VISUALIZATION AND MAPPING OF ACTIVE AND POTENTIAL MINE SITES IN ALASKA USING AERIAL AND SATELLITE BASED IMAGERY: APPLICATION OF REMOTE SENSING DATA FOR PERMITTING OF COAL MINES IN ALASKA

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2008 Geospatial Conference:
"Incorporating Geospatial Technologies
into SMCRA Business Processes"
March 25 - 27, 2008, Atlanta GA

Introduction

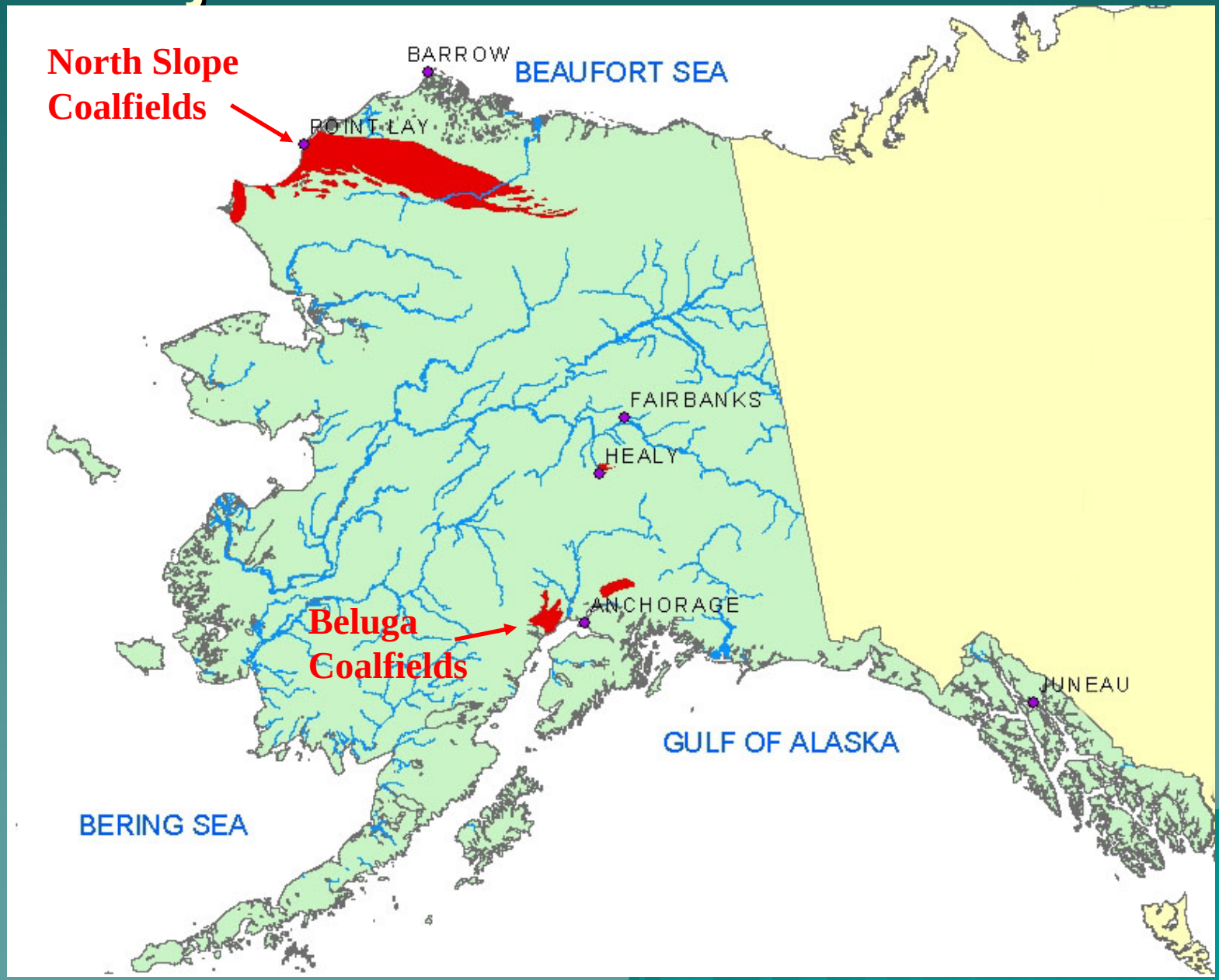
- This project uses current and historic imagery to map land cover changes in active and proposed mining areas.
- Two methods of performing change detection will be presented, Simple image difference and Post classification.
- This presentation will look at the steps taken to prepare and process the imagery.
- Images were processed using ERDAS IMAGINE and exported for use in ArcGIS.

Introduction (Cont.)

- Example 1: Usibelli Coal Mine is an active coal mine in the interior of Alaska. Aerial photography was used to show the changes in disturbance area and the extent of reclamation in different parts of the mining operations.

- Example 2: The Chuitna Coal Mine is a proposed mining project west of Anchorage. Pre-mining disturbances in this area include oil and gas development, logging, and extensive spruce beetle infestation. Many of these disturbances are hidden by revegetation.

Major Alaskan Coal Fields



Method 1: Change Detection: Simple Image Difference

- Image algebra produces a change image as the result of mathematical manipulation on the brightness values of the two input images.
- This method computes the differences between two images. The resultant image is the direct result of subtraction of the Before Image from the After Image
  - Band X(image1)-Band X (image2)=New Image.
- Pixels in the images that exceed a user-specified threshold are highlighted.

Method 1: Change Detection: Simple Image Difference

Advantage:

- Image algebra can be programmed or adjusted to depict the level of change required.
- Many of the algorithms are simple, and can be easily applied through the process of trial and error and logical reasoning.

Disadvantage:

- While change is highlighted, the thematic classes which have undergone change are not indicated.
- At times it is difficult to select the correct change/no-change threshold to highlight changes, often being accomplished by trial and error.

Method 2: Post-Classification Change Detection

- Compares the difference between independently classified images from each of the dates in question.
- Allows “from and to” classes to be calculated for each changed pixel.

Method 2: Post-Classification Change Detection

Advantage:

- As this method uses thematic images, any type of original imagery can be used.
- This allows easy use of differing imagery types, and even reduces problems with illumination and reflectance in differing images.

Disadvantage:

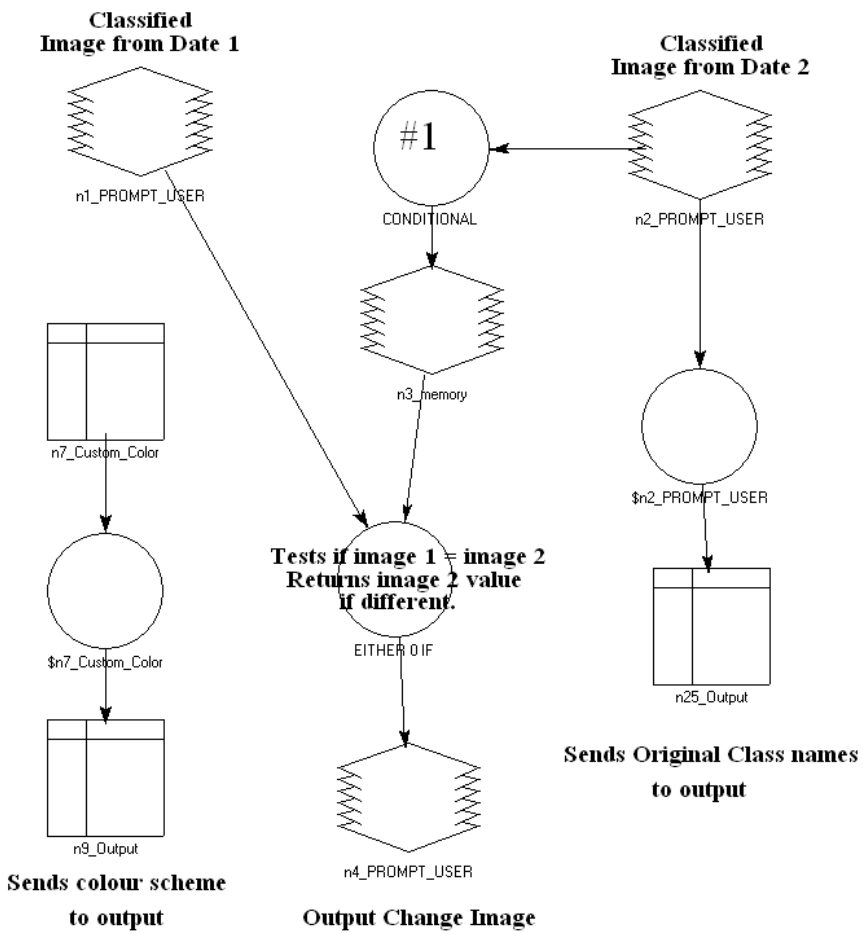
- Method requires two separate image classifications which can be time consuming depending on the dataset type and extent.
- Errors in each classification will be brought forward to the final change image.

c:/program files/leica geosystems/geospatial imaging 9.1/etc/models/cd_class_quantify2.gmd

File Edit Model Text Process Help

Change Detection for Classified Images

(Up to 6 Classes, Showing from and to Classes)

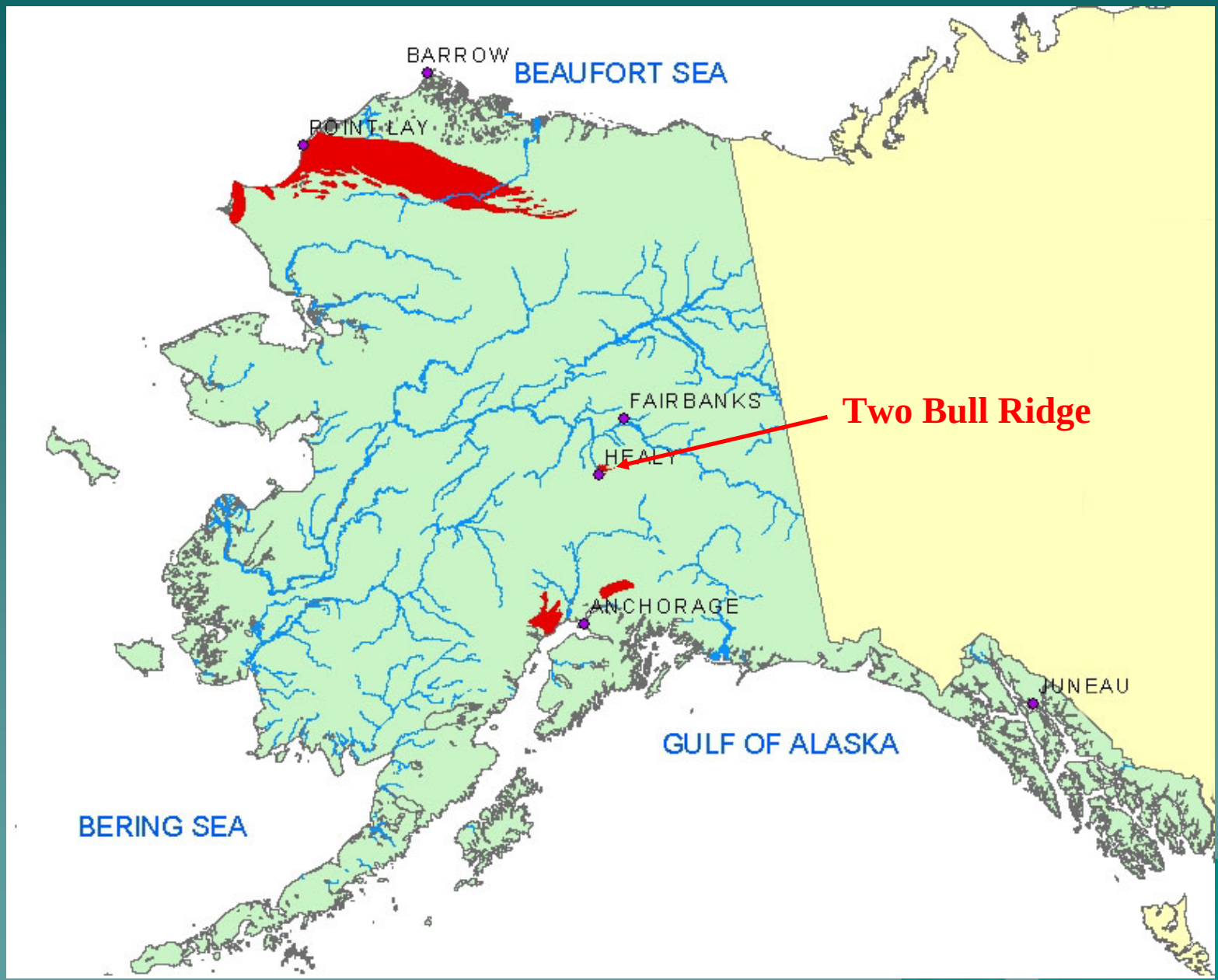


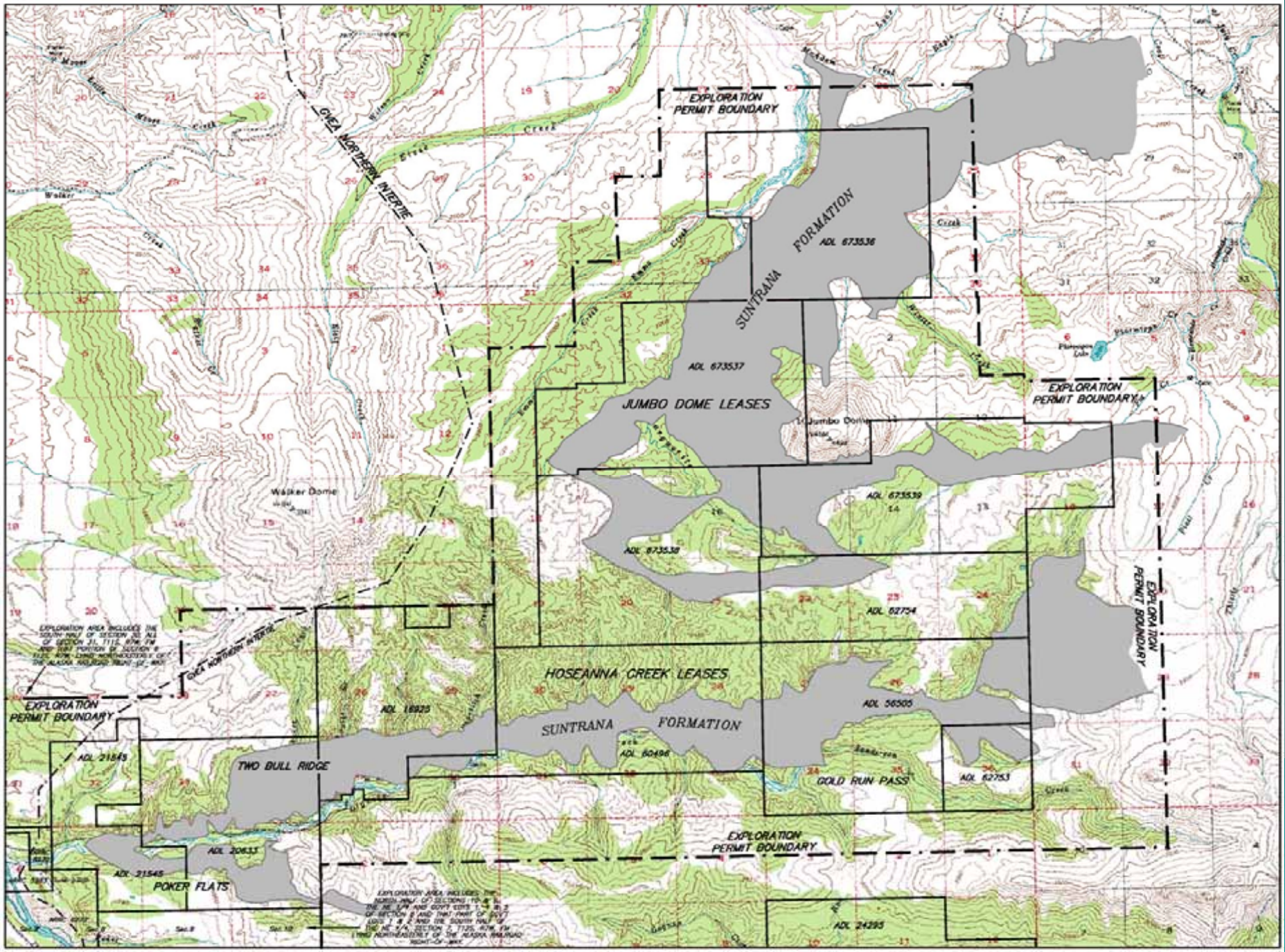
#1

CONDITIONAL { ($n2_PROMPT_USER==1) 10 , ($n2_PROMPT_USER==2) 20 , ($n2_PROMPT_USER==3) 30 , ($n2_PROMPT_USER==4) 40 ,($n2_PROMPT_USER==5) 50 , ($n2_PROMPT_USER==6) 60 , ($n2_PROMPT_USER==0) 0 , ($n2_PROMPT_USER >= 7) 0 }

Two Bull Ridge

- Operating since 1997
- Reserves of 40 mt, 20 year mine life
- Multi-seam operation
- Mining method is a combination of dragline and truck shovel.

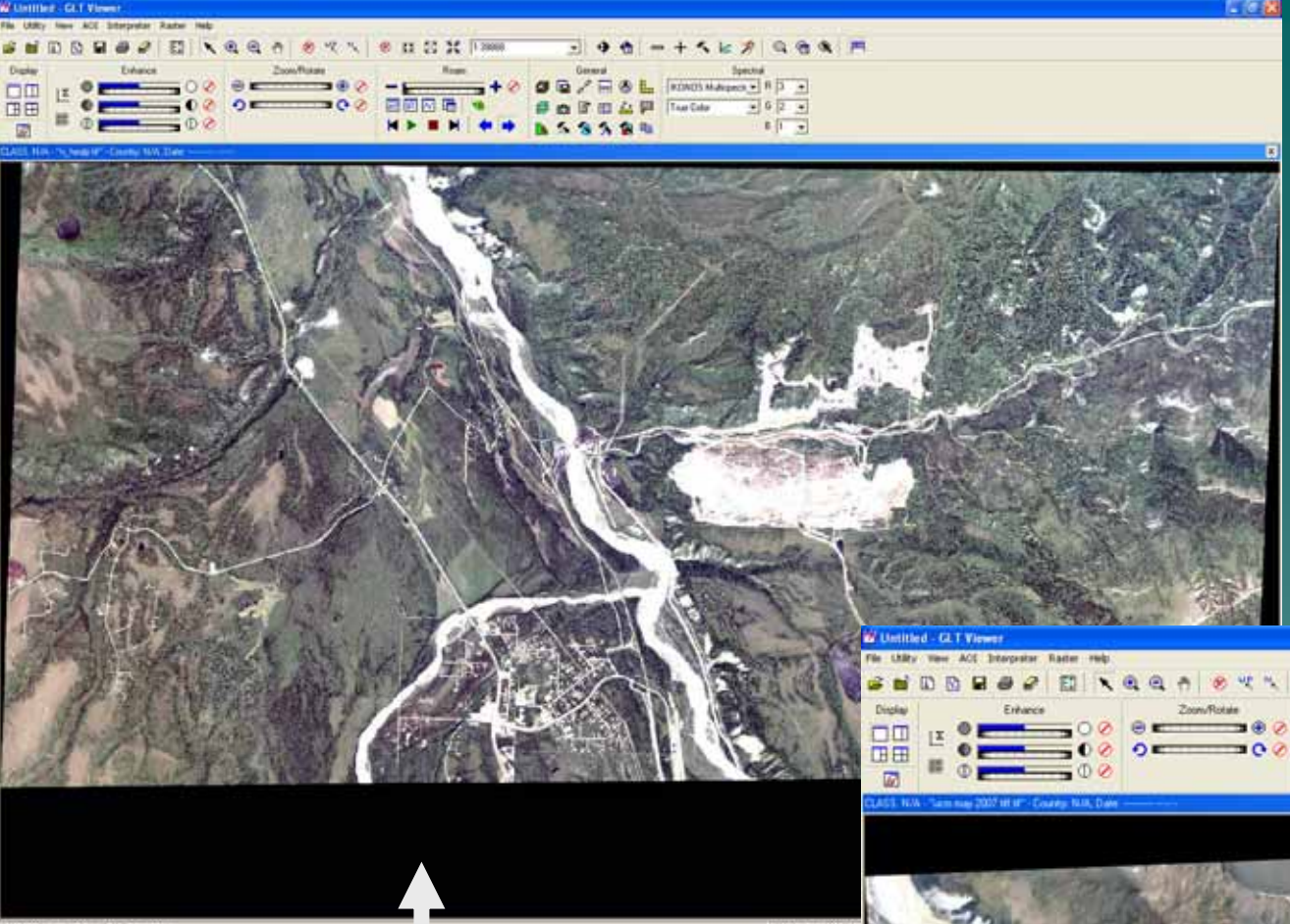

BARROW
BEAUFORT SEA
POINT LAY
FAIRBANKS
Two Bull Ridge
HEALY
ANCHORAGE
JUNEAU
GULF OF ALASKA
BERING SEA


EXPLORATION PERMIT BOUNDARY
GVEA NORTHERN INTERTIE
SUNTRANA FORMATION
ADL 673536
ADL 673537
JUMBO DOME LEASES
Jumbo Dome
Walker Dome
ADL 673539
ADL 673538
ADL 62754
HOSEANNA CREEK LEASES
ADL 56505
ADL 16925
SUNTRANA FORMATION
ADL 60496
ADL 21845
TWO BULL RIDGE
GOLD RUN PASS
ADL 62753
ADL 20633
ADL 21545
POKER FLATS
ADL 24295
EXPLORATION AREA INCLUDES THE SOUTH HALF OF SECTION 30, ALL OF SECTION 31, T11S, R7W, FM AND THAT PORTION OF SECTION 6, T12S, R7W, LYING NORTHEASTERLY OF THE ALASKA RAILROAD RIGHT-OF-WAY.
EXPLORATION AREA INCLUDES THE NORTH HALF OF SECTIONS 19 & 30, THE NE 1/4 AND GOVT LOTS 1, 2 & 3 OF SECTION 6 AND THAT PART OF GOVT LOTS 1 & 2 AND THE SOUTH HALF OF THE NE 1/4 OF SECTION 1, T12S, R7W, FM LYING NORTHEASTERLY OF THE ALASKA RAILROAD RIGHT-OF-WAY.

Purpose

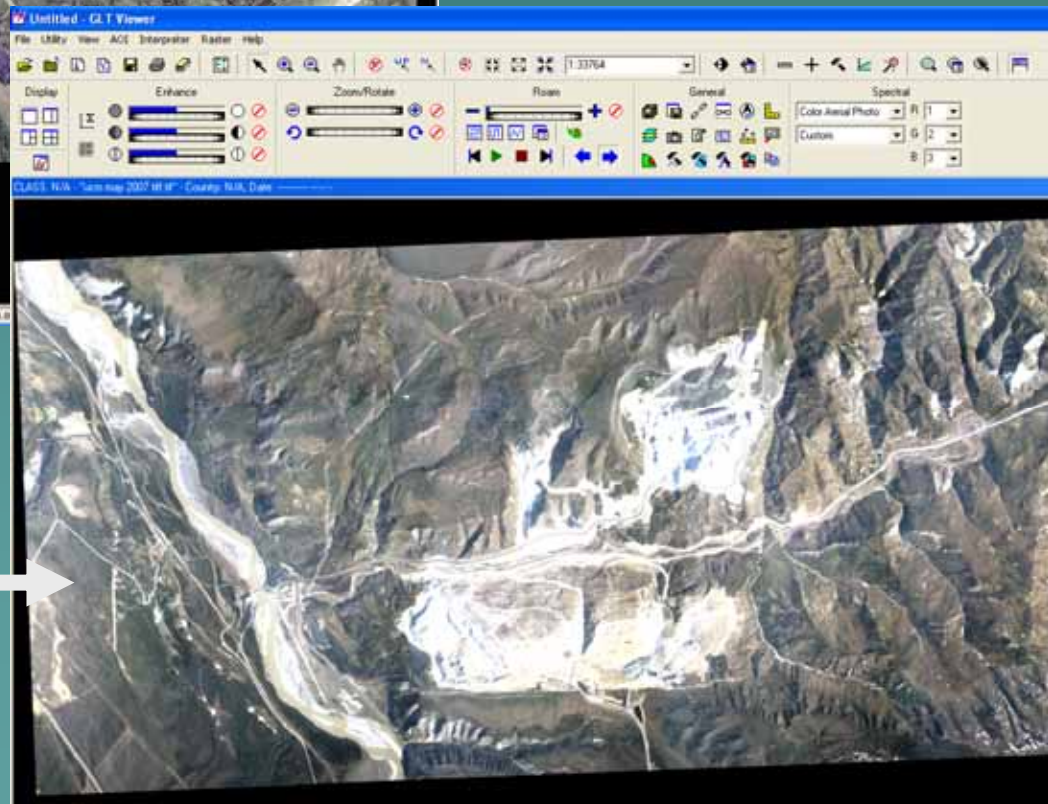
- Track year to year changes in disturbed and reclaimed areas using available resources.

Unclipped Imagery

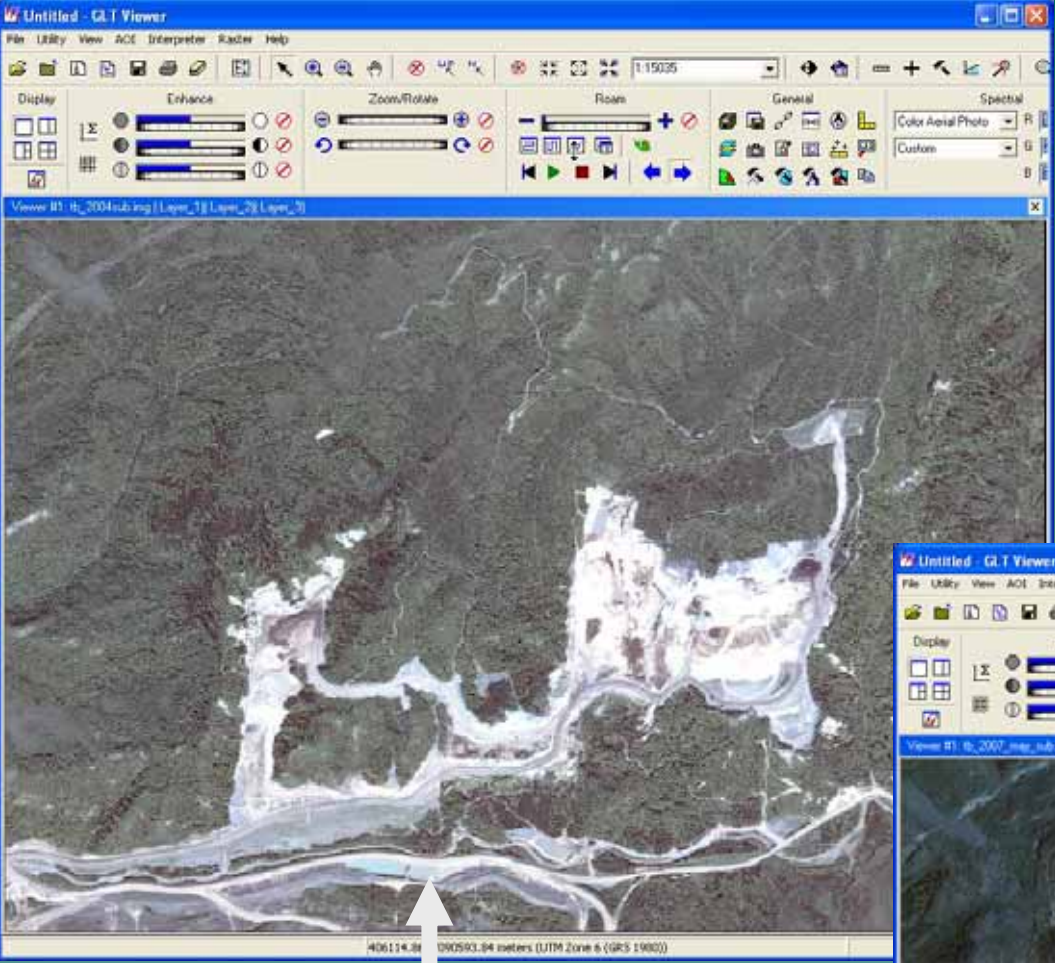


2004

2007

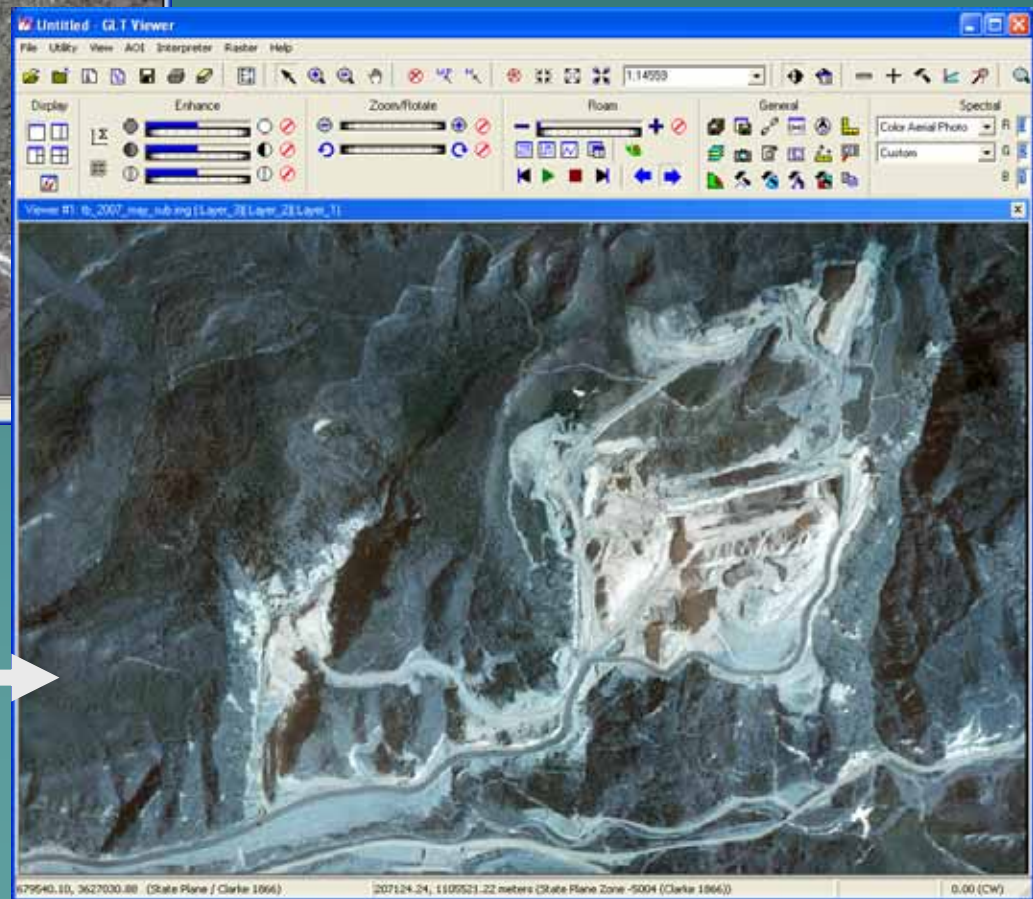


Clipped

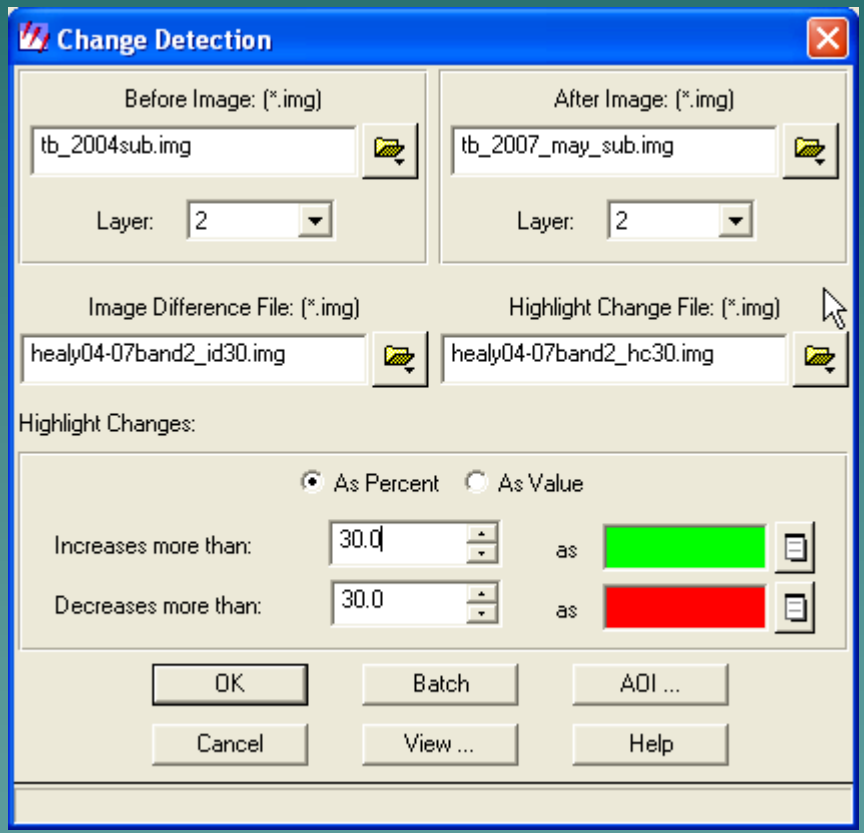


2004

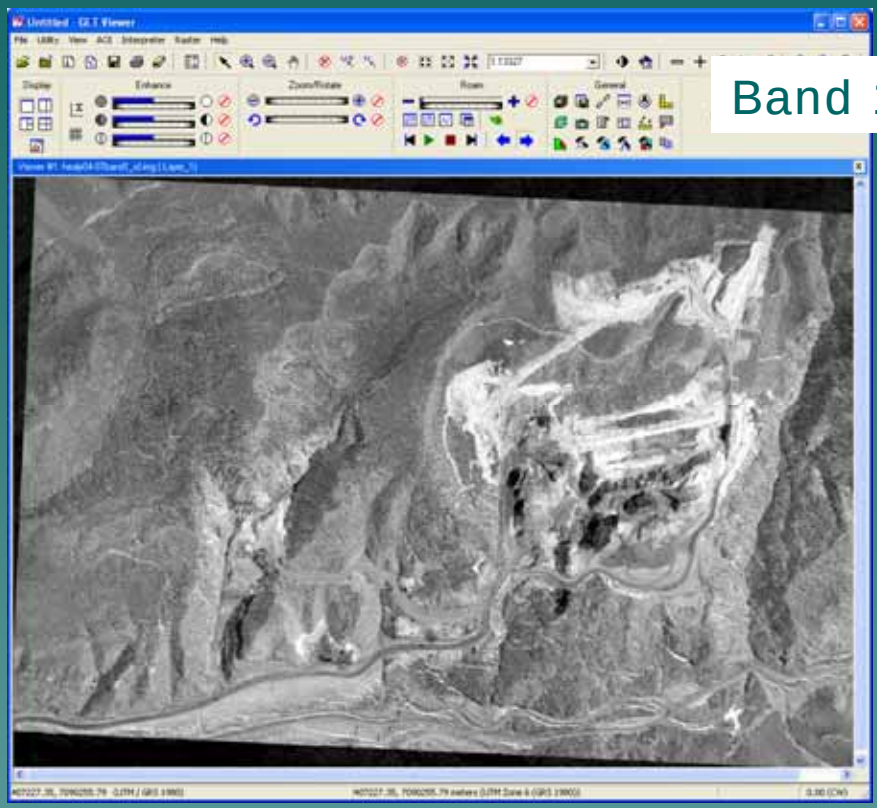
2007



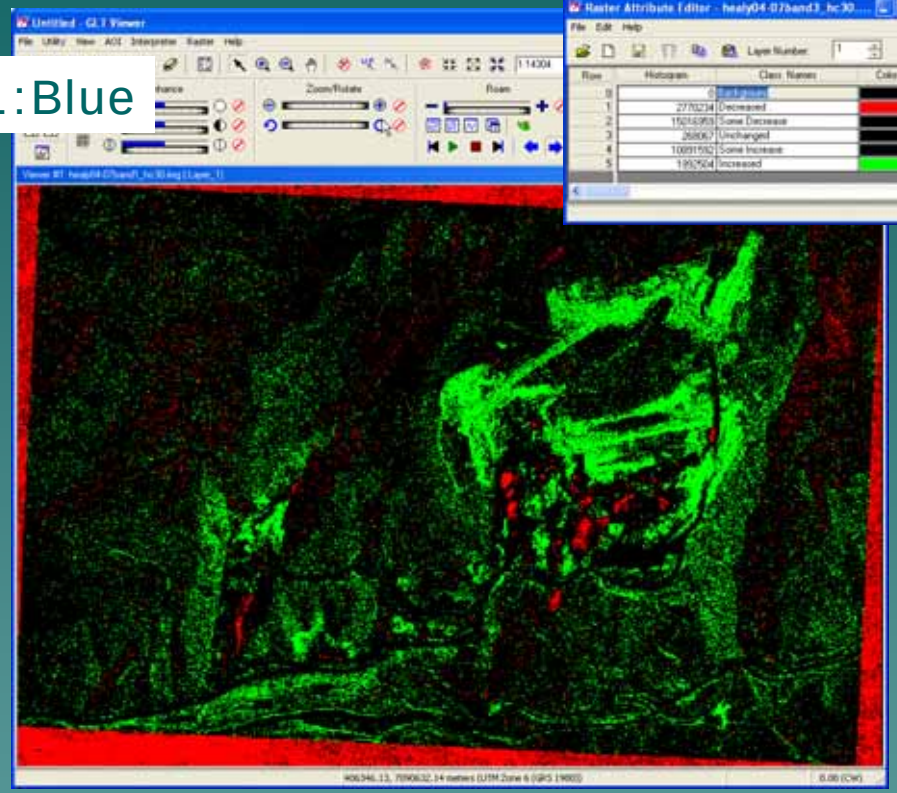
Change Detection: Simple Image Difference

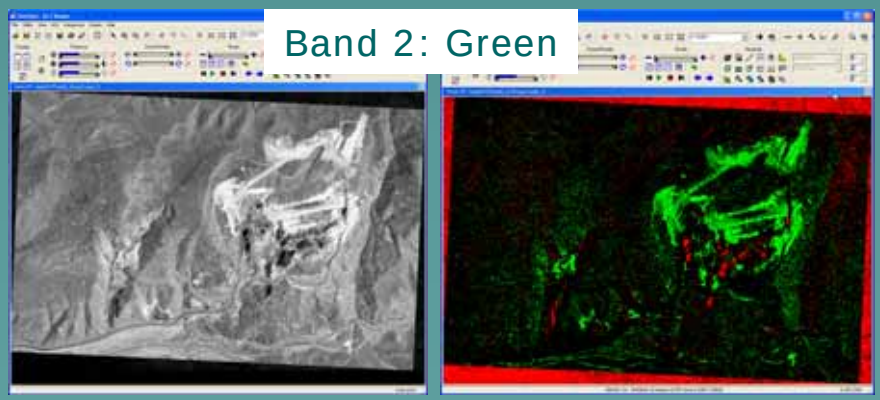


Simple Image Difference

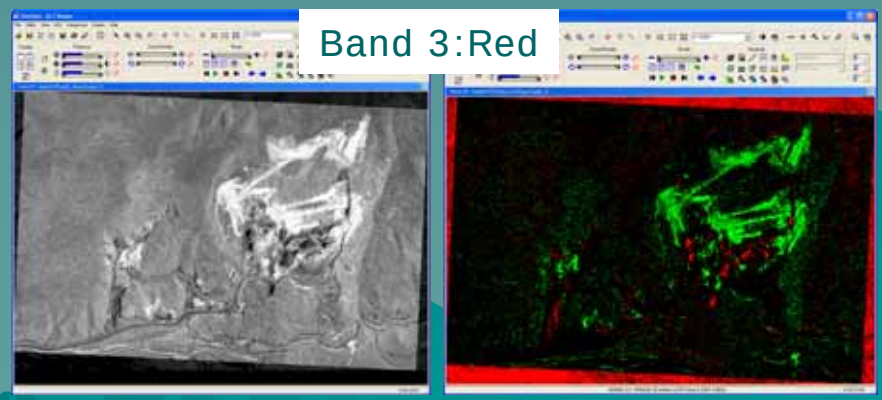


Band 1:Blue



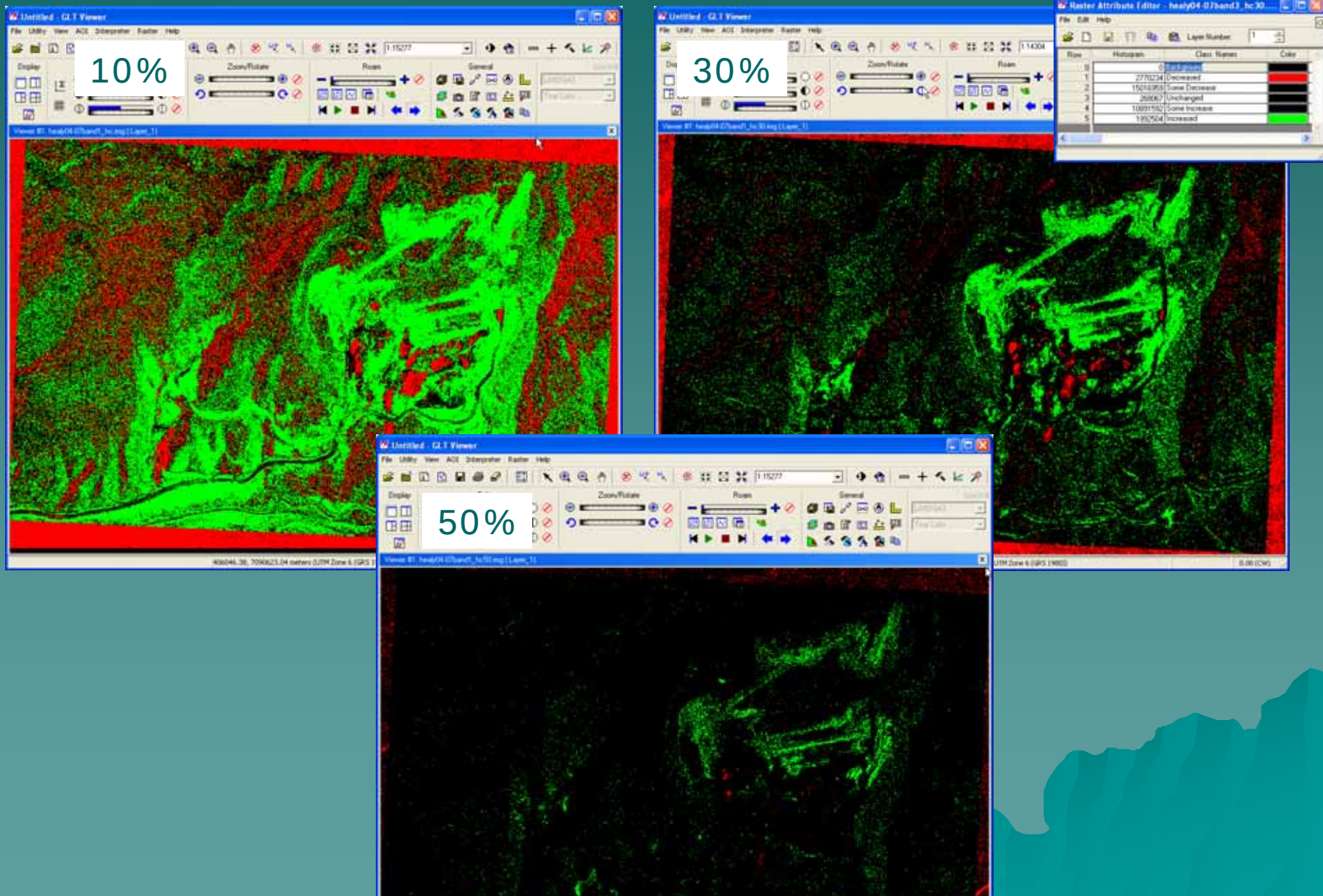


Band 2: Green

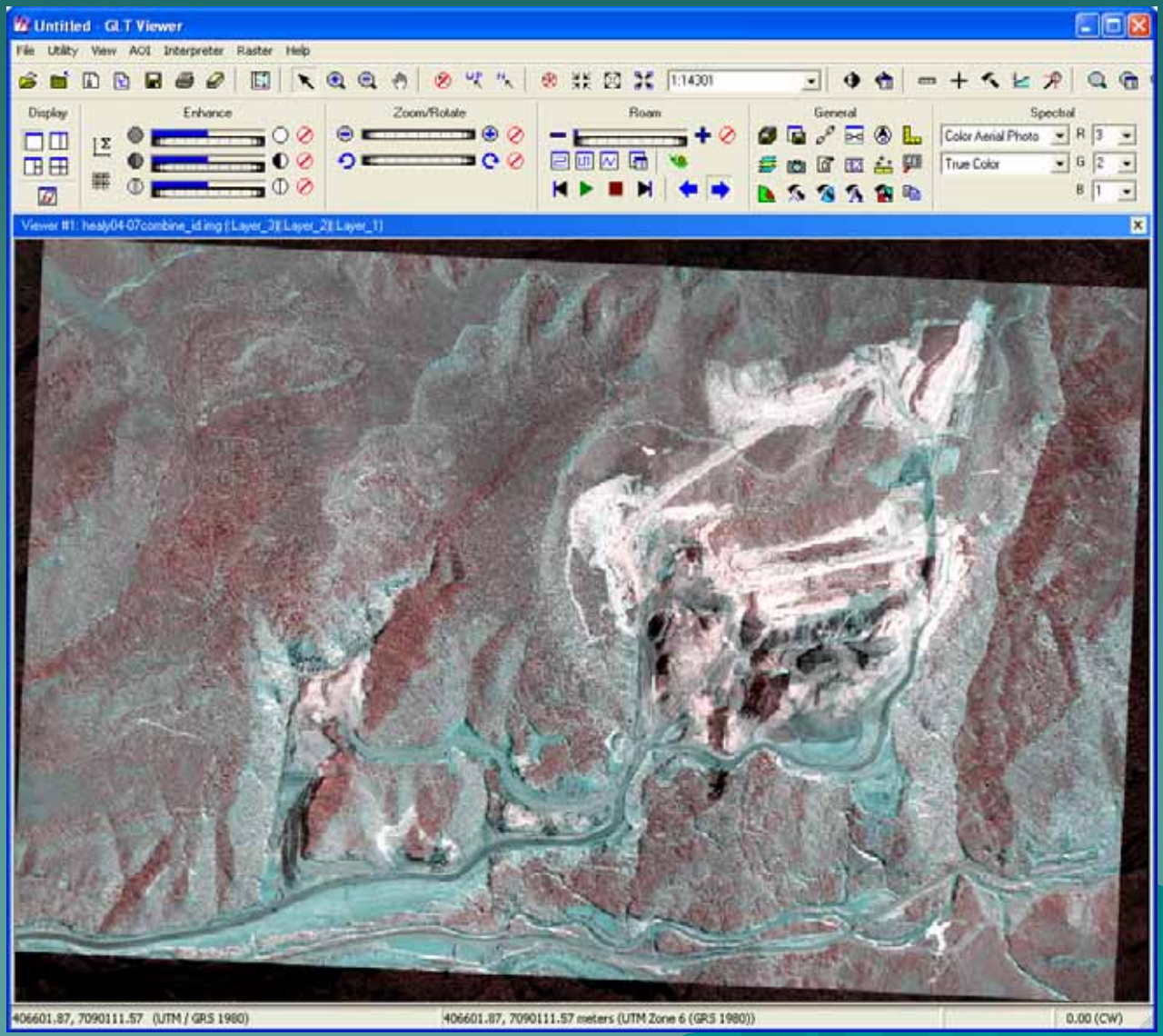


Band 3:Red

How Much Change is Important?



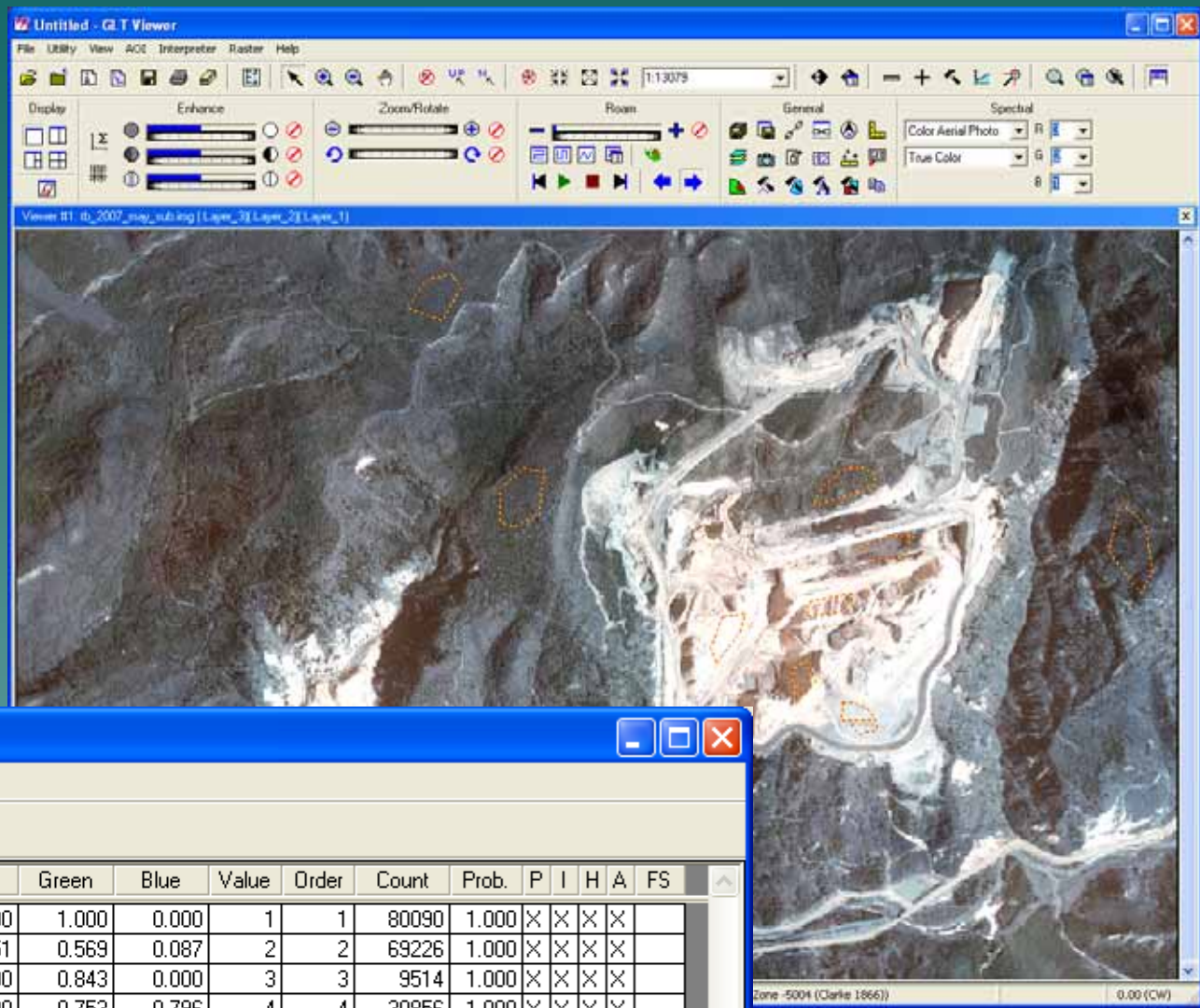
Simple Image Difference : Layer Stack



Post-Classification Change Detection

- For both the 2004 and 2007 imagery, two training sets of 3 and 6 classes each were picked for the supervised classification.
- Training areas were picked and in some cases combined to maximize the signature quality of each class.
- General classes for both the 3 and 6 classes are undisturbed, disturbed and reclaimed.

Image Classification: Training Areas

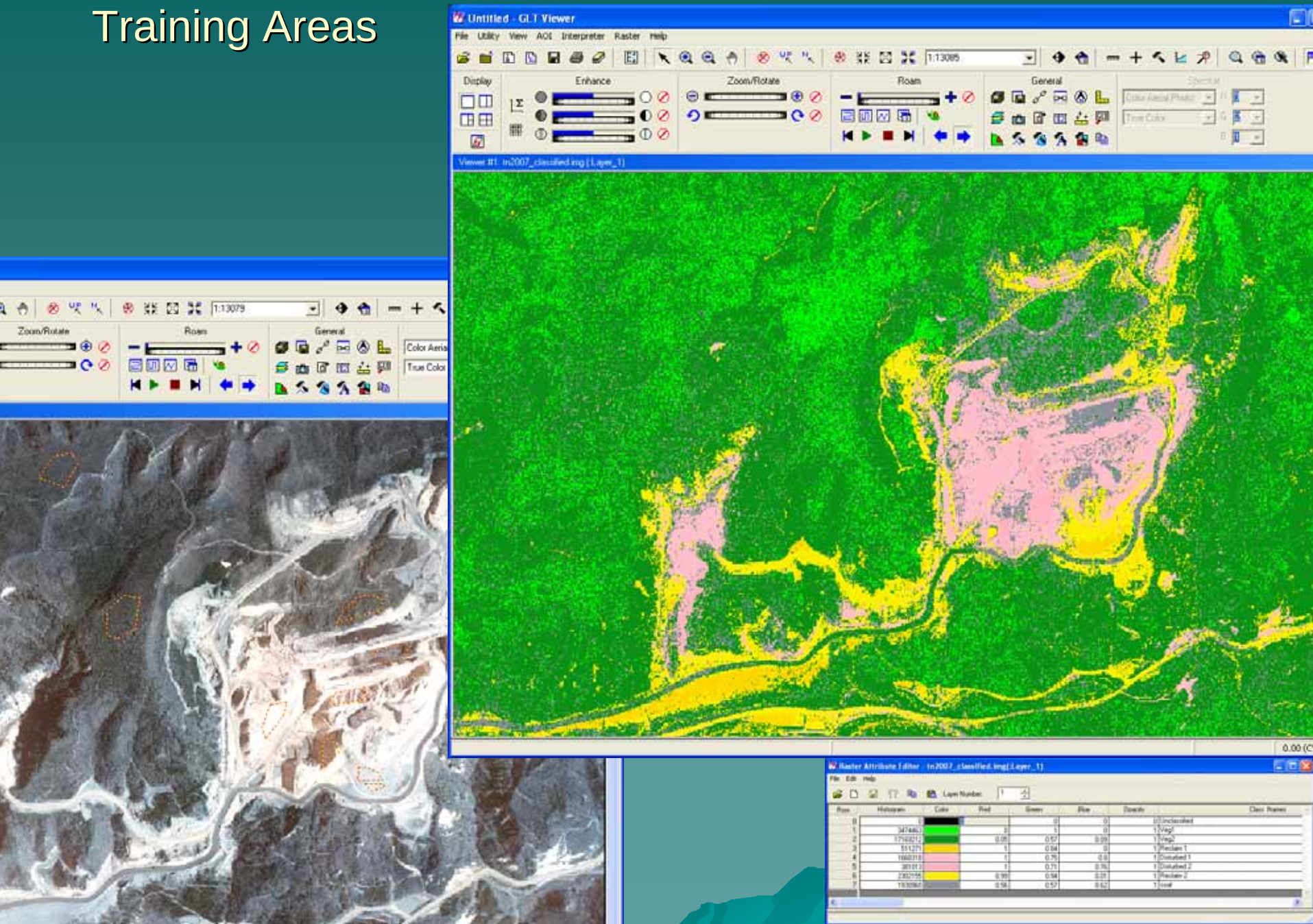


Signature Editor (firstpass.sig)

File Edit View Evaluate Feature Classify Help

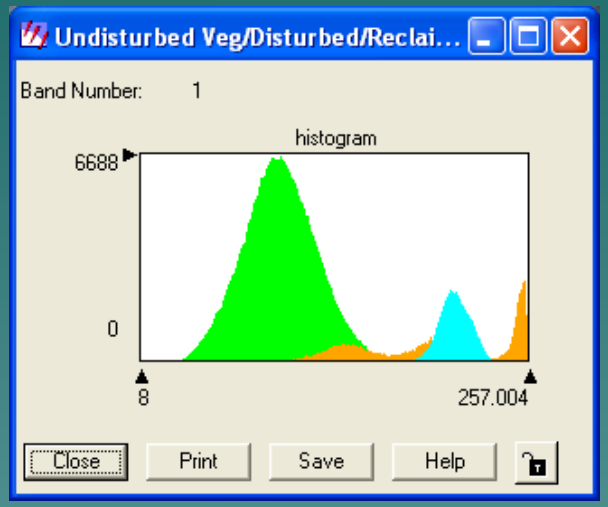
Class #	Signature Name	Color	Red	Green	Blue	Value	Order	Count	Prob.	P	I	H	A	FS
1	Veg1		0.000	1.000	0.000	1	1	80090	1.000	X	X	X	X	
2	Veg2		0.051	0.569	0.087	2	2	69226	1.000	X	X	X	X	
3	Reclaim 1		1.000	0.843	0.000	3	3	9514	1.000	X	X	X	X	
4	Disturbed 1		1.000	0.753	0.796	4	4	30856	1.000	X	X	X	X	
5	Disturbed 2		1.000	0.714	0.757	5	5	17386	1.000	X	X	X	X	
6	Reclaim 2		0.989	0.944	0.011	6	6	9931	1.000	X	X	X	X	
7	coal		0.559	0.569	0.620	7	7	8794	1.000	X	X	X	X	

Image Classification: Training Areas

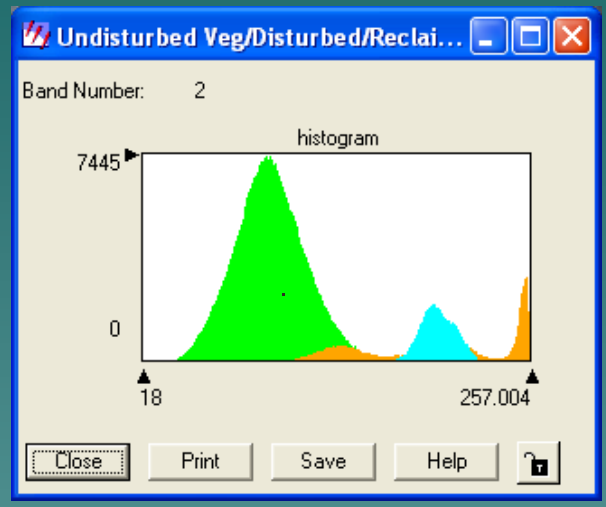


Three Class Classification: Training Area Histogram

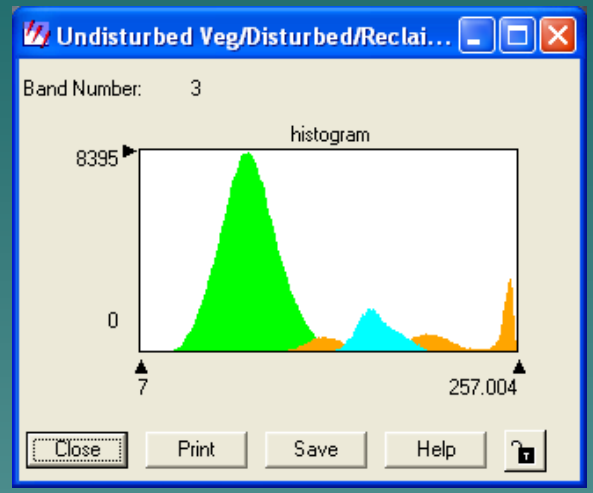
Blue

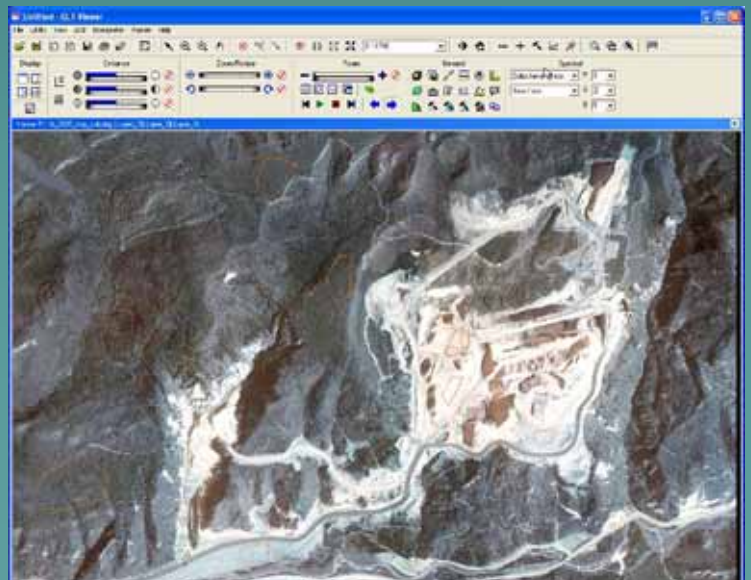


Green



Red

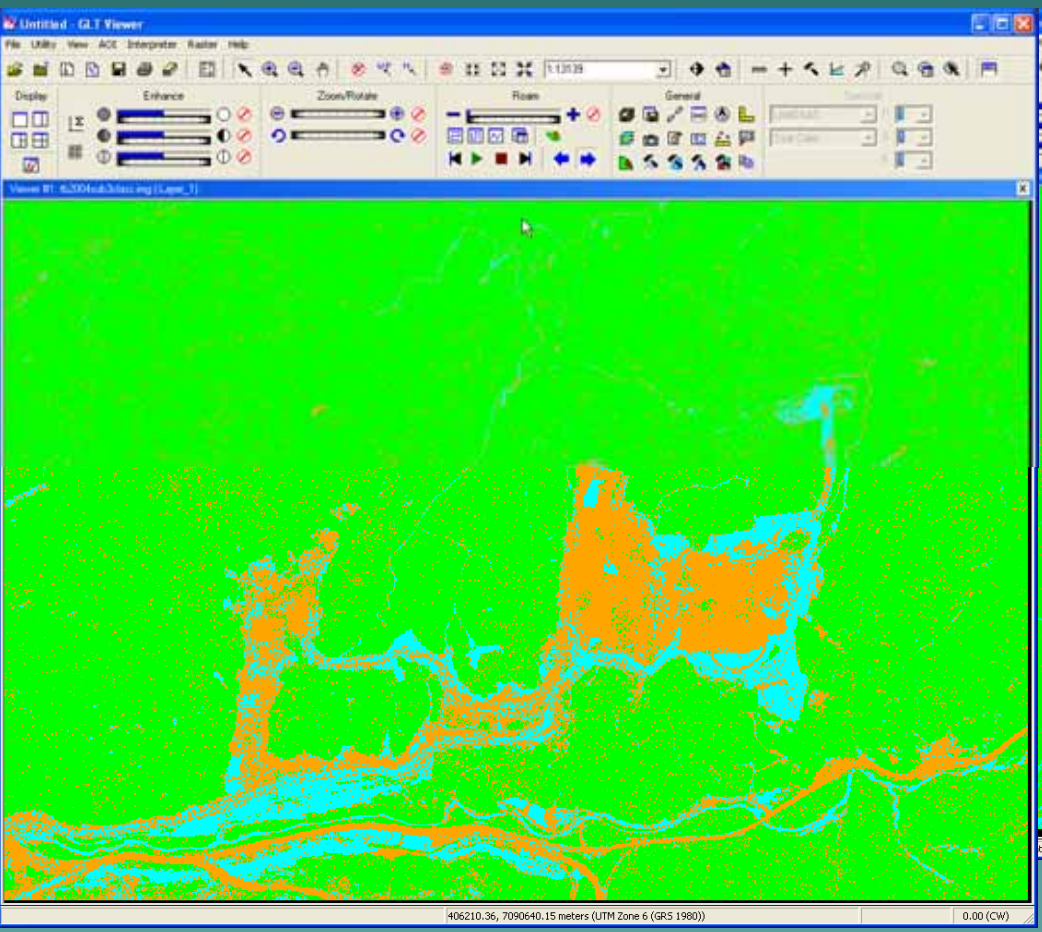




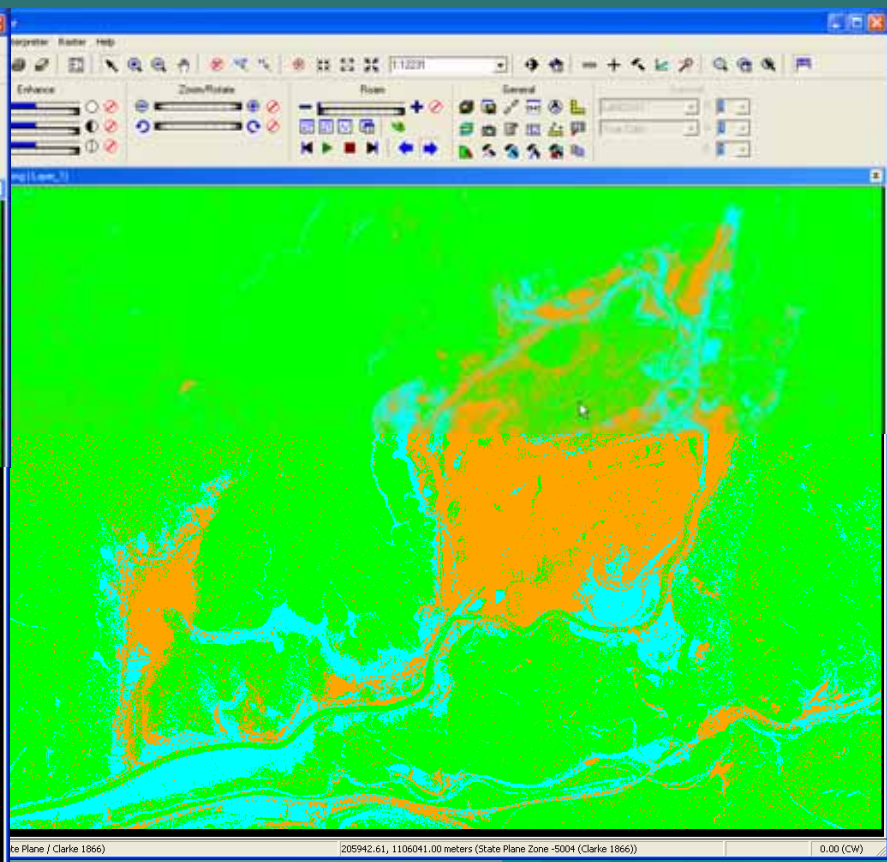
Class #	Signature Name	Color	Red	Green	Blue	Value	Order	Count	Prob.	P
1	Undisturbed Veg		0.000	1.000	0.000	4	4	375061	1.000	X
2	Disturbed		1.000	0.647	0.000	5	8	80053	1.000	X
3	Reclaimed		0.000	1.000	1.000	3	11	55808	1.000	X

Three Class Classification: Classification Results

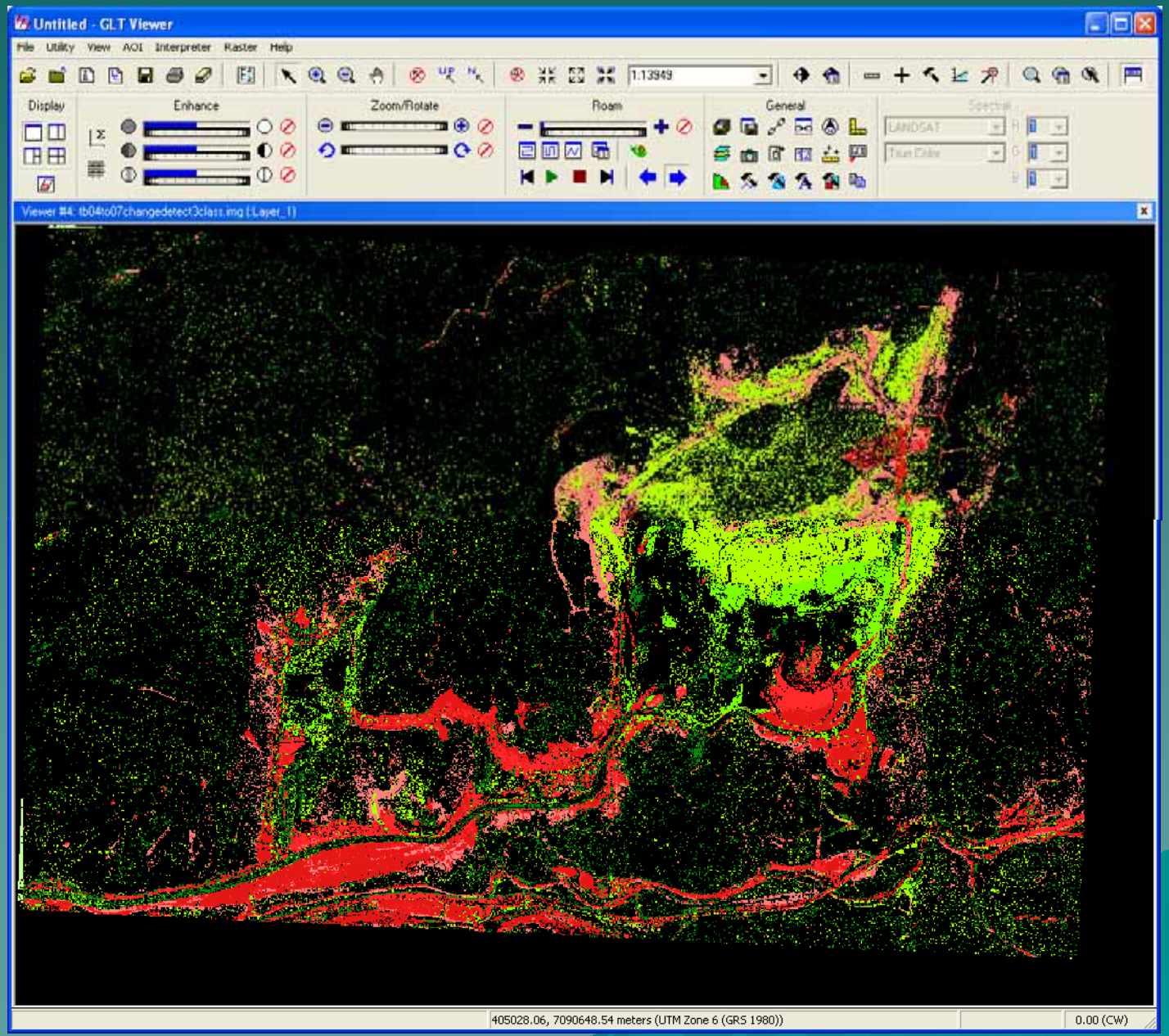
2004

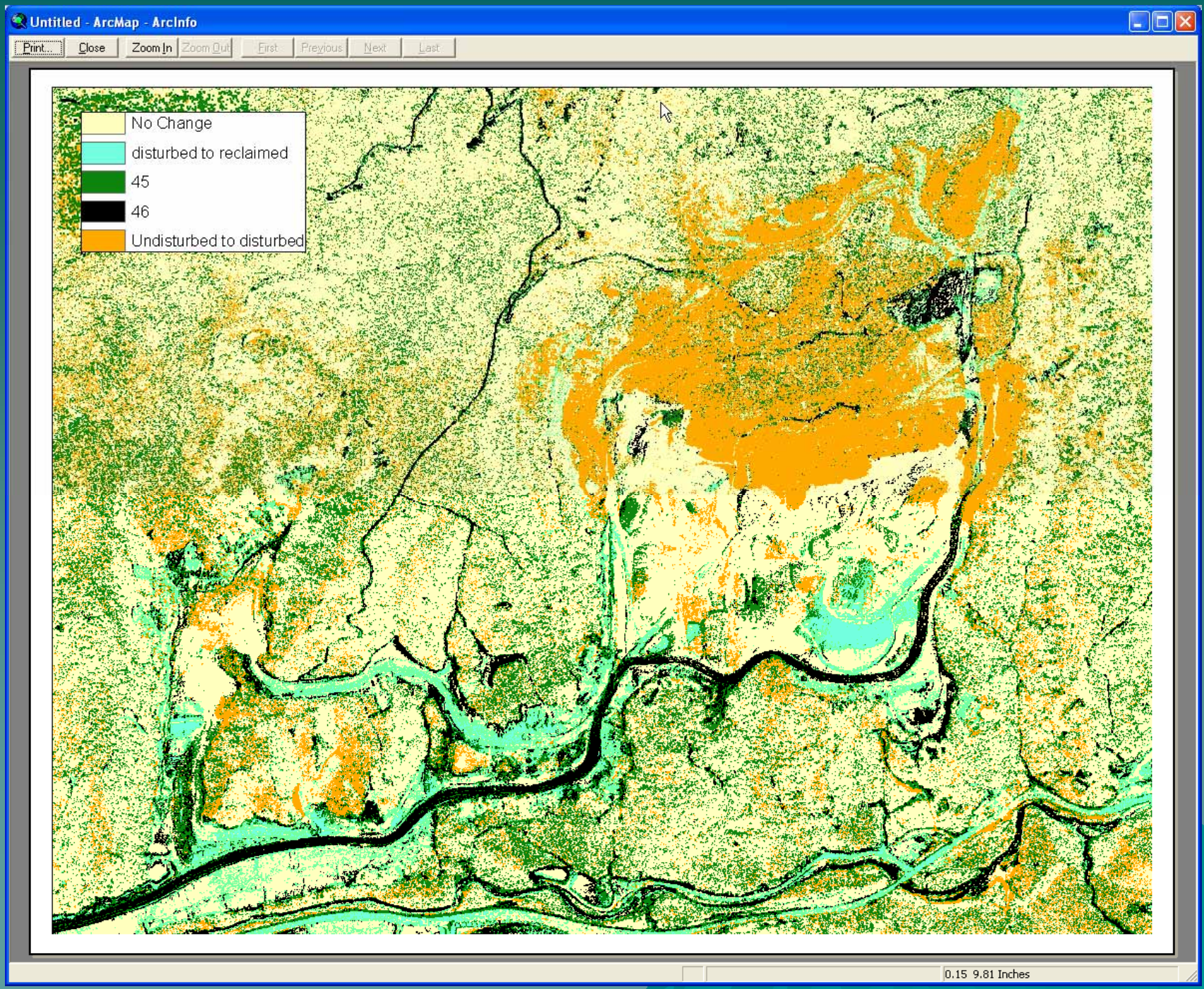


2007



Change Detection: Raw Results



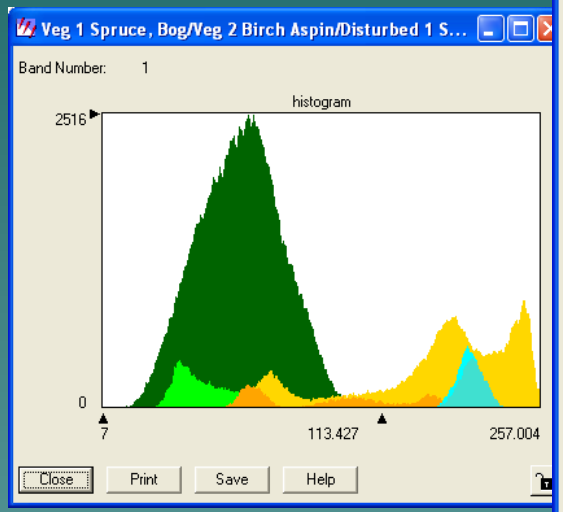

Untitled - ArcMap - ArcInfo
Print...
Close
Zoom In
Zoom Out
First
Previous
Next
Last
No Change
disturbed to reclaimed
45
46
Undisturbed to disturbed
0.15 9.81 Inches

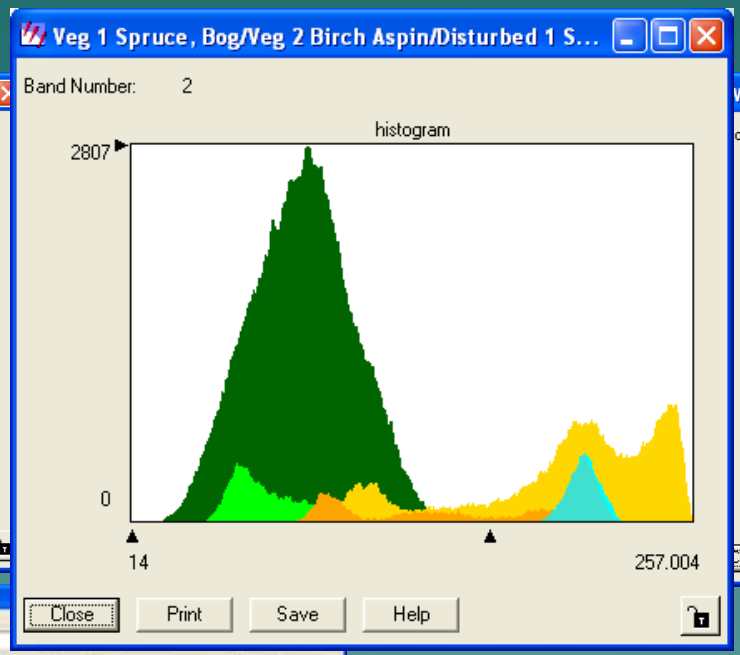
Six Class Classification: Training Area Histogram

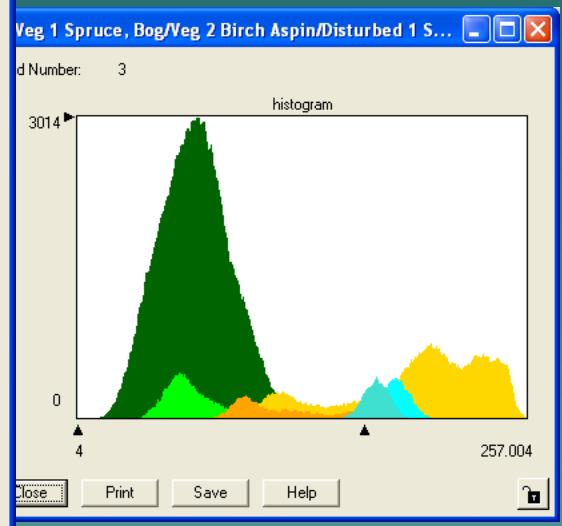
Green

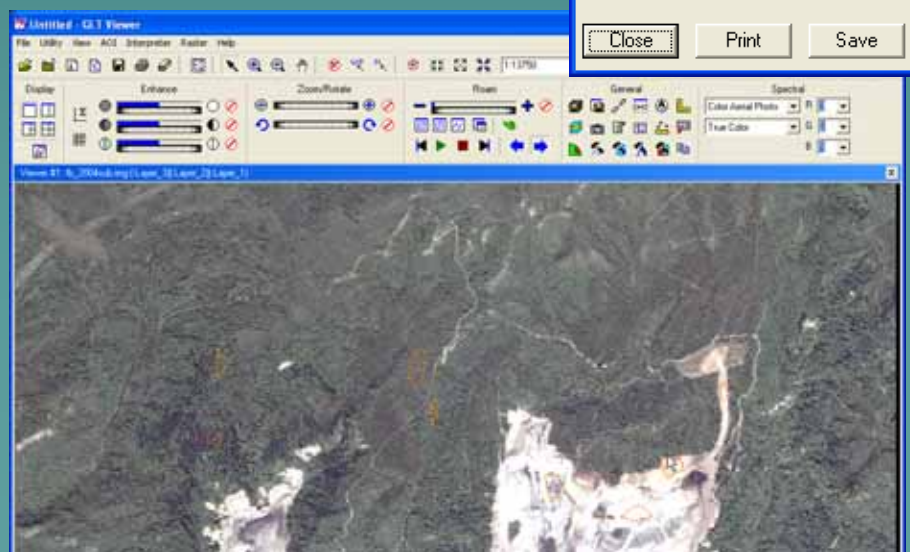
Blue

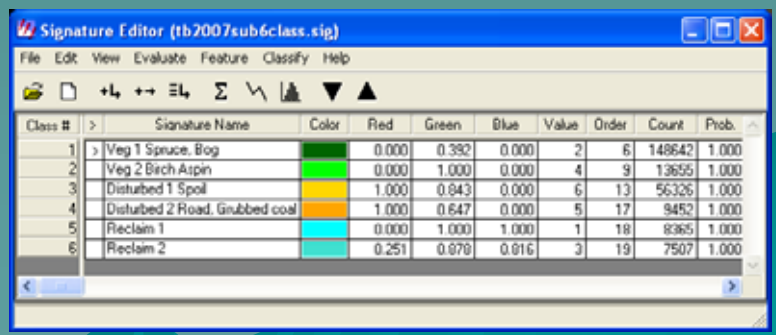
Red



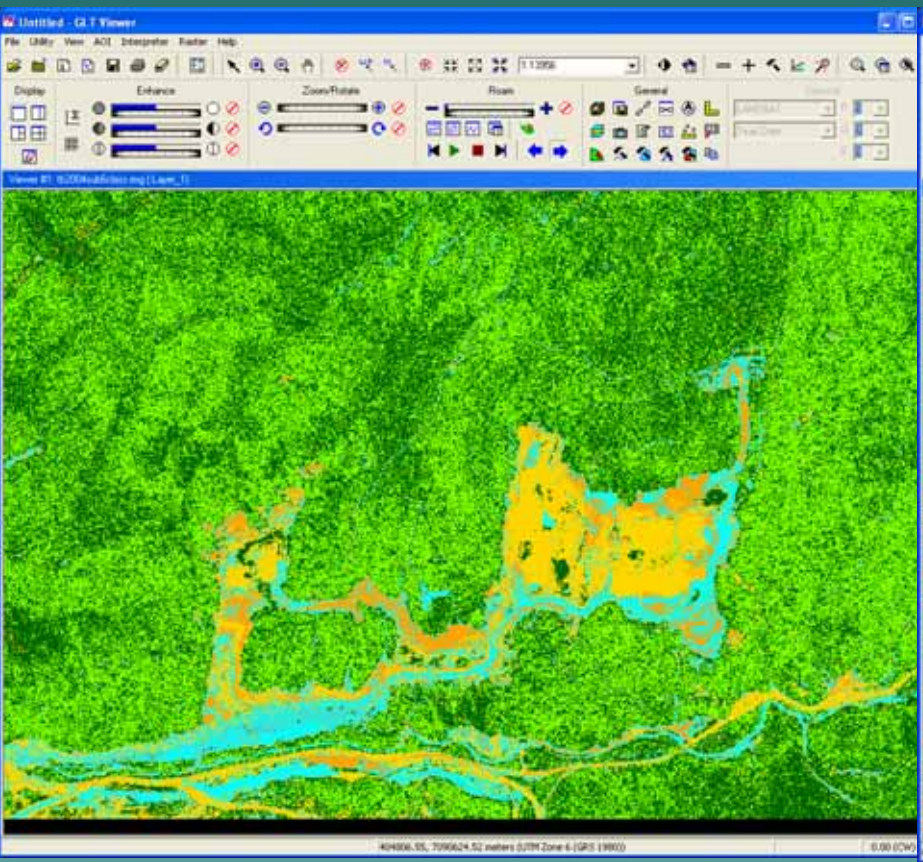


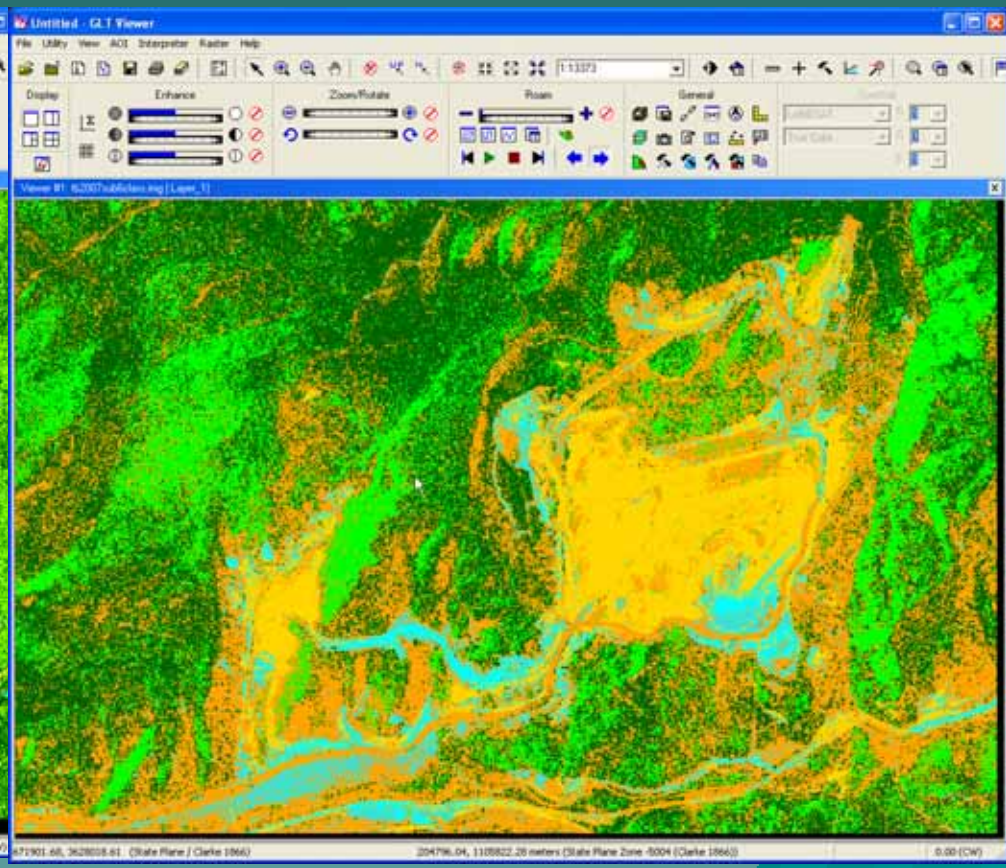




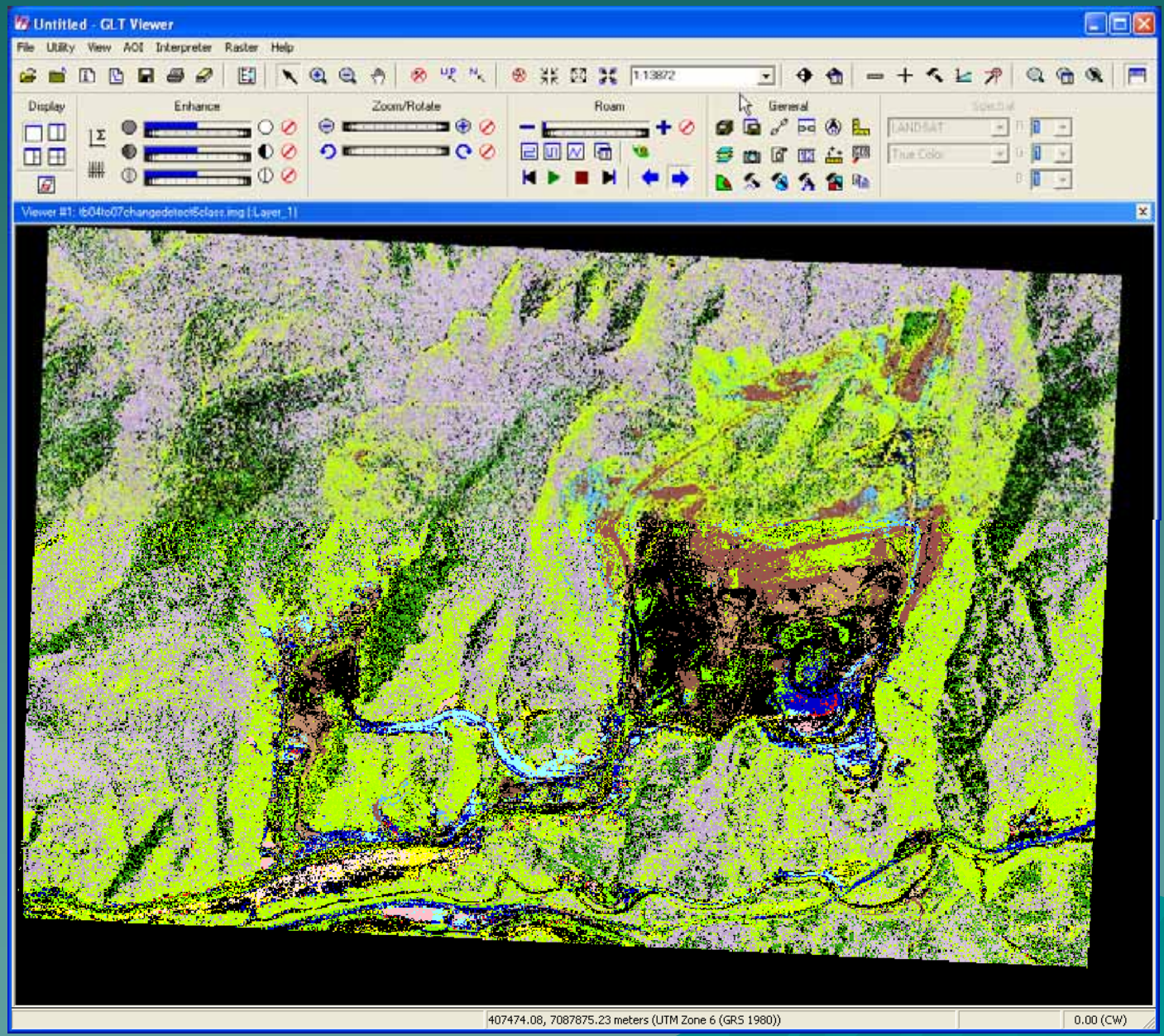


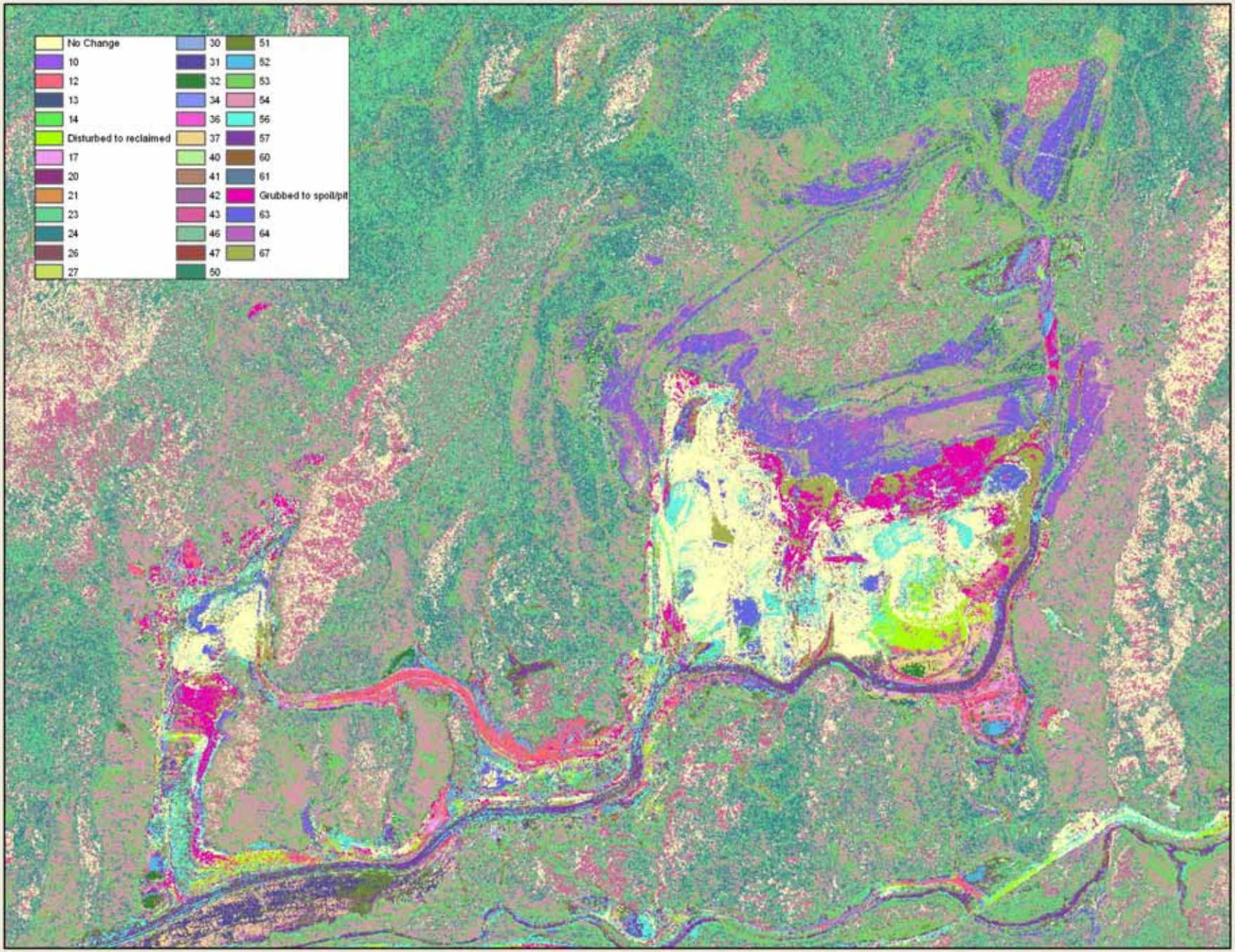
Six Class Classification: Training Area Histogram





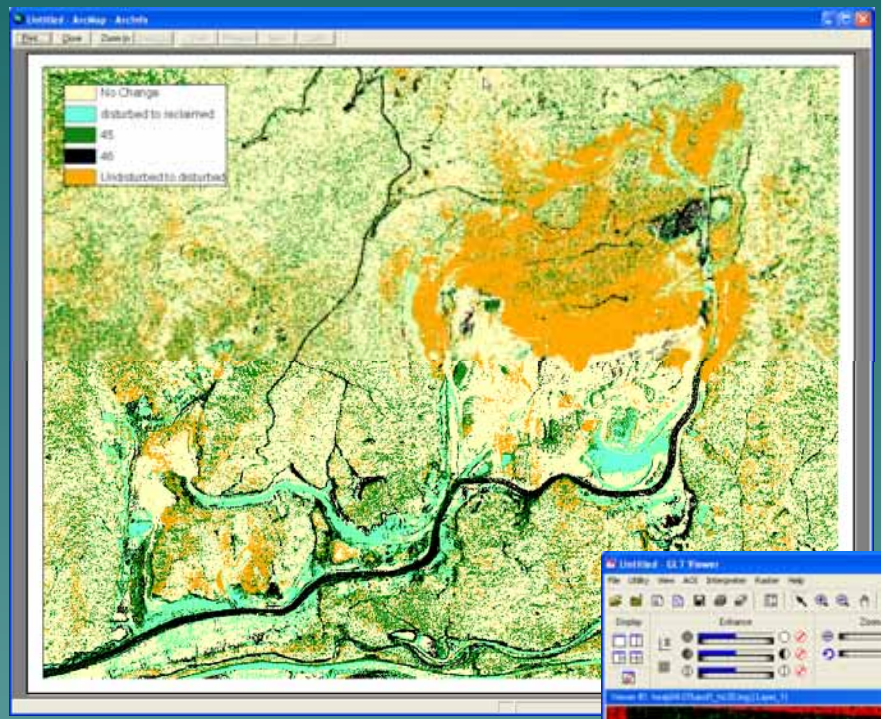
Change Detection: Raw Results




No Change
10
12
13
14
Disturbed to reclaimed
17
20
21
23
24
26
27
30
31
32
34
36
37
40
41
42
43
46
47
50
51
52
53
54
56
57
60
61
Grubbed to spoil/pit
63
64
67

Review: How did the results stack up?

3 Classes



6 Classes

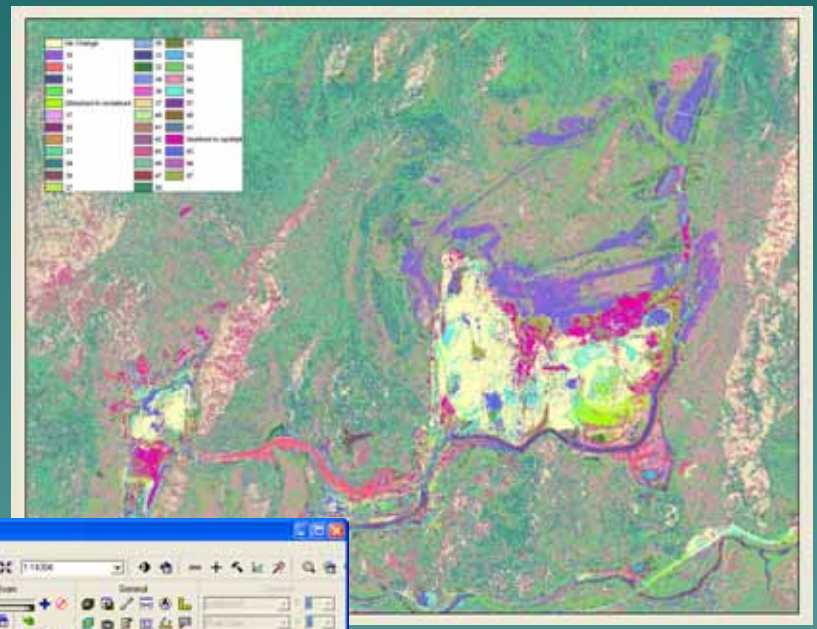
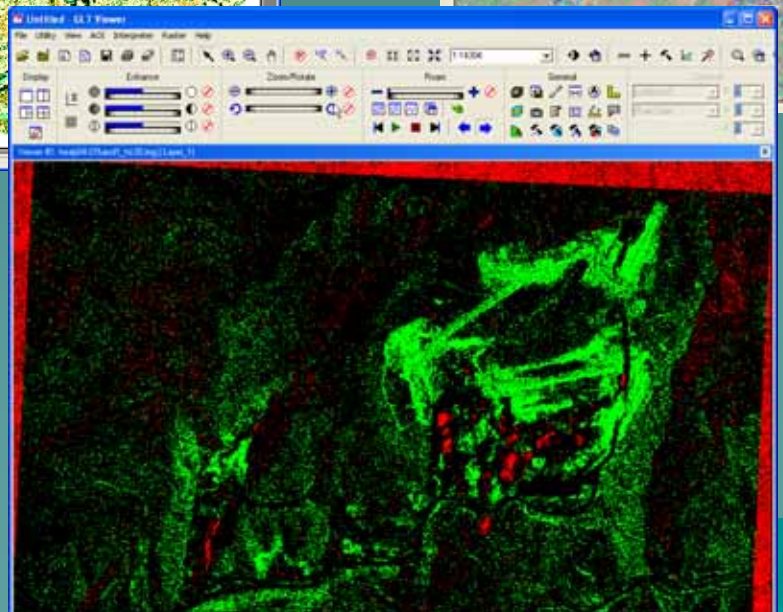


Image diff.



Conclusions:

Image Difference Change Detection

- Image algebra can be programmed or adjusted to depict the level of change required.
- Can be difficult to select the correct change/no-change threshold to highlight changes, often being accomplished by trial and error.
- Results are limited to change or no change.

Conclusions
(Post-classification Change Detection)

- Allows for the comparison of a wide variety of imagery at different times and sun aspect.
- Accuracy of this method depends on how robust the initial classification of the before and after imagery.
- Initial processing of the classified imagery can be time consuming.
- More classes in the original classification does not mean better results.

Questions?

Thank You

Chuitna

Chuitna Coal Project

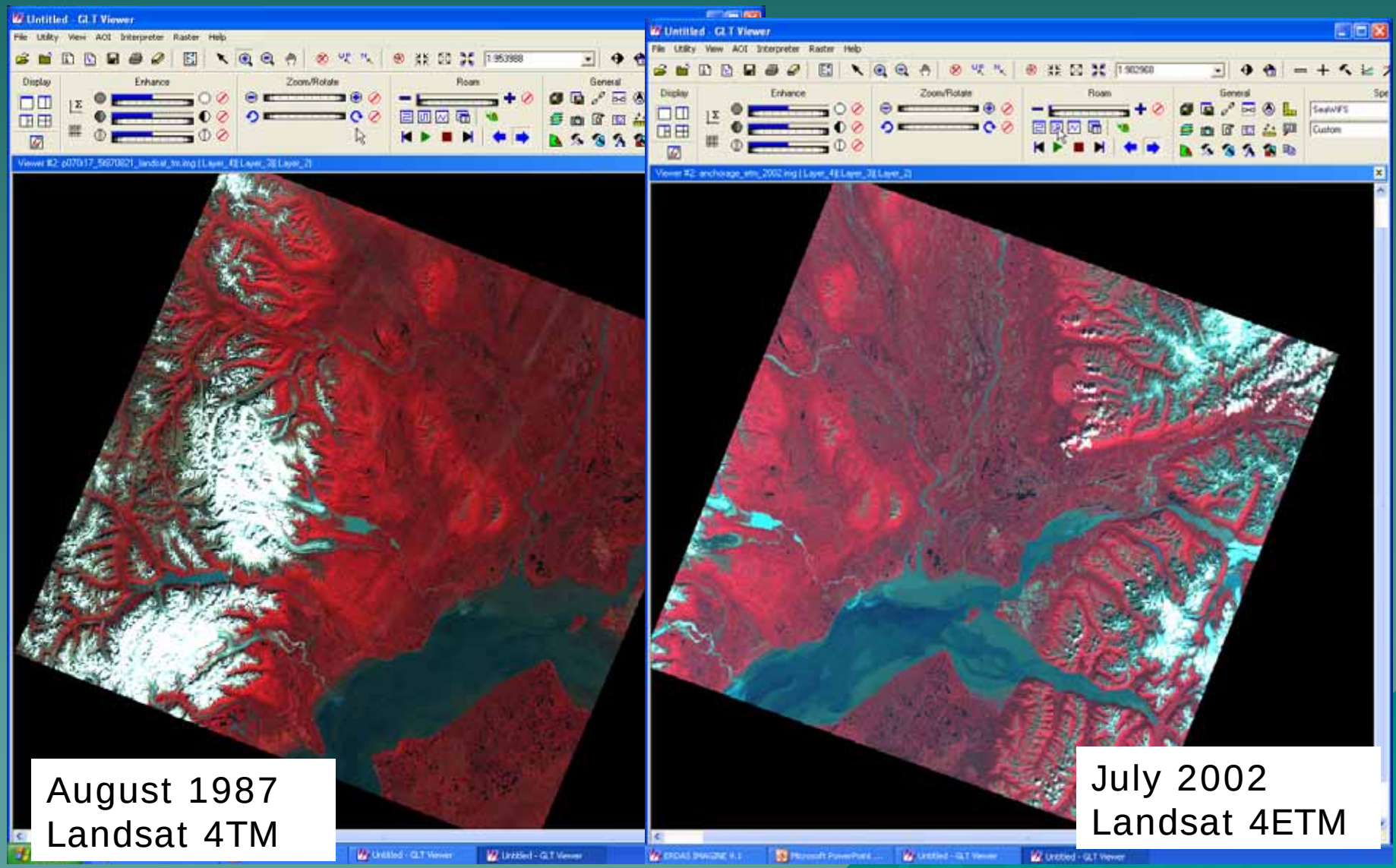
Applicant: Pac Rim Coal

Est. Production: 12million tons/year

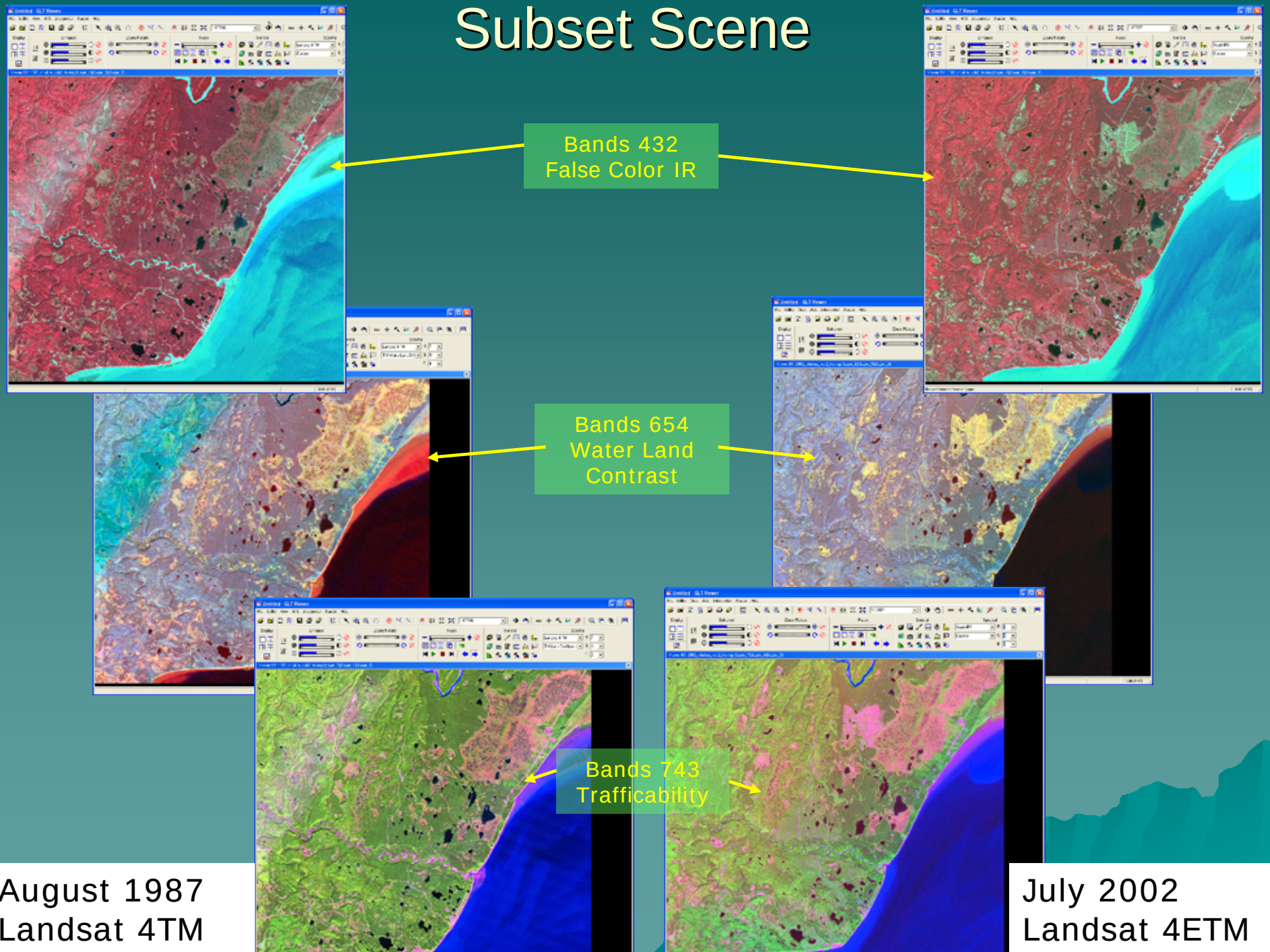
Location: 70 km west of Anchorage

Primary access routes

Full Scene Landsat 4 & 7



Subset Scene



August 1987
Landsat 4TM

July 2002
Landsat 4ETM

Change Detection: Simple Image Difference

Post-Classification Change Detection

Post-Classification Change Detection

CD result