Midwest Research Institute

Solutions through science and technology

Using Satellite Imagery to Inventory Erodible Lands in Las Vegas Valley

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Background

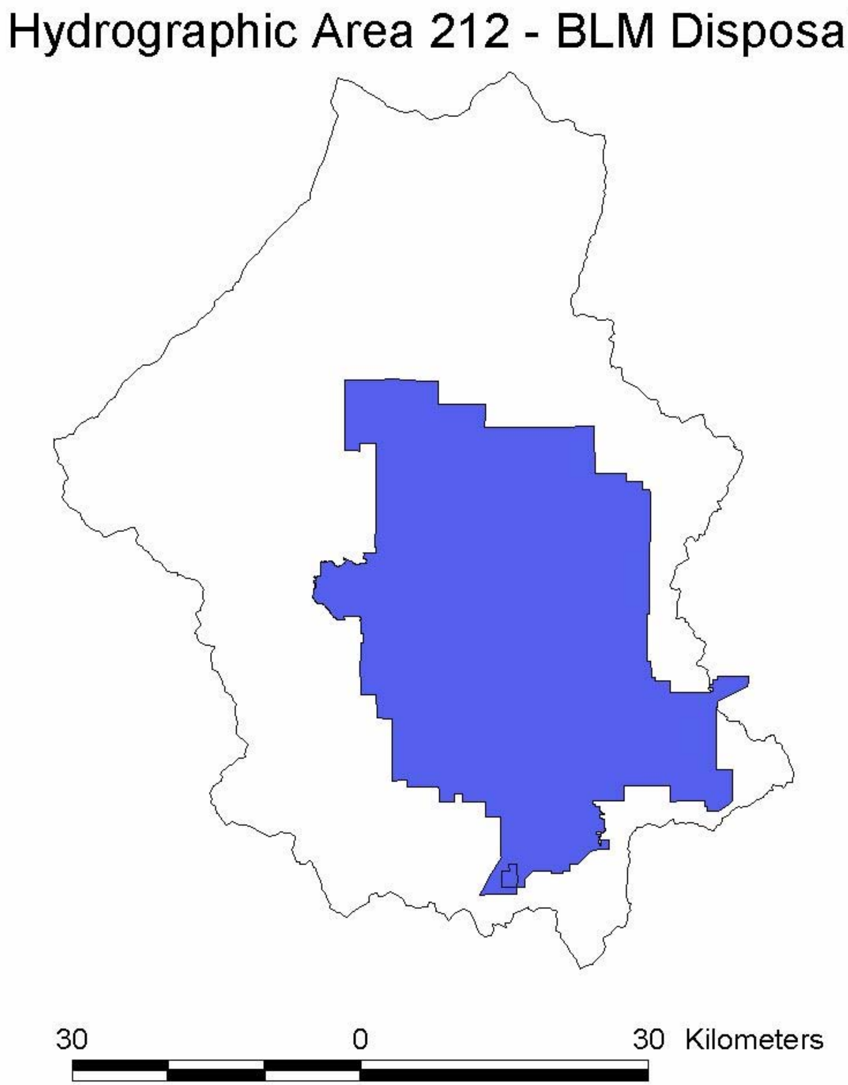
- Windblown dust in the Las Vegas Valley contributes to exceedances of PM air quality standards
- Increasing land disturbance associated with population growth is intensifying the problem
- A precise tool is needed to track land disturbances and assure that stabilization measures are applied

Purpose

- Use Satellite Imagery to Inventory Erodible Land Areas in Las Vegas Valley (Hydrographic Area 212)
  - Native desert (natural state)
  - Disturbed, unstabilized vacant land (loss of surface protection)
  - Disturbed, stabilized vacant land (restoration of surface protection)
- Use Aerial Photography to Inventory Private Unpaved Roads and Obtain Traffic Counts

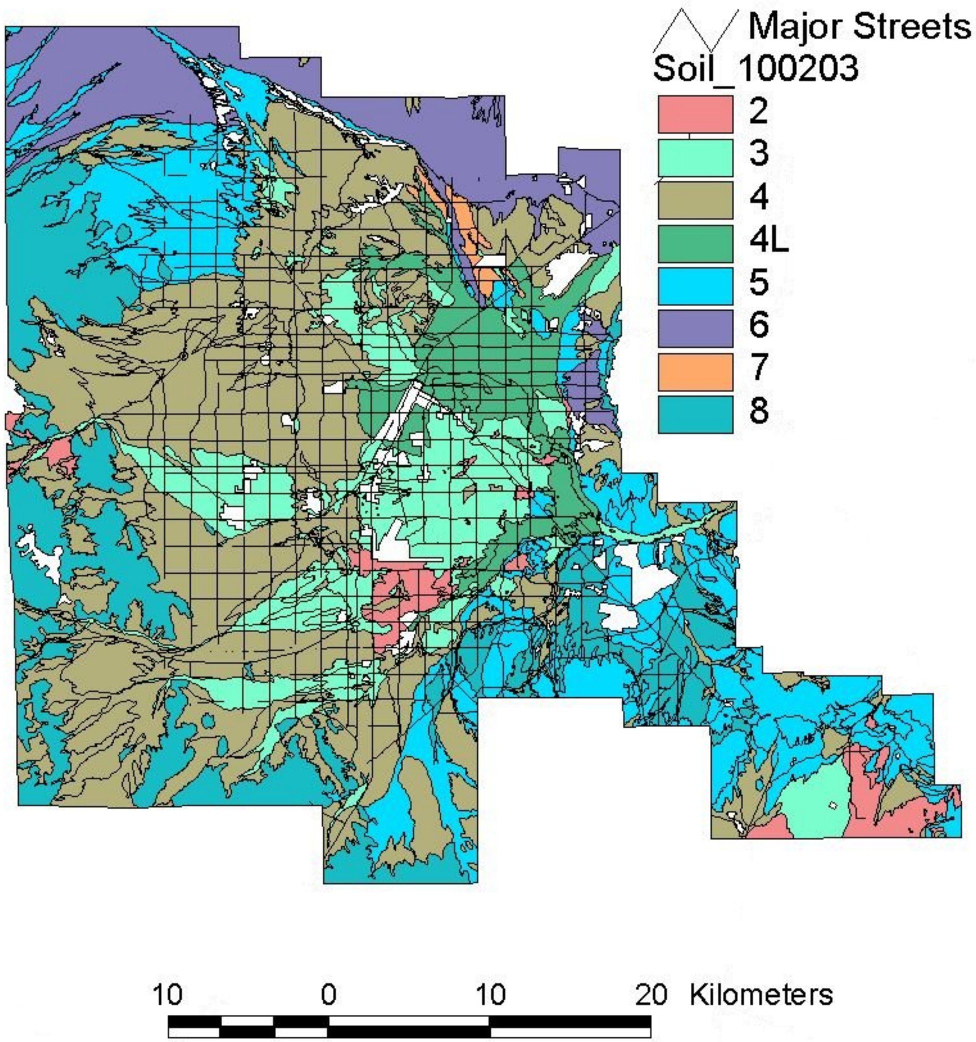
Vacant Land in Las Vegas Valley

Study Area Boundaries



BLM Disposal Area

WEG and Major Streets



Desert Pavement

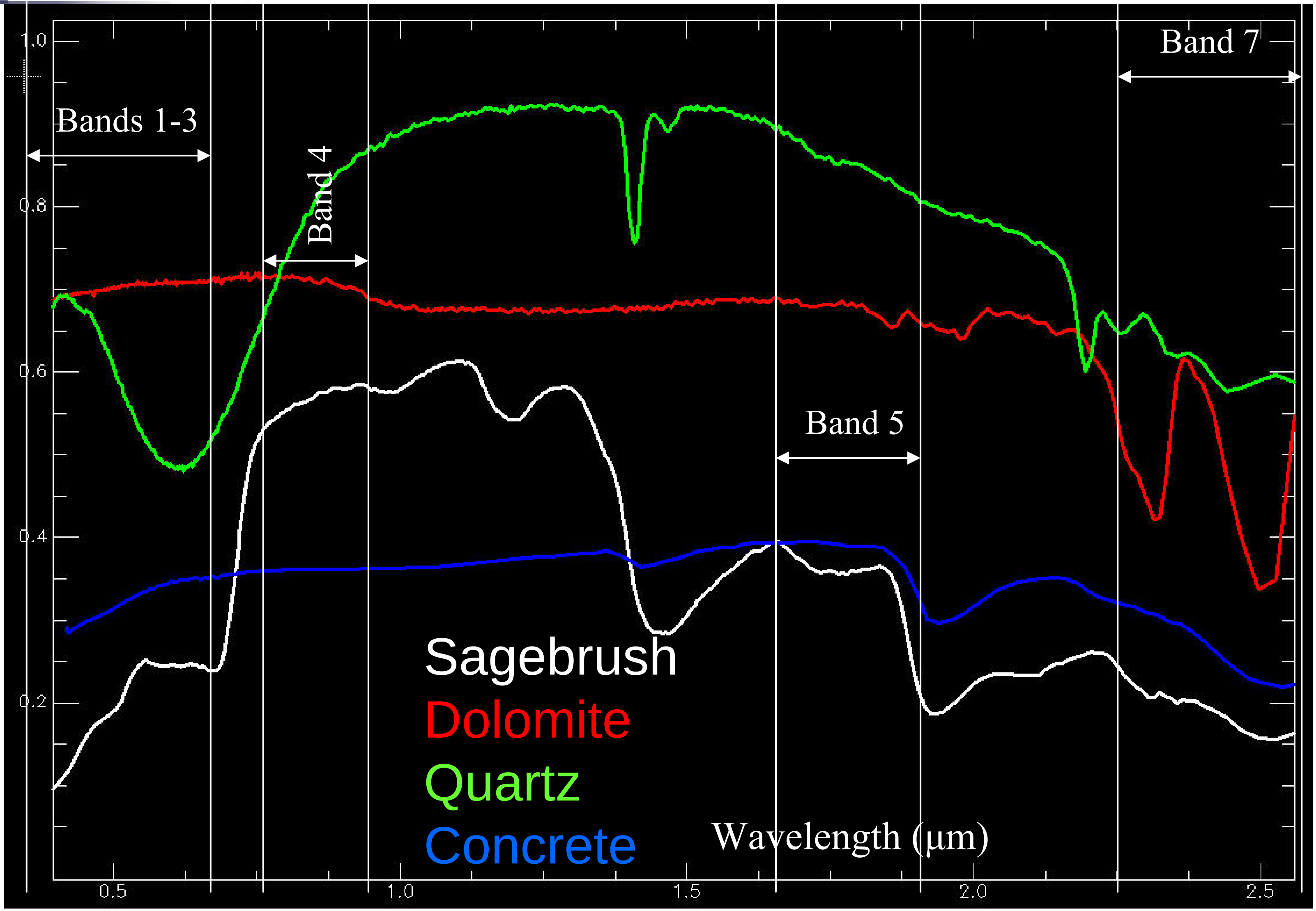
Other Satellite Imagery Studies

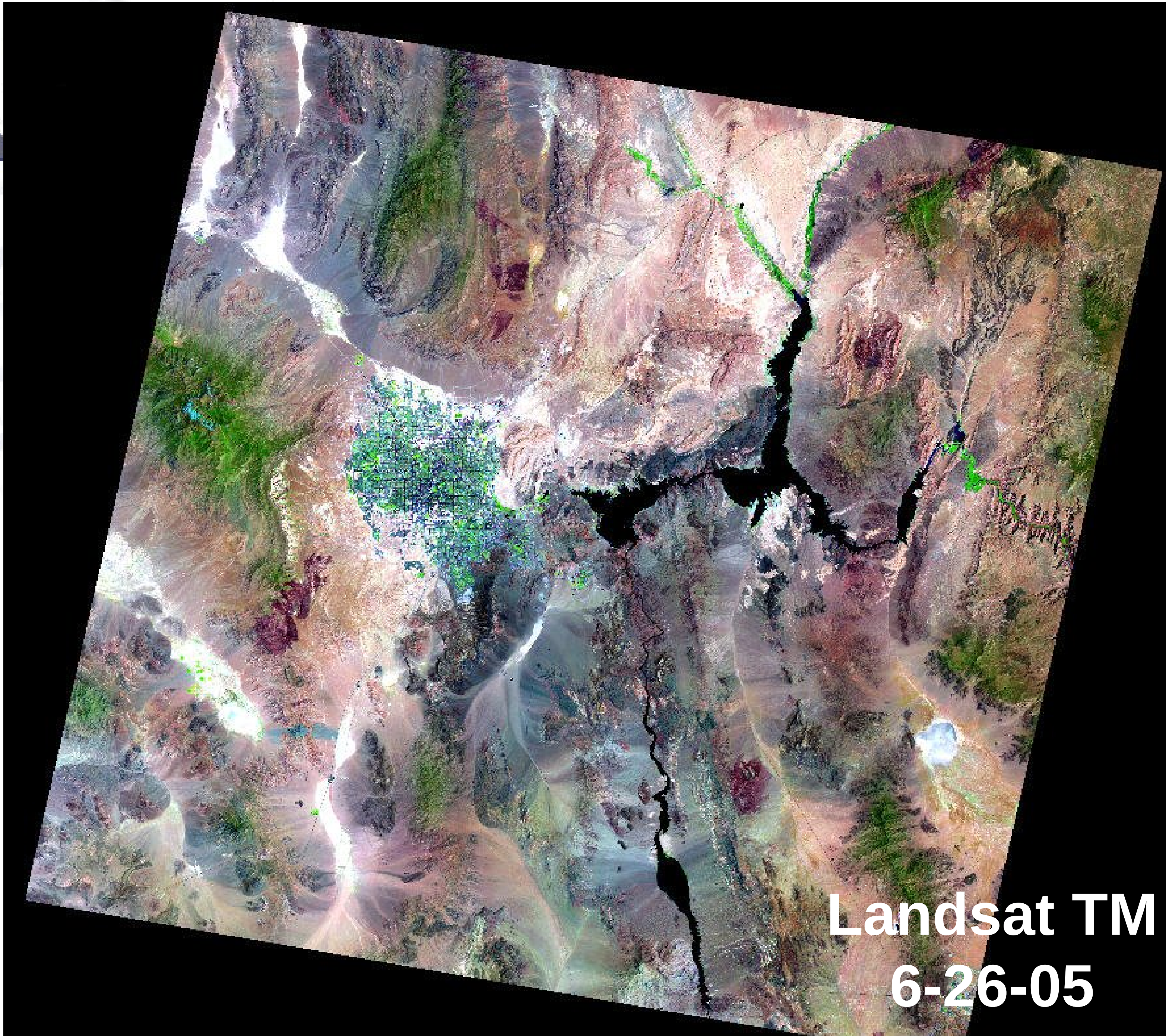
- Owens Lake Vegetation
  - Test for compliance with 50% coverage requirement
  - Use TM7 and Quickbird data to characterize South Farm area (16 training sites)
- Antelope Valley Blowsand Areas
  - Blowsand areas drive wind erosion of farmland
  - Use Landsat data to map blowsand areas (8 training sites)

Comparison of Satellite Data

- IKONOS/QuickBird
  - High spatial resolution, but expensive
  - Lack longer wavelengths for broader spectral signatures
- Landsat TM 5
  - Lower spatial resolution, but very affordable
  - Contains longer wavelength bands for broader spectral signatures
  - Larger pixels remove undesirable influence of unimportant micro-features

Natural and Manmade Features in a Landsat TM Context




Landsat TM
6-26-05

Project Phases

- Pilot Study (two 100 km2 areas)
  - Indentify training sites for each land category
  - Develop and test predictive algorithms
- Main Study (rest of BLM zone)
  - Complete spectral analysis and land mapping
  - Use verification sites for accuracy assessment
- Private Unpaved Roads

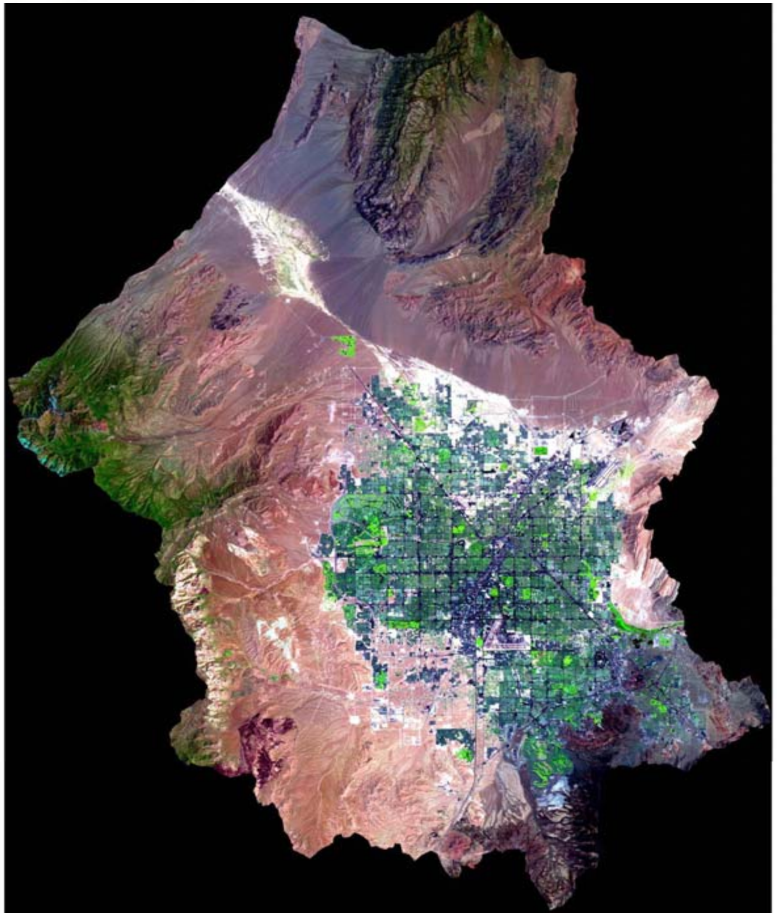
Procedure for Spectral Analysis

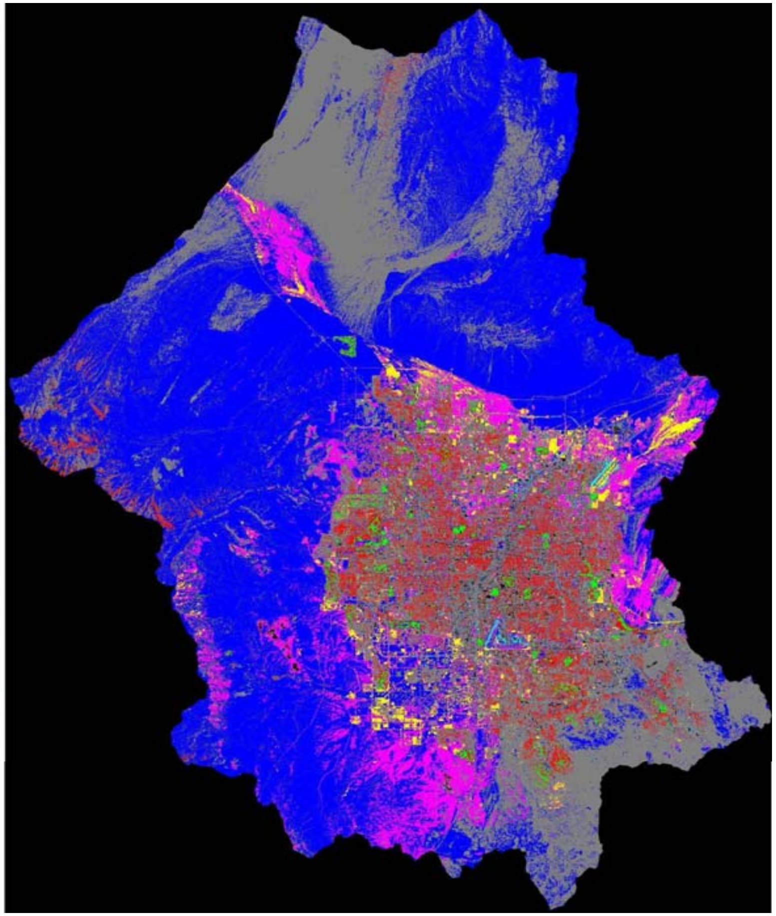
- Establish training sites that are representative of land categories
- Perform supervised classification of satellite imagery
- Determine classification mapping accuracy by constructing an error matrix

Project Issues: Ground Truthing

Issue	Resolution
Large range of variation in “native desert” (e.g., vegetation coverage)	Define subcategories of native desert, e.g., surface drainage
Great difficulty in finding “disturbed unstable land”	Add other land categories and determine class by inference
Poor correlation between soil maps and soil analyses	Determine that only “disturbed unstable land” has signature affected by soil type

Mahalanobis Supervised Classification of Landsat TM Imagery for HB 212





Urban   Native Desert   Disturbed Stable   Barren/Shadow
Vegetation   Surface Drainage   Concrete   Unclassified

Land Areas (HB 212)

Category	% of Total	Sq. KM
Native Desert	48.1	1897
Disturbed (Unstable)	<1.1	<45
Disturbed Stablilized	3.1	1223
Drainage	9.1	357
Barron/Shadow	33.1	1307
Concrete	0.7	26
Urban	4.9	192

Approach for Accuracy Assessment

- Gather Landsat TM 5 imagery for full study area and perform supervised classification
- Use aerial photography to define random verification sites for each land category
- Compare predicted (imagery) vs. observed (photography) land category determinations
- Perform field checks to determine reliability of land classification for disturbed areas

Classification Error Matrix

Error Matrix

Reference Data

Classified Data

	Barren/ Shadow	Concrete	Disturbed Stable	Vegetation	Natural Drainage	Urban	Native Desert	Row Total
Barren/Shadow	43					6		49
Concrete		45						45
Disturbed Stable		5	50		18			73
Vegetation				50				50
Natural Drainage					31			31
Urban	7				1	44		52
Native Desert							50	50
Column Total	50	50	50	50	50	50	50	350

Overall accuracy = 313 / 350 = 89%

Procedure for Unpaved Roads

- Use GIS maps to establish inventoried private unpaved road segments
- Use aerial photography to map road segments systematically
- Identify test roads and collect traffic counts
- Evaluate traffic count data

Conclusions

- The Landsat satellite imagery is more cost-effective for this purpose than high spatial resolution imagery, and avoids classification errors due to confounding effects of small pixel size.
- High-resolution aerial photography is an important tool to supplement imagery, because of its usefulness of providing broad-scale ground truthing.
- There is far less unstable land in the Las Vegas Valley than previously thought. The enforcement of regulations controlling construction-related dust has significantly decreased unstable land across the Valley.

Conclusions

- Soil chemistry is an important variable in classification of disturbed, unstable land. Mapping of this land category is not feasible because of small training sites and soil diversity.
- Soil erodibility is not closely correlated with Wind Erodibility Groups (WEG), but more so the condition of the surface. WEG classification is based on deep soil horizons rather than surface soil characteristics. In turn, the chemistry of surface soil is homogenized by deposition of mixed soils following wind erosion events.