Using Satellite Imagery for an Inventory of Paved and Unpaved Vacant Land

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Background

- Windblown dust in Clark County, NV comprises a significant portion of particulate air pollution
- 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
- Follow-up to earlier study of the Las Vegas Valley area only

Purpose

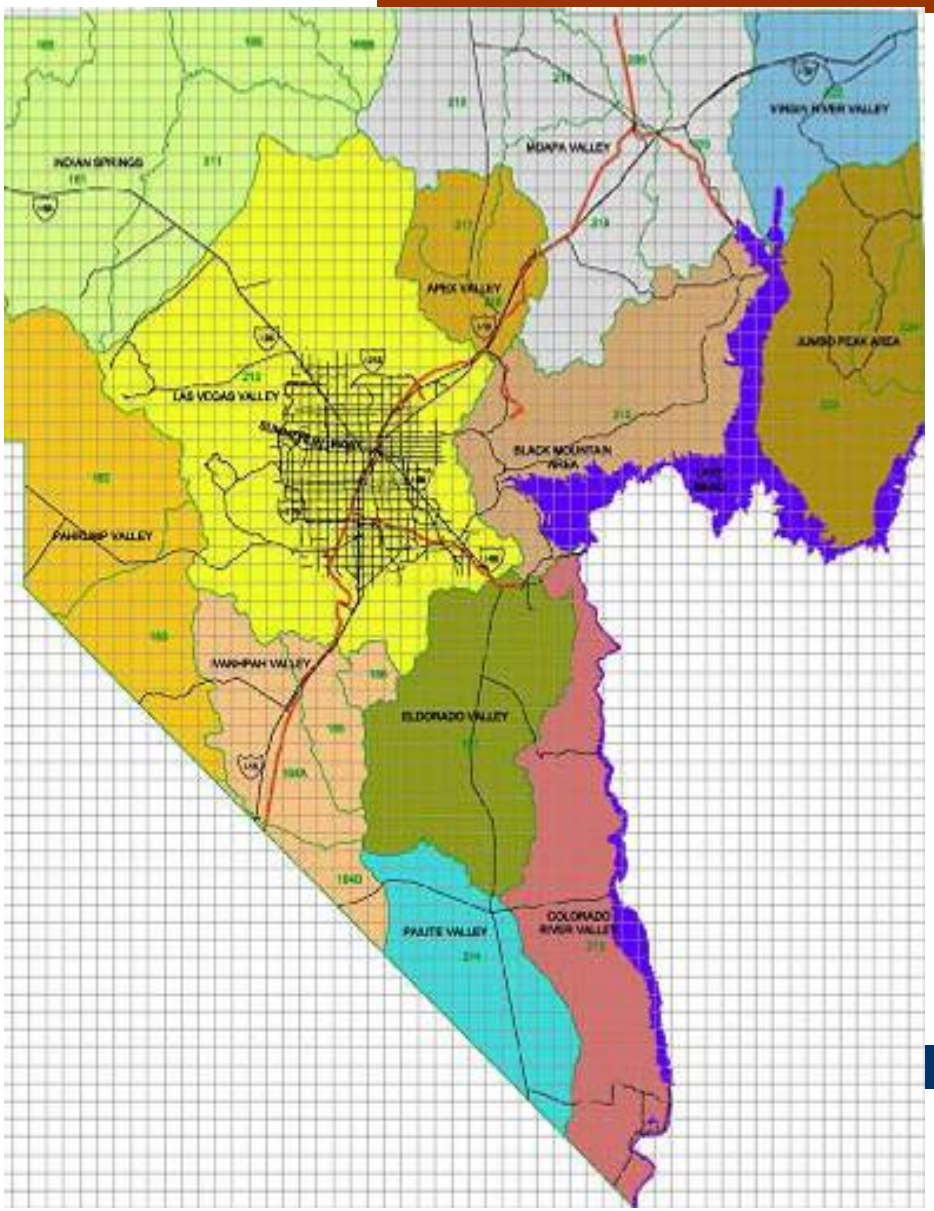
- Original study used Satellite Imagery to Inventory Erodible Lands in Las Vegas Valley portion of Clark County, Nevada
- Current study uses Satellite Imagery to Inventory Erodible Lands in expanded area of Clark County
  - Native desert (natural state)
  - Disturbed, unstable vacant land (loss of surface protection)
  - Disturbed, stable vacant land (restoration of surface protection)
- Use Aerial Photography/Satellite Imagery to Inventory Private Unpaved Roads
- Obtain Traffic Counts

Vacant Land Categories

- Native desert
  - moderate to heavy vegetation
  - little or no vegetation
  - Unvegetated rocky surface (naturally stable)
- Disturbed land
  - Unstable vacant land
    - ATV's and other disturbances
    - Sand dunes (naturally disturbed)
  - Stable vacant land
    - Restoration of surface protection by vegetation, rain, watering, application of dust suppressant, etc.
- Private unpaved roads [dirt and gravel] (typically unstable)

Clark County Hydrographic Basins

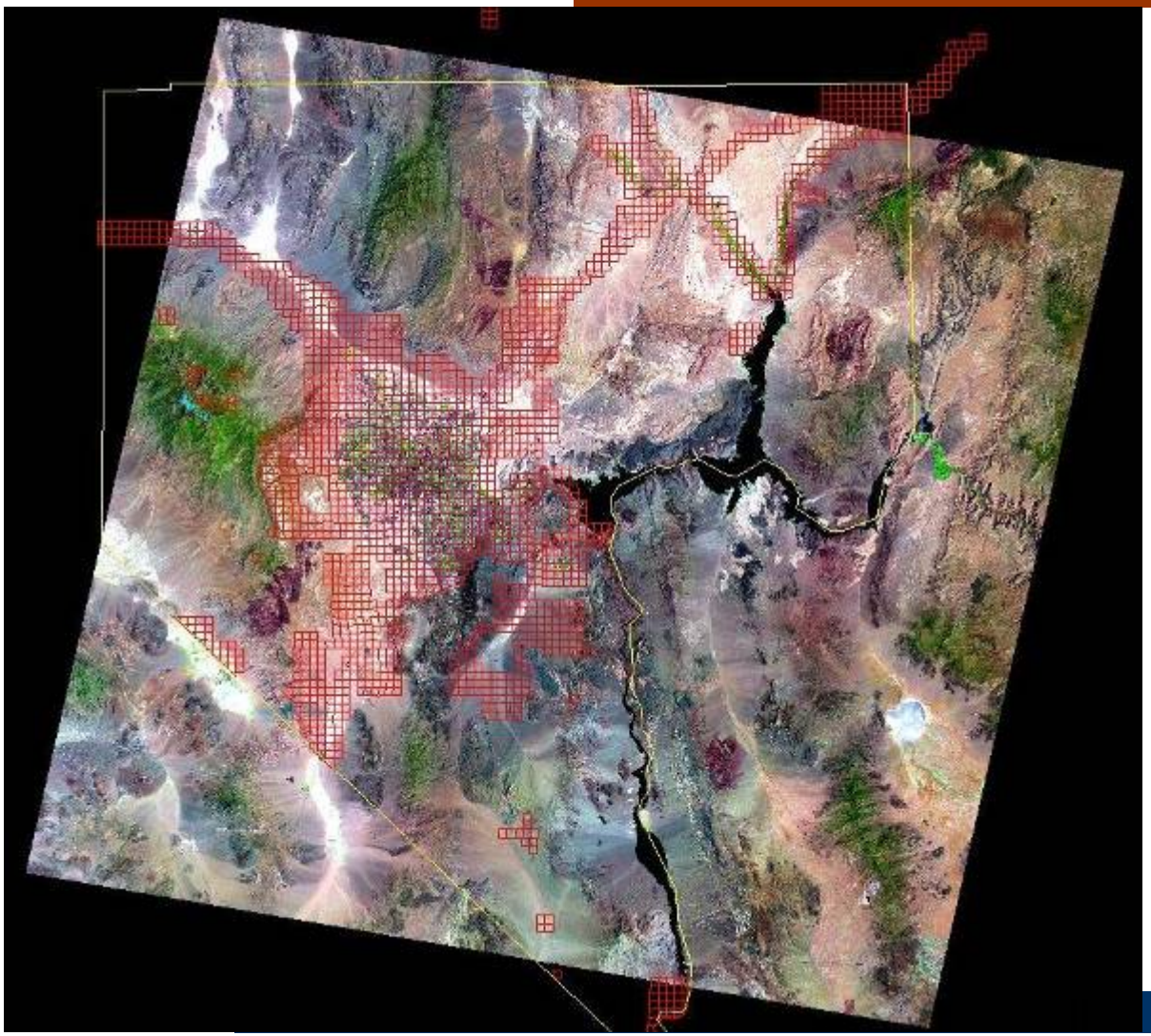
- El Dorado
- Ivanpah
- Apex
- Virgin River
- Indian Springs
- Pahrump
- Moapa



Comparison of Satellite Data

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

Clark County, Landsat Scene and Fall 2006 Aerial Photography



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

Ground Truthing Locations

Valley	Disturbed Stable	Disturbed Unstable	Native Desert
El Dorado	7	1	3
Ivanpah	3	1	3
Apex	4	1	3
Virgin River	3	1	3
Indian Springs	5	1	3
Pahrump	5	2	3
Moapa	7	3	3

IPV 4 - New Airport Site--Stable

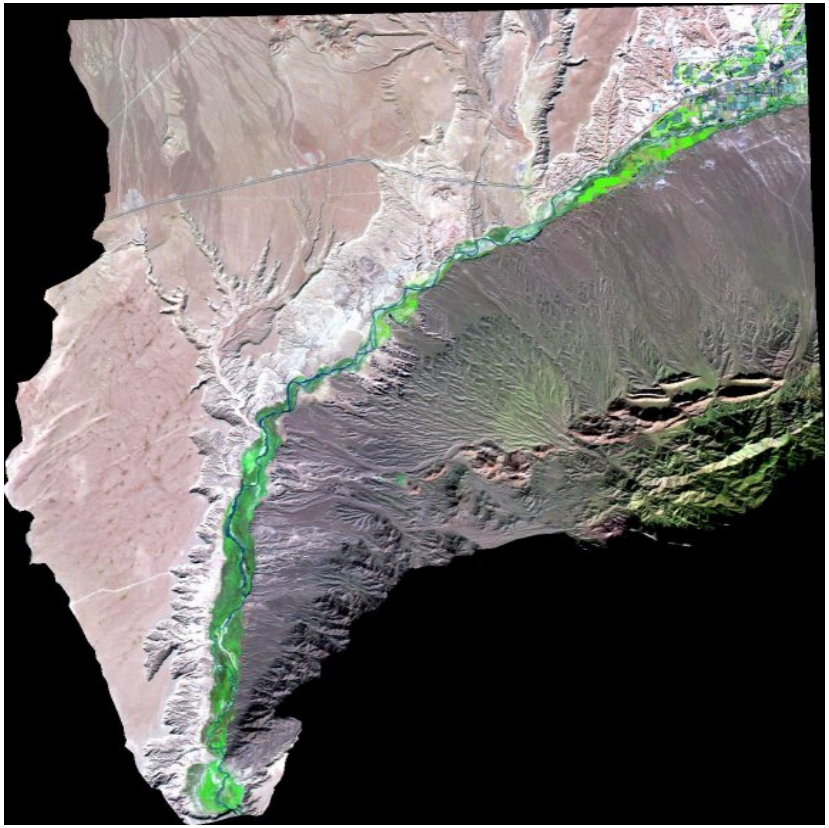
MPV 6 – Sand Dune Area--Unstable

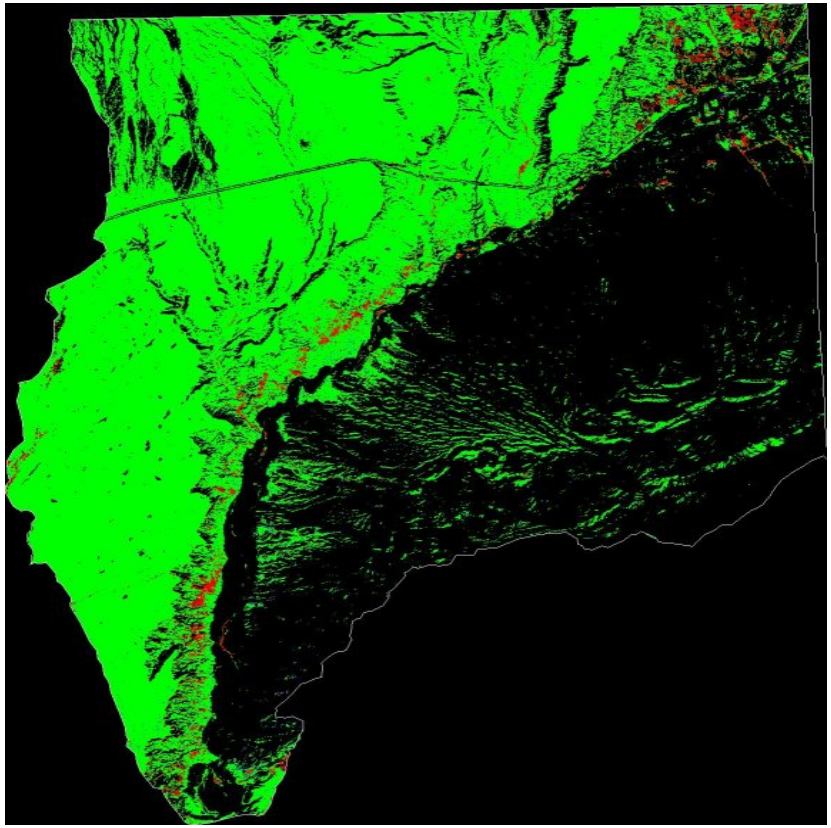
PHV 9 – Highly Vegetated Site

Project Issues

Issue	Resolution
Infeasible to cover all study areas for groundtruthing in 48 hours	*Used multiple Landsat scenes* *Indian Springs (10/2/06)* *Eldorado and Ivanpah (11/4/06)* *Apex and Virgin River (11/20/06)* *Pahrump and Moapa (4/29/07)*
Geographic expanse of study areas raises likelihood of need for subcategories	*Select the most effective classifier for each hydrographic basin*
Poor coverage of aerial photography limits mapping of roads in study areas	*Purchase selective IKONOS imagery in subareas of most likely activity*

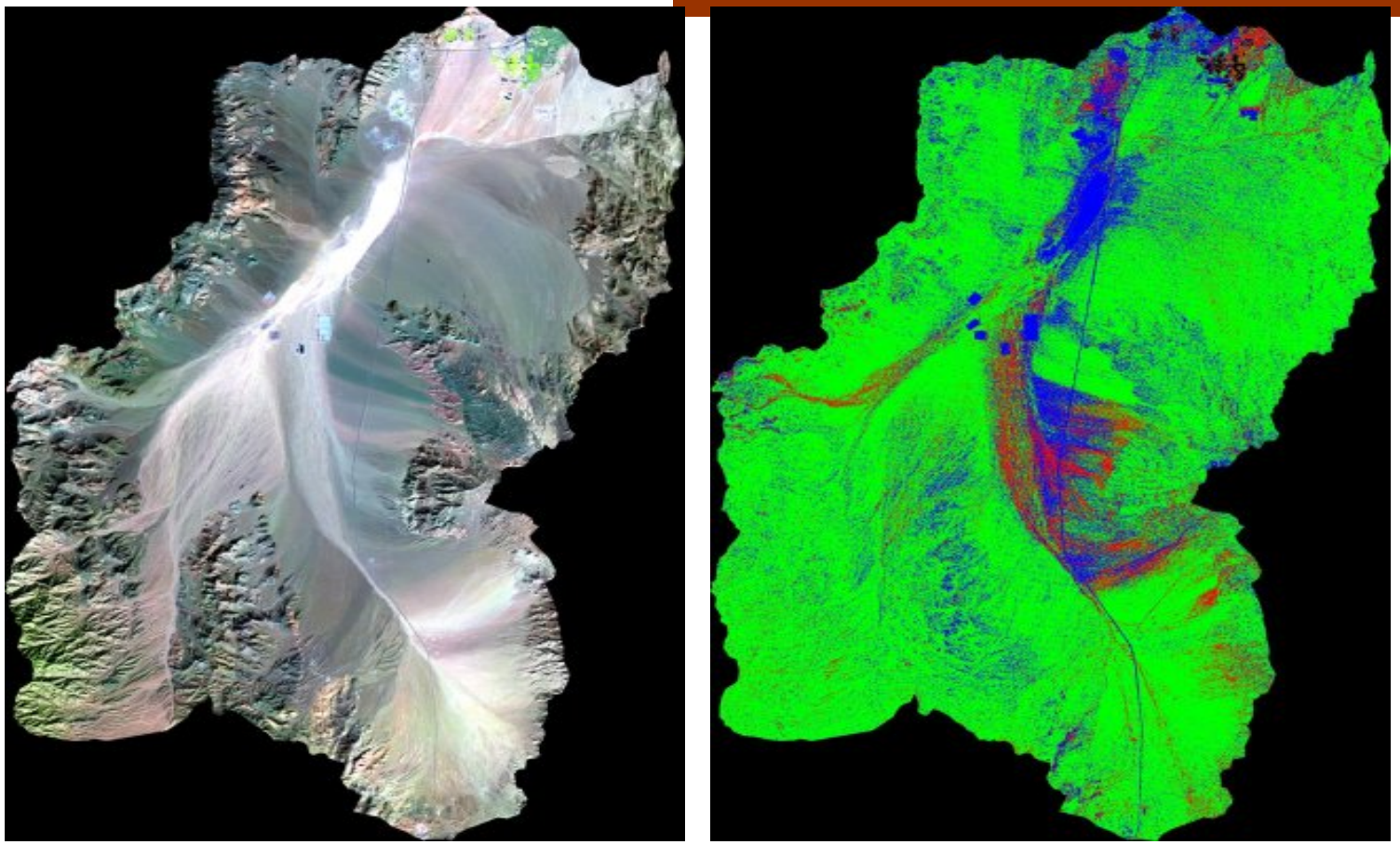
Virgin River Valley – Hybrid Classifier





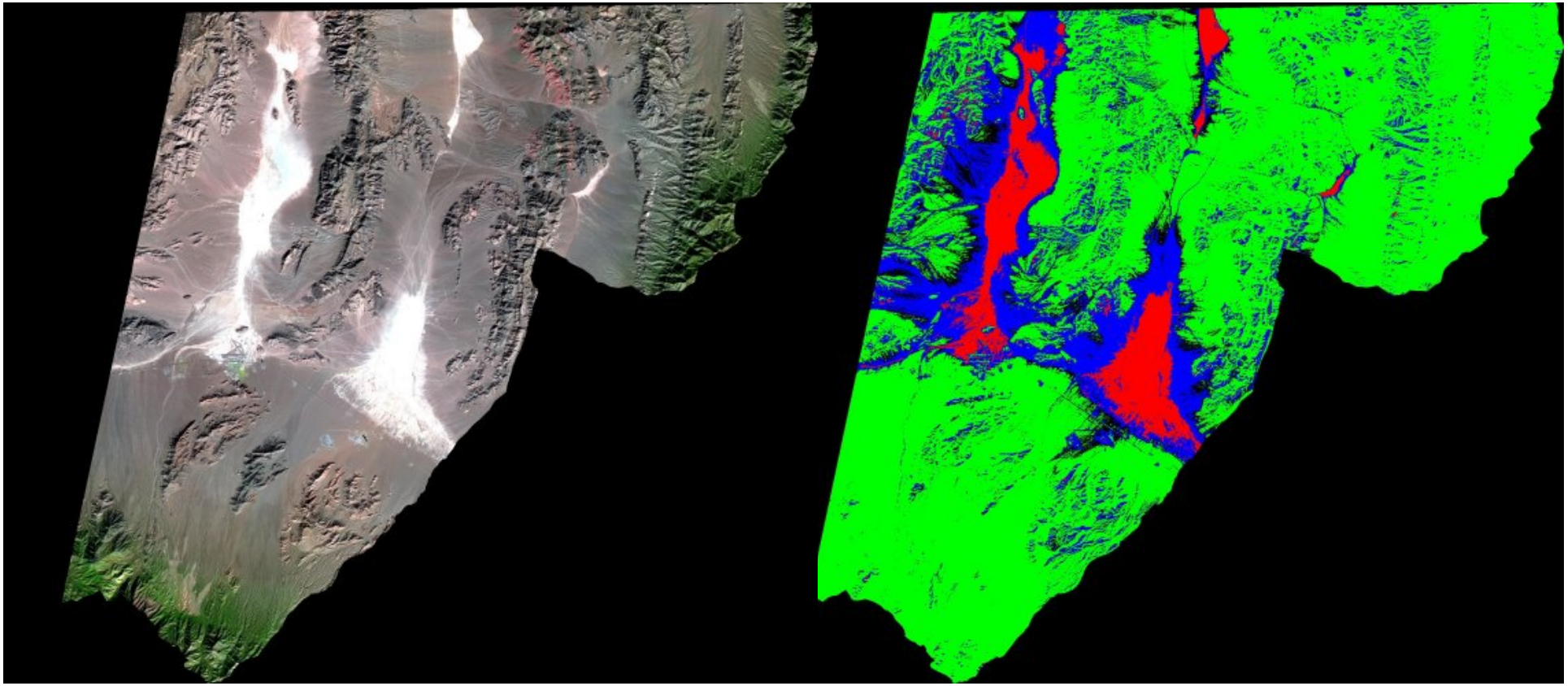
Disturbed Unstable Native Desert Disturbed Stable

Eldorado Valley Mahalanobis Classifier



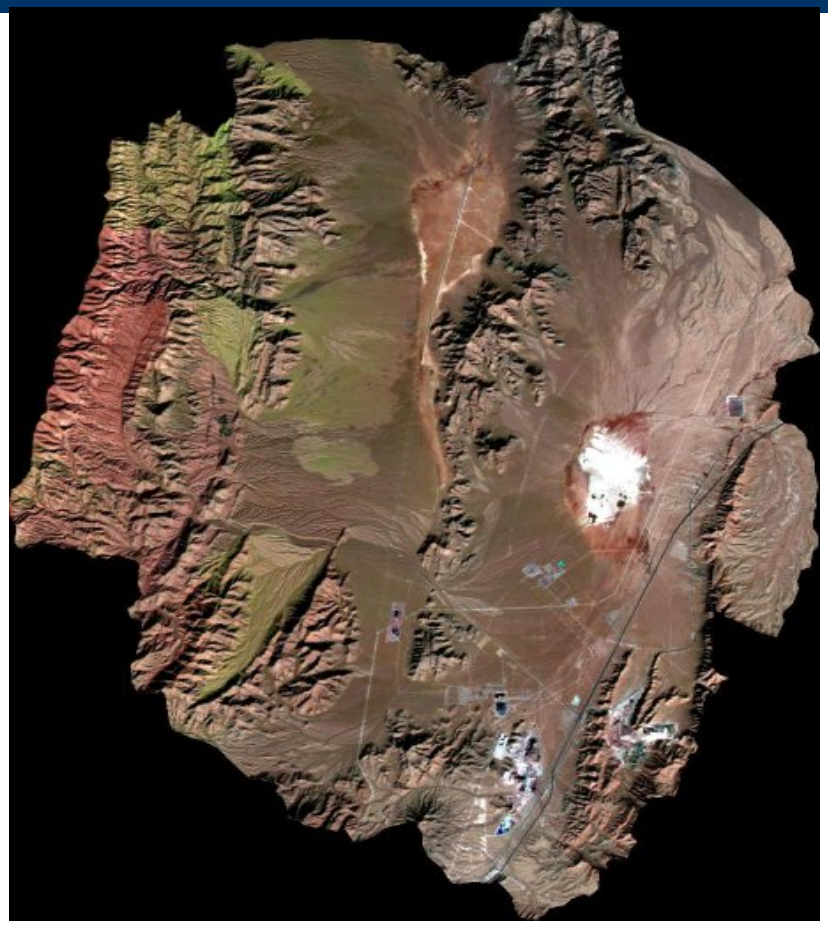
Disturbed Unstable Native Desert Disturbed Stable

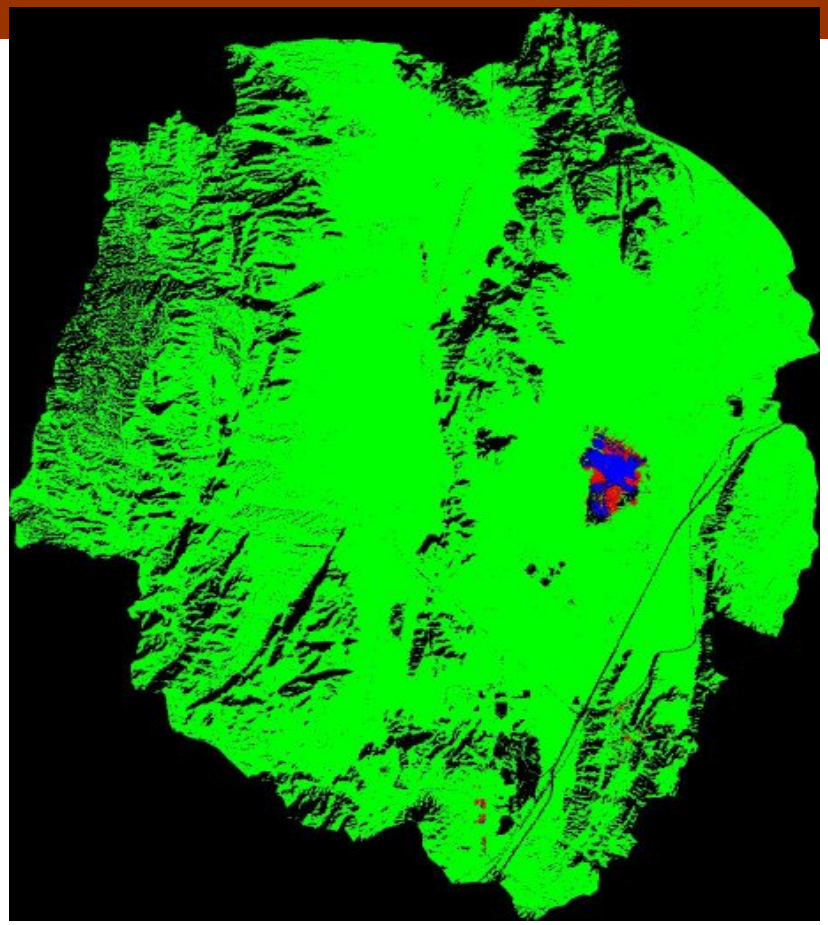
Indian Springs Valley – Neural Net Classifier



Disturbed Unstable Native Desert Disturbed Stable

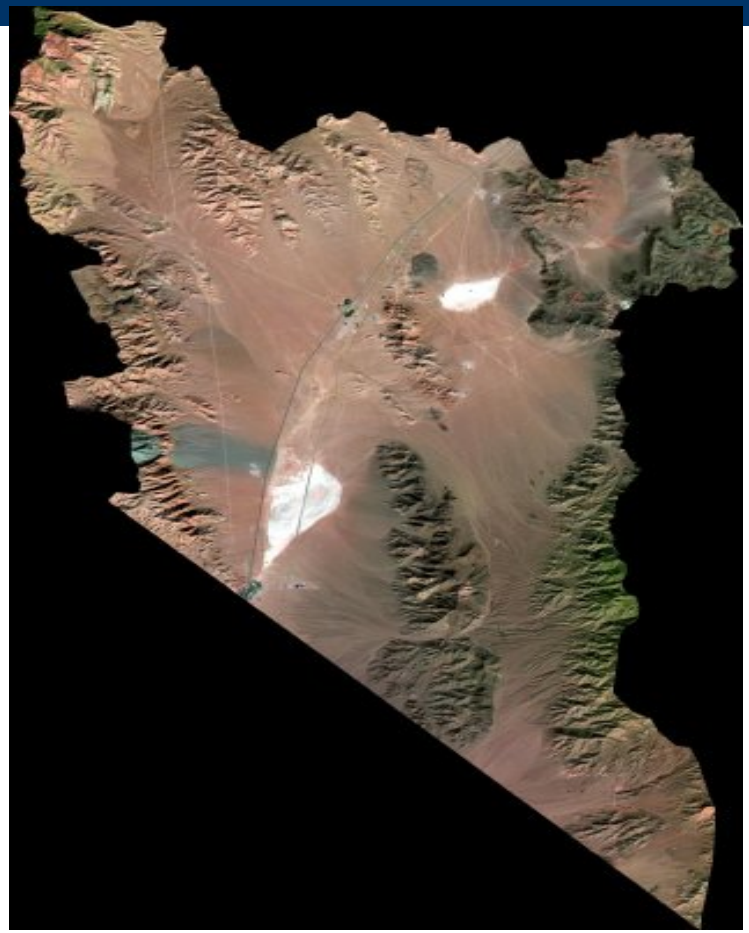
Apex Valley - Hybrid Classification

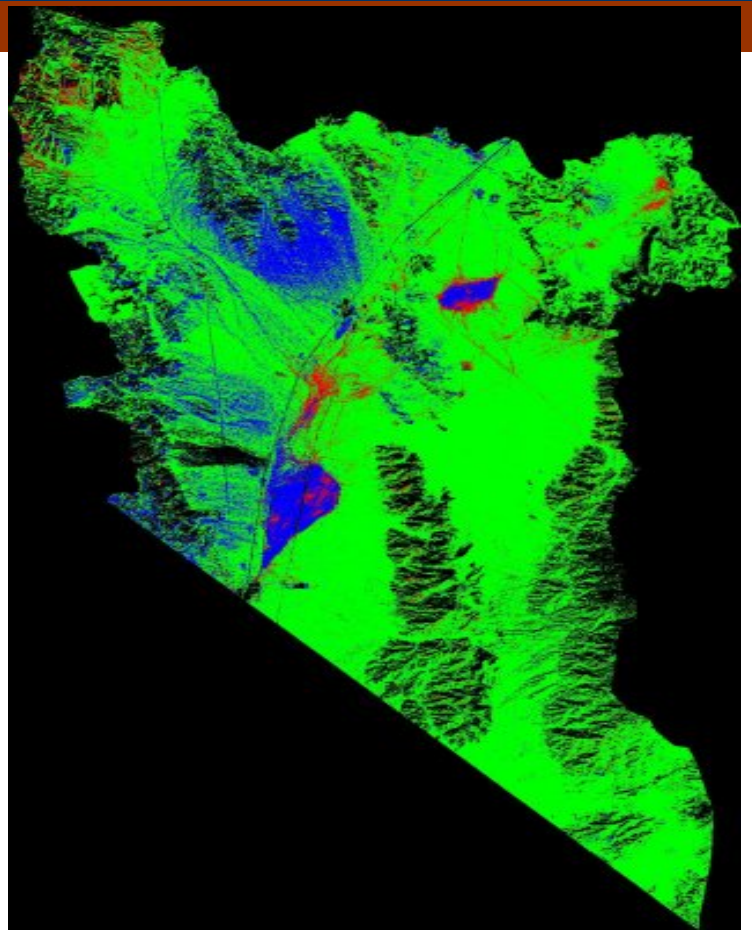




Disturbed Unstable Native Desert Disturbed Stable

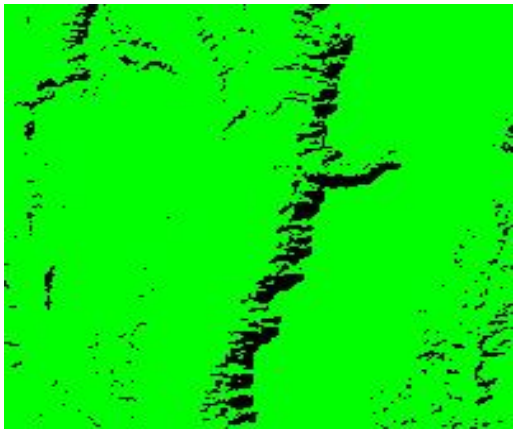
Ivanpah Valley Mahalanobis Classifier





Disturbed Unstable Native Desert Disturbed Stable

Unclassified Areas



*Almost all of the Unclassified appears to be Native Desert. The area for the Unclassified category has been added to the Native Desert category.

Area of Land Categories

	Native Desert*	Disturbed Stable	Disturbed Unstable	Total
Apex Valley	859 km^2	64 km^2	6 km^2	929 km^2
Virgin River Valley	1,219 km^2	17 km^2	163 km^2	1,399 km^2
Indian Springs Valley	3,654 km^2	444 km^2	141 km^2	4,239 km^2
Eldorado Valley	1,054 km^2	229 km^2	99 km^2	1,382 km^2
Ivanpah Valley	1,027 km^2	110 km^2	42 km^2	1,179 km^2
Pahrump Valley	3,251 km^2	171 km^2	2 km^2	3,424 km^2
Moapa Valley	2,303 km^2	143 km^2	39 km^2	2,485 km^2
Total	13,367 km^2 89%	1,178 km^2 7.8 %	492 km^2 3.3 %	15,037 km^2

Approach for Accuracy Assessment

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

Error Matrix – Pahrump Valley

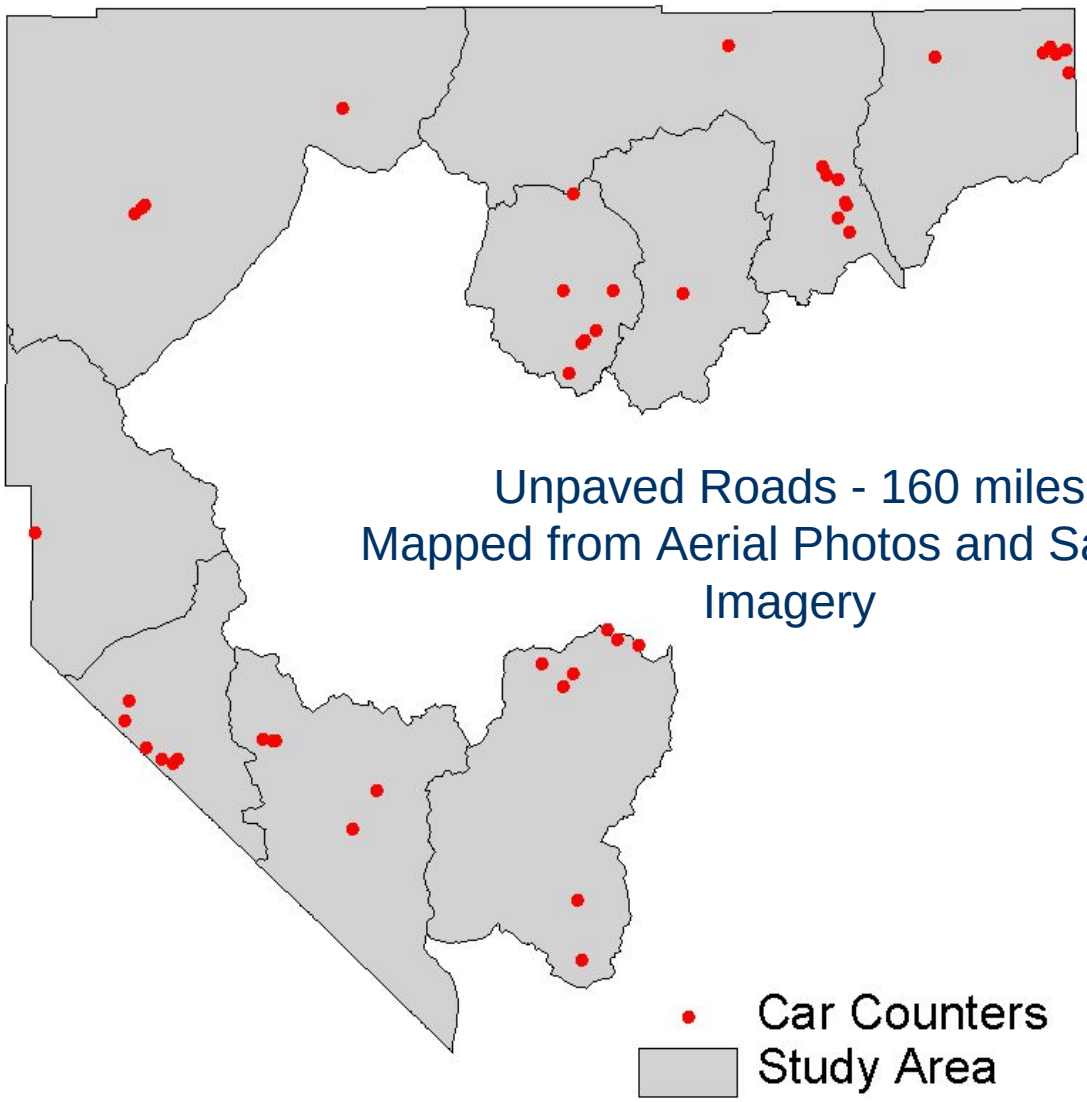
Vacant Land Type		Field Reference Data			
		Native Desert	Disturbed Stable	Disturbed Unstable	Row Total
Classified Data	Native Desert	32			32
	Disturbed Stable	8	20		28
	Disturbed Unstable		1	23	24
	Total	40	21	23	84
Overall Accuracy = 75 / 84 = 89%					

Procedure for Unpaved Roads

- No GIS maps available in expanded study area
- Use aerial photography and satellite imagery to map road segments
- Define unpaved road as 22 ft. minimum width
- Identify roads for traffic counts
- Collect traffic counts
- Evaluate traffic count data

IPV, Good Springs Mine Access: 31 ft wide

Locations of Car Counters



Unpaved Roads - 160 miles
Mapped from Aerial Photos and Satellite Imagery

Conclusions

- Landsat TM imagery is effective for land use mapping.
- Areas without urban features can be mapped with fewer land use categories.
- Naturally disturbed areas (playas, alluvial fans) are often mapped as Disturbed Stable/Unstable.
- Training sites for Disturbed Unstable are difficult to locate and are unevenly distributed.
- Mapping unpaved roads with satellite imagery and aerial photography is reasonably accurate.