water or oxygen-deficient air and dangerous gases following mining. If the workings are accidentally entered into, water or bad air can prove fatal to those underground. Moreover, mine residue drainage negatively impacts the local watershed ecology. Some of the major hazards that might be monitored by higher-resolution satellites include acid mine drainage, clogged streams, impoundments, slides, piles, embankments, hazardous equipment or facilities, surface burning, smoke from underground fires, and mine openings.

An EPA (U.S. Environmental Protection Agency) watershed approach to AML (Abandoned Mine Lands) reclamation identifies specific watersheds that are affected by abandoned mine effluent. This approach targets mine sites that deteriorate the quality of surface and ground waters. If mixed ownership exists, then owner responsibility for that watershed is addressed. The watershed approach provides for control and management of significant physical hazards during the environmental cleanup.

The principal economic benefit of mine monitoring via the use of satellite imagery is cost savings. Spaceborne imaging addresses the problem of monitoring remote mined areas without inviting the costs of the administration, accommodation, and logistics of detection and/or surveillance by on-site teams. Moreover, higher-resolution satellite imagery can be used to generate a baseline against which mining companies and government agencies can evaluate and assess mine and environmental recovery plans. Information derived from higher-resolution satellite imagery can be used to lessen insurance costs and legal claims as well as to confirm environmental compliance. This candidate solution aligns with the Public Health and Water Management National Applications.

3. Detailed Description of Candidate Solution

a. Purpose/Scope

The Bureau of Land Management has identified a multitude of abandoned mine sites in primarily Western states for cleanup. Dangers posed by abandoned mines are recognized widely and will tend to increase with time because some of these areas are increasingly used for recreation and, in some cases, have been or are in the process of development. Abandoned mine workings often fill with water or oxygen-deficient air and dangerous gases following mining. If the workings are accidentally entered into, water or bad air can prove fatal to those underground. Moreover, mine residue drainage negatively impacts the local watershed ecology. Cooperation for mine land reclamation is sought at local, state, and federal agency level to aid in identification, inventory, and cleanup efforts.

This candidate solution will address detecting, monitoring, and mapping abandoned mine areas that potentially impact public safety and community health. The solution focuses on monitoring of abandoned mines areas on the Abandoned Mine Lands list. However, areas other than Western states that are impacted by AML issues would be considered, such as Texas and Oklahoma. The suggested solution would aid in the mapping of abandoned mine areas that can directly affect public health because of open mine pit or quarry areas and associated toxic mine tailings that may not have been inventoried in these areas.

The proposed solution supports the Public Health and Water Management National Applications. The BLM and USDA (U.S. Department of Agriculture) Forest Service GeoCommunicator Web-based DST (decision support tool) and the U.S. Environmental Protection Agency SMARTe DST would both benefit from the inclusion of LDCM (Landsat Data Continuity Mission) imagery as part of the data layers presented to potential users. The imagery would be used to identify mine openings, detect talus piles, and map vegetation stress associated with acid mine drainage into the local watershed.

b. Identified Partners

The primary Federal entities associated with this candidate solution are the EPA and BLM. The AML program was formed in part to aid in information sharing and integration between federal, state, and local agencies that rely on datasets provided by the above primary agencies. Abandoned mine lands are not simply the immediate region about a mine but also the local watershed wherein mine residue drains. These AML regions represent degraded areas that exhibit increased erosion, which compounds the problem of reclamation (Moore et al., 1991).

Presently, the BLM has identified thousands of abandoned mine sites in primarily Western states for cleanup. Dangers posed by abandoned mines are recognized widely. Abandoned mine workings can fill with water, oxygen-deficient air, or dangerous gases. Some of the major hazards that might be

monitored by satellites sensor systems include the following: detection of mine openings, acid mine drainage, heavy metal assemblages, clogged streams, impoundments, slides, piles, embankments, remnant hazardous equipment or facilities, surface burning, and smoke from underground fires.

Baseline data used for AML assessments are historical mine data, remotely sensed imagery acquired from airborne platforms, and on-site data collection: water, soil sample collection, and subsequent chemical analysis. The airborne imagery acquired ranged from aerial photos to hyperspectral sensor collects. For example, NASA's Jet Propulsion Laboratory has flown the hyperspectral instrument, the AVIRIS (Airborne Visible/Infrared Imaging Spectrometer), over AML areas in Utah and Colorado (Rockwell et al., 2004). The resulting data was used to identify mineral assemblages of various kinds on the ground. Also, the imagery was used to assess the impact of various mine residues on the local watershed.

BLM and EPA are the targeted federal agencies that are responsible for the decision-making processes associated with AML. Acquired data is used to formulate decisions on possible remedial actions (Anderson et al., 1977).

The BLM's GeoCommunicator sites provide a Web-based access to data needed for decision-making (BLM, 2006). The GeoCommunicator is one of four NILS (National Integrated Land System) project modules. The NILS is a joint project between the BLM and the USDA Forest Service that partners with states, counties, and private industry. Its goal is "to provide business solutions for the management of cadastral records and land parcel information in a Geographic Information System (GIS) environment" (BLM, 2007). The GeoCommunicator could benefit from the use of VNIR (visible and near-infrared (VNIR) band image data for identifying AML areas and for use as base map overlays.

The EPA's SMARTe (Sustainable Management Approaches and Revitalization Tools – electronic) is in development (EPA, 2006). It is slated to be operational in the last quarter of 2007. SMARTe provides a toolbox useable for AML decision support. At present, imagery data layers are not mentioned as part of the DST. Again, LDCM imagery could compose a data layer that would be valuable to the DST.

In general, NASA remotely sensed data would serve as both a complement to field-collected data from on-site AML observations, historical data, soil and water sampling, and chemical analysis and as a primary data source layer for detection and mapping of mines and their residue.

c. NASA Earth-science Research Results

The instrument of choice for supplying Earth application imagery to BLM and EPA DSTs is LDCM – a joint mission by NASA and the USGS (U.S. Geological Survey). The objective of the LDCM mission is a continuation of the venerable Landsat sensor mission. The data product required is 30 m multispectral, VNIR bands, and the higher-resolution 15-m pan image products in HDF or GeoTIFF format. The higher-resolution pan images can be used to sharpen the multispectral data to achieve higher spatial resolution for better mapping fidelity. These images can be processed to highlight mine openings, mine tailings, acid drainage impacts, and vegetative stress (Peters and Hauff, 2000; Singhroy, 2000).

The LDCM is scheduled to launch in the 2011 timeframe. It will collect imagery from an 838 km altitude, sun-synchronous orbit, revisiting with a period of 101 minutes. The data archived will be consistent with data and applications from the previous Landsat satellites. The deployment of LDCM will fill an expected gap of Landsat data. Landsat 5 and Landsat 7 are operational, fulfilling their missions—but Landsat 5 is 22 years old. Landsat 7, launched in 1999, lost the use of its Scan Line Corrector and gyro backup.

The Table 2 displays the proposed LDCM spectral band placements available for different uses.

Table 2. LDCM spectral bands.

Band #	Band Use	Center of Band/Bandwidth (approximate) (nm)
1	Coastal Aerosol	443±10
2	Blue	482±32
3	Green	562±37
4	Red	655±25
5	NIR	865±20
6	SWIR 1	1610±50
7	SWIR 2	2200±100
8	Panchromatic	590±90
9	Cirrus	1375±15

Source: GSFC, 2007

d. Proposed Configuration's Measurements and Models

NASA satellite data has proven itself valuable for detecting mine openings, talus piles, and environmental impact of mine residue (Cohen and Gorman, 1991; Starnes and Gasper, 1995). Moreover, higher-resolution satellite imagery can be used to generate a baseline against which mining companies and government agencies can evaluate and assess mine and environmental recovery plans. Information derived from higher-resolution satellite imagery can be used to lessen insurance costs and legal claims as well as to confirm environmental compliance (Anderson et al., 1977). Using LDCM image data layers should complement the targeted DSTs in a beneficial manner.

Since both candidate DST's operate from a database that searches and fetches data layers, processed LDCM image layers should be an easy fit with little or no difficulty associated with installation. Presently, LDCM is slated for launch in the 2011 timeframe. Other imagery could be used to demonstrate the value of spaceborne imagery for GeoCommunicator and SMARTe.

4. Programmatic and Societal Benefits

A straightforward societal benefit exists in the form of protecting public health and welfare from abandoned mines and their associated hazards. Moreover, environmental concerns of the impact of mine residue and drainage on the local and regional watershed will be addressed. The impact on local wildlife and fisheries can be quite dramatic (McCormick et al., 1994).

The main economic advantage of mine detection and monitoring using satellite imagery is cost savings (Salopek, 2002). Satellite imaging deals with the difficulty of monitoring remote mined areas without engaging costs of on-site detection and inspection teams. Spaceborne sensors can provide supplemental data to combine with baseline data collection. Satellite imagery can produce a baseline for mining companies and government agencies so that they can evaluate and assess mine and environmental recovery plans. Information resulting from satellite imagery can lessen insurance costs and legal claims; it can also verify environmental compliance.

5. References

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