

# Hyperspectral Sensing Technology for Best Practice Mine Environmental Management - Dream or Reality?

**Cindy ONG**

# The dream .....



## HIGH IMPACT - KEY MINE ENVIRONMENTAL ISSUES IN AUSTRALIA

- **Acid Drainage**
- **Rehabilitation – Performance Monitoring/Closure Criteria**
- **Dust**
- **Mining below the water table**

## WHY CHANGE? - CHALLENGES WITH CURRENT METHODS

- **Obtaining accurate and representative information**
  - point measurements;
  - labour intensive;
  - limited sampling especially when
    - Remote;
    - Inaccessible;
    - culturally or environmentally sensitive;
- **Consistent over time**
  - subjective;
- **Ability to compare information both spatially and temporally**
- **Known quality standard**
- **Ability to deal with issues of contamination and pollution**

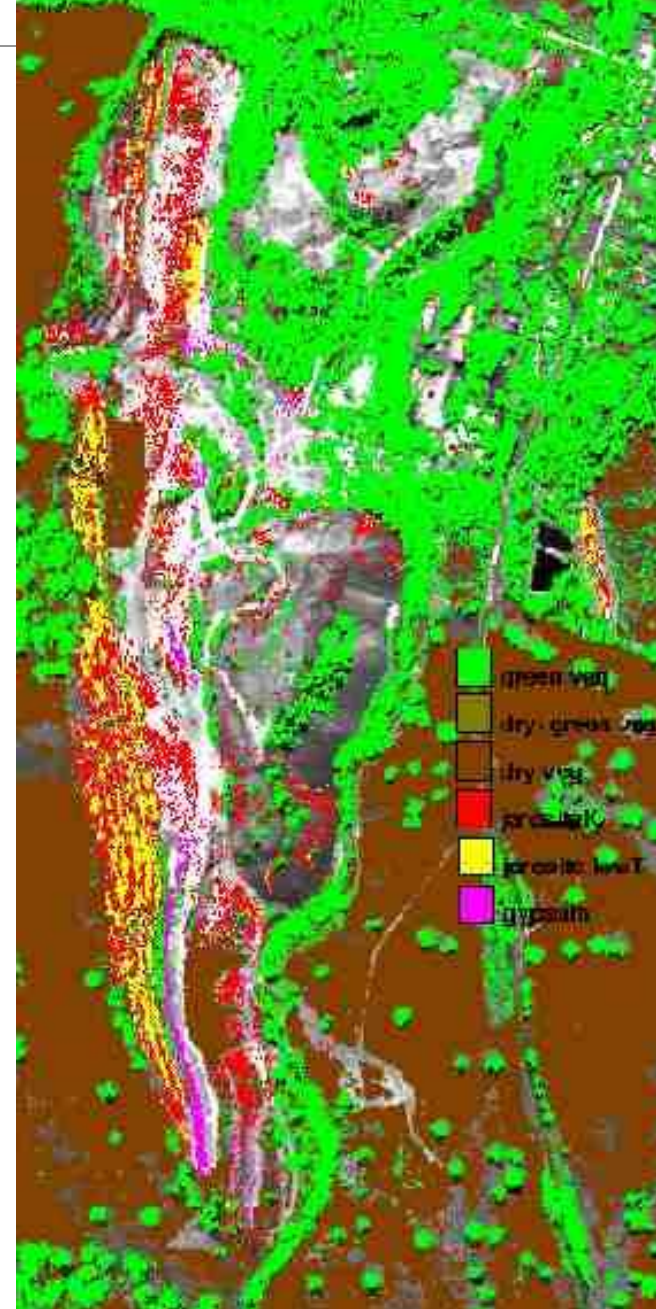
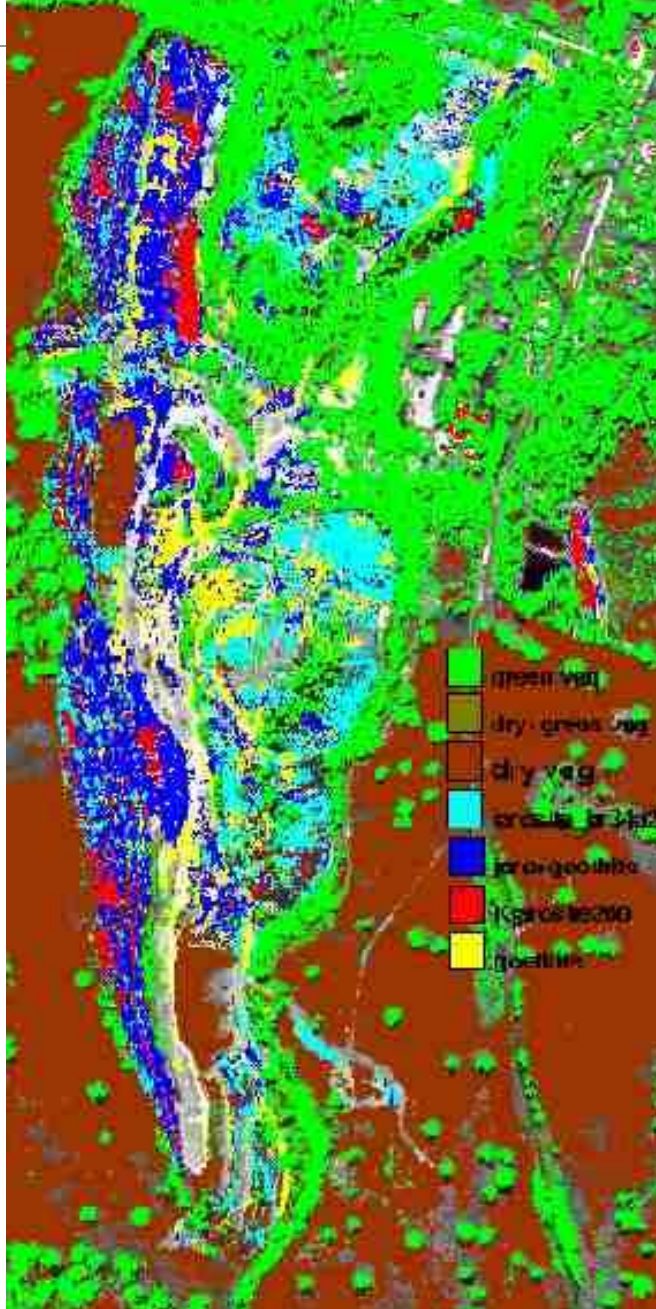


# AD: one of the main strategic environmental issues facing the mining industry in Australia





# Mineral mapping with imaging spectroscopy





# Multi-temporal pH mapping

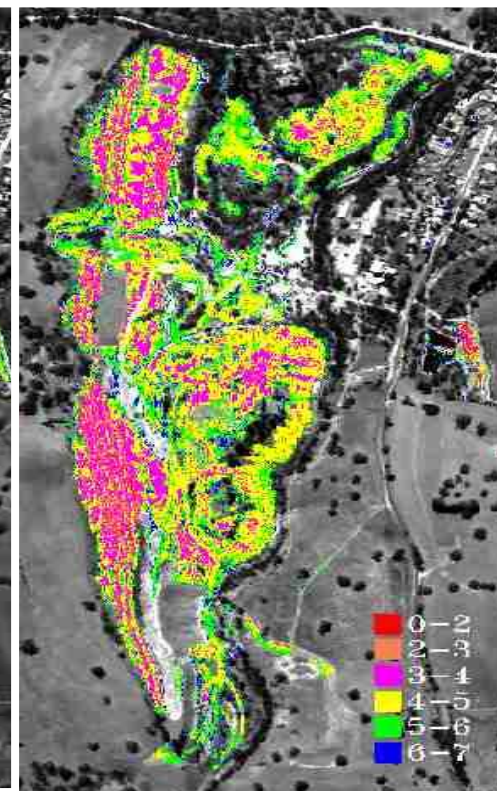
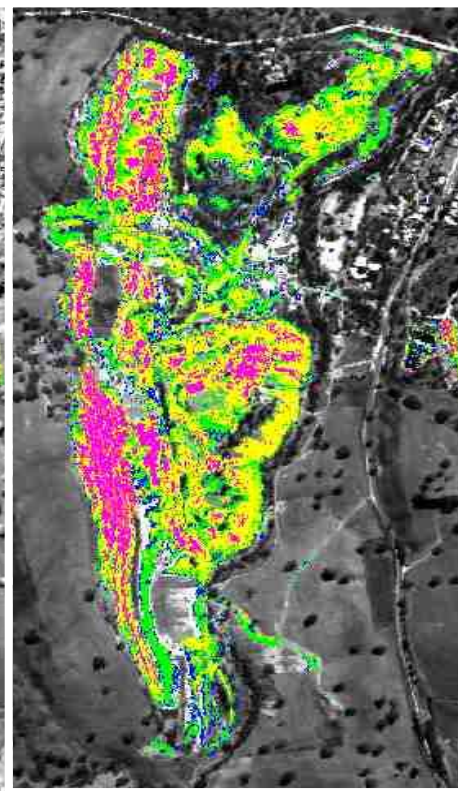
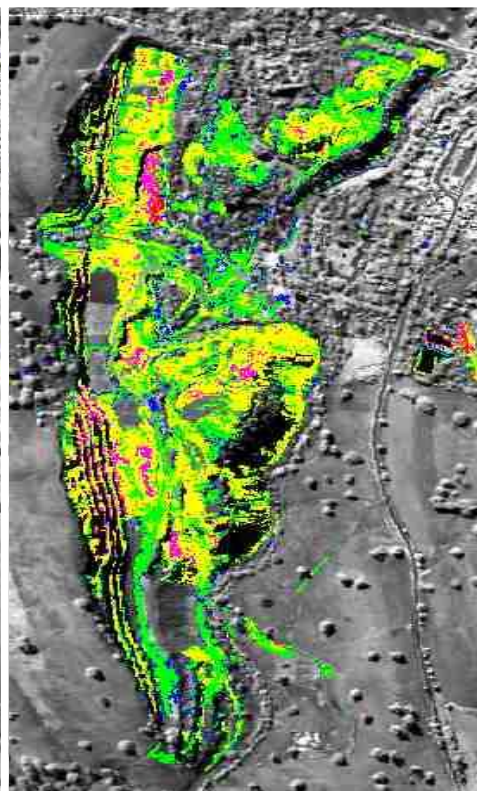
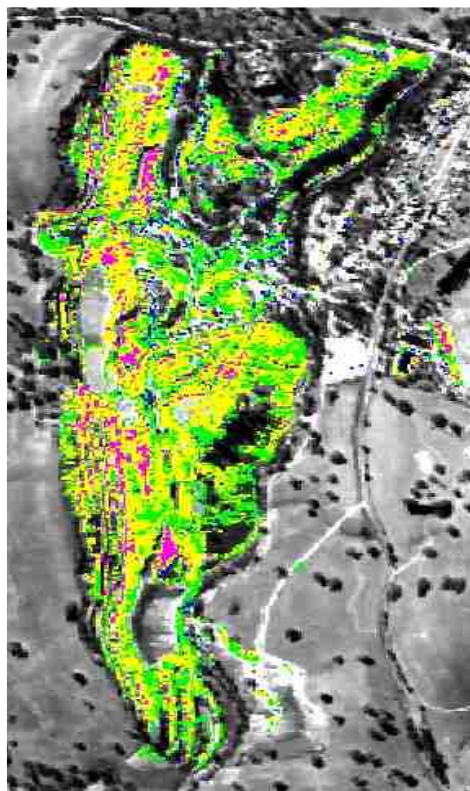


1998

1999

2000

2001

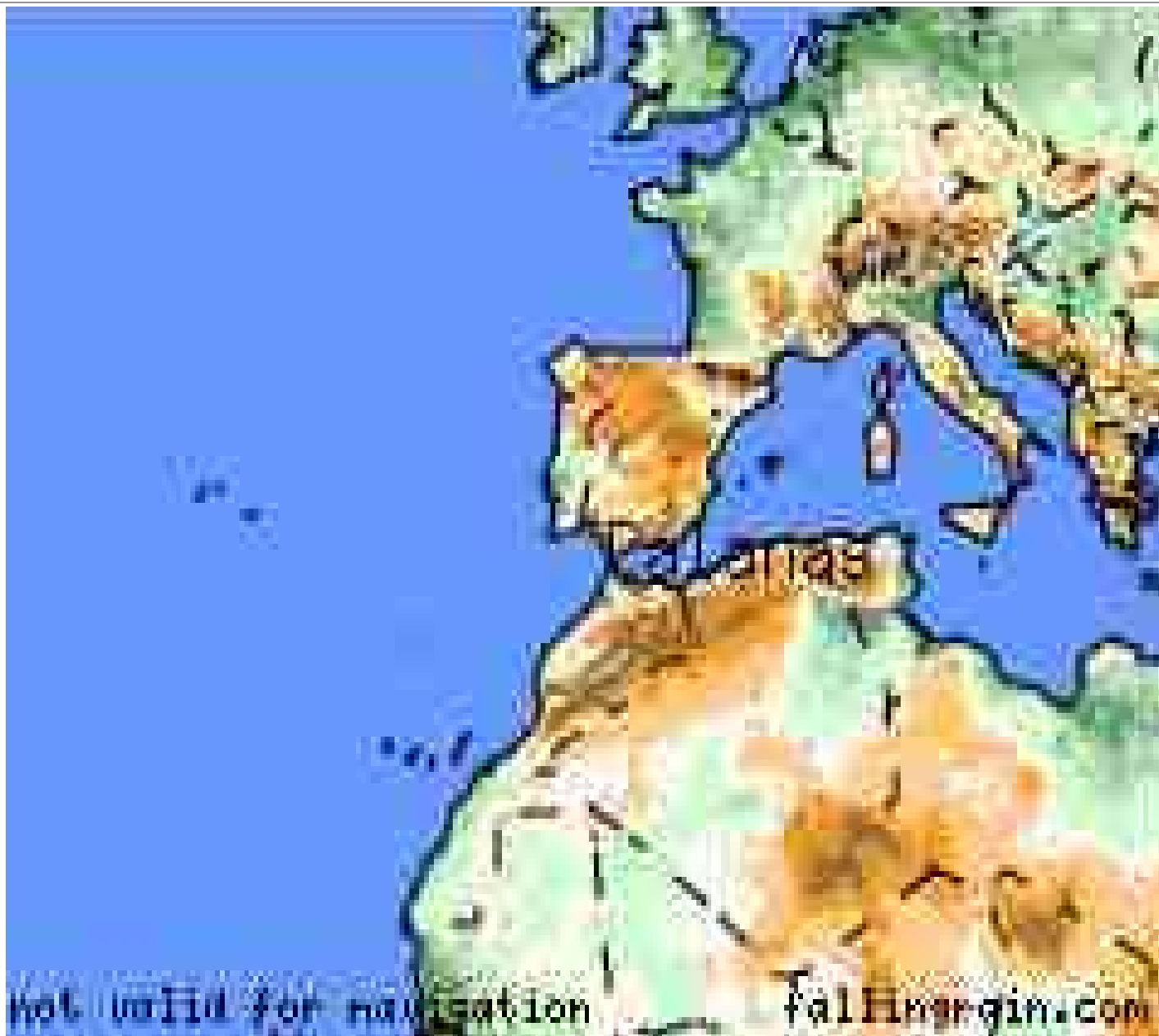


German Remote

CSIRO Explorat

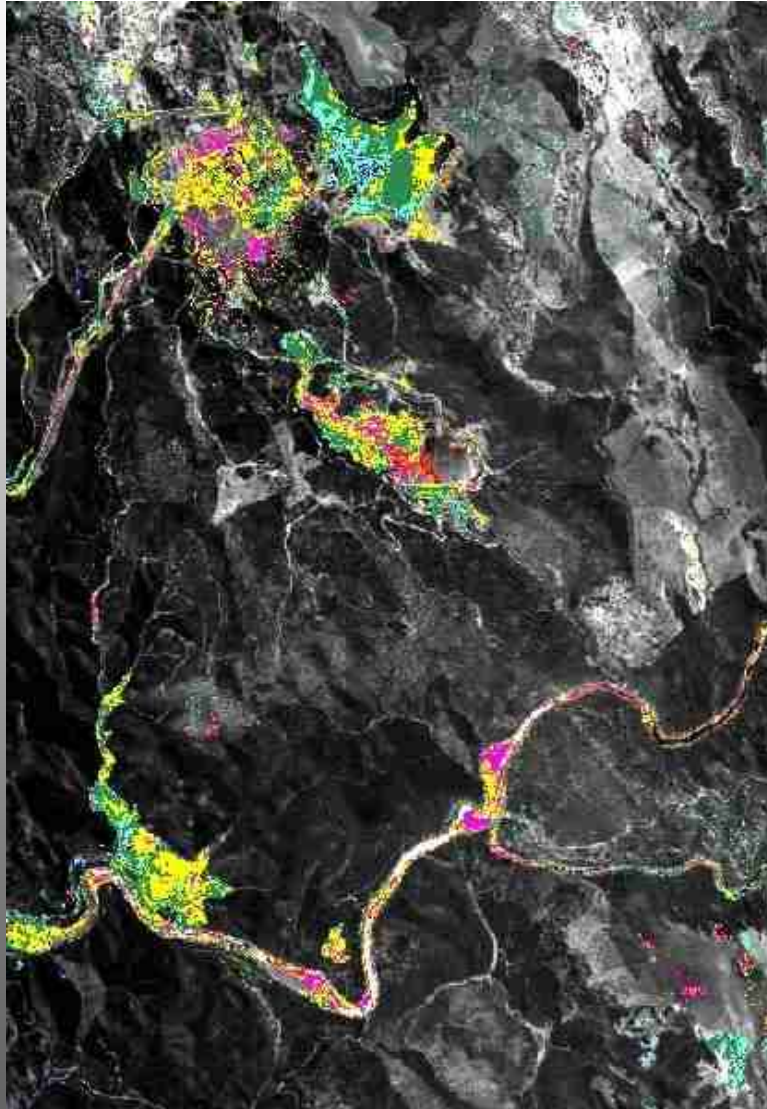


# Inventory, monitoring and risk assessment of abandoned mines

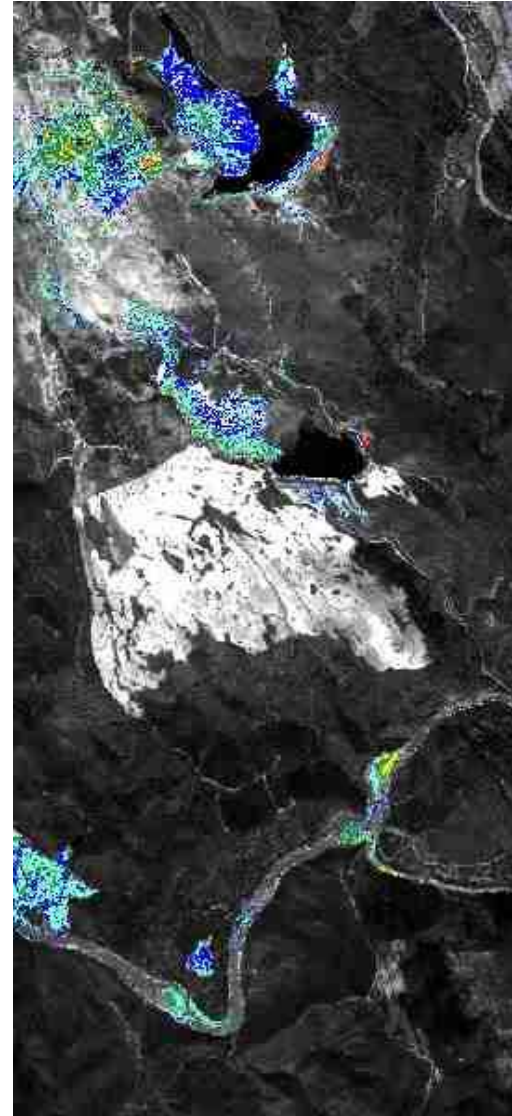




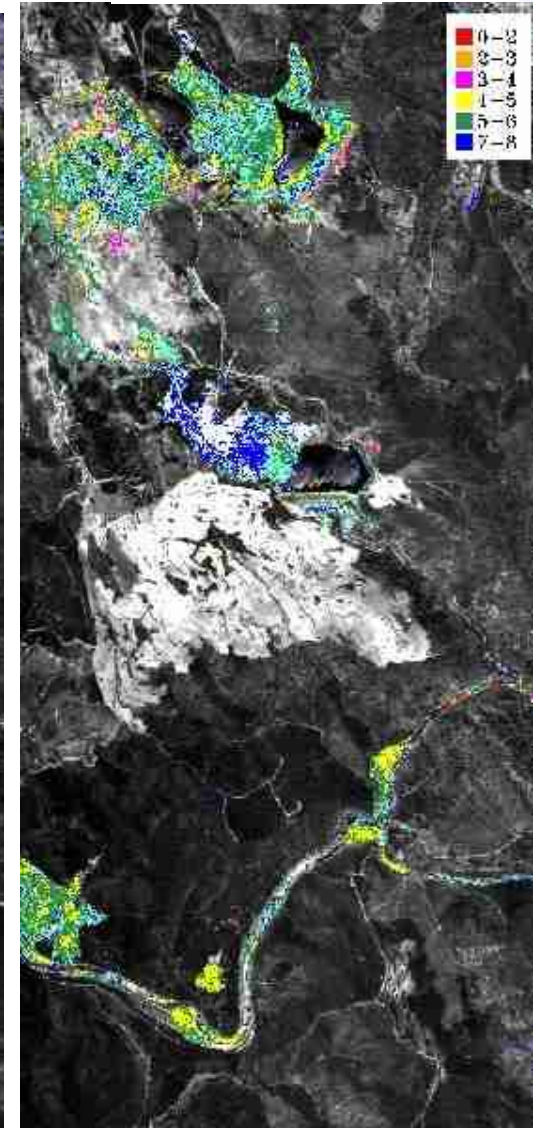
May 1999



June 2004



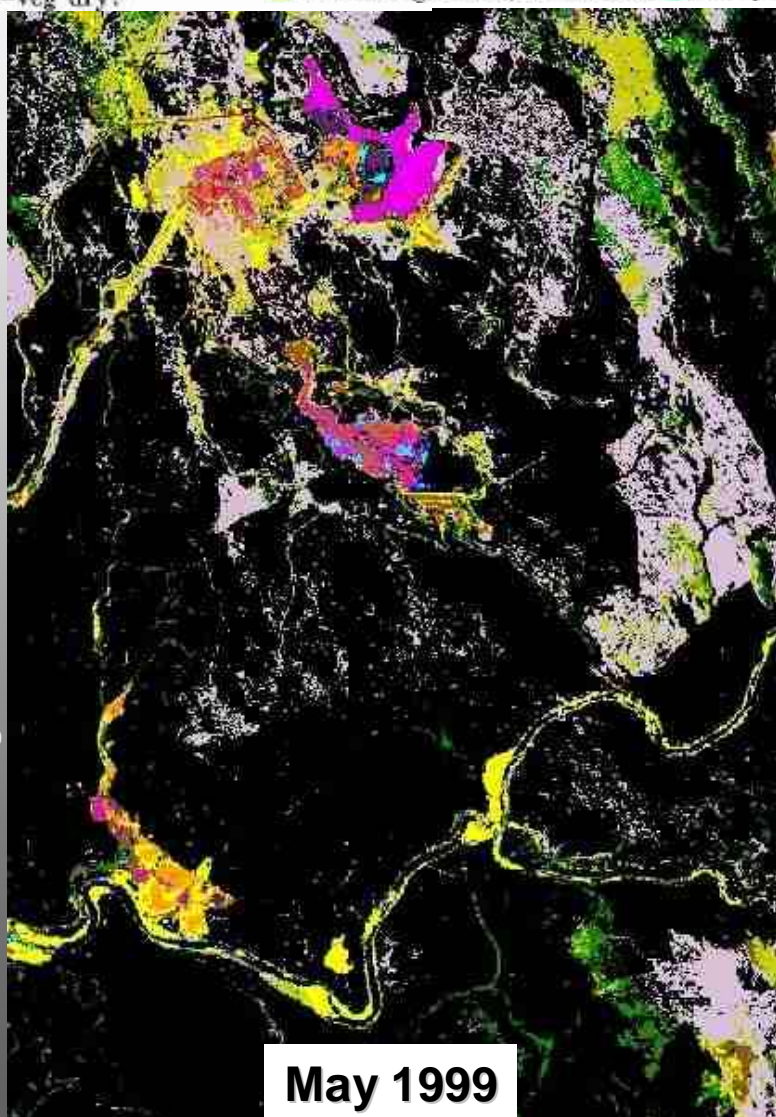
June 2005



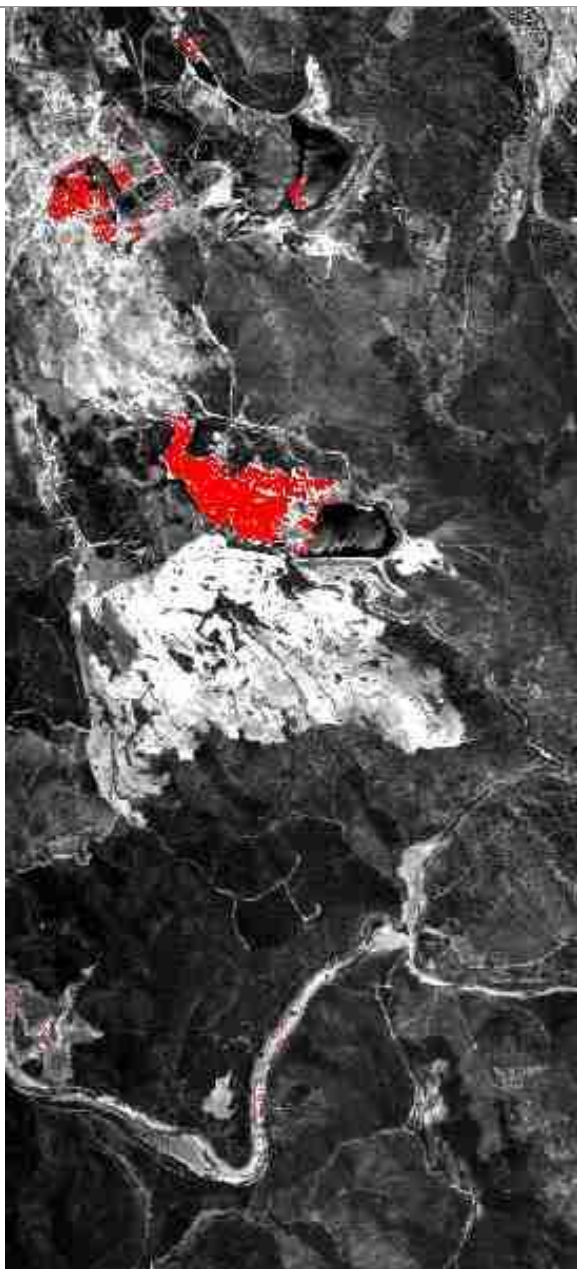
# Mapping acid drainage contamination

- |                       |                              |                                  |                                  |                          |
|-----------------------|------------------------------|----------------------------------|----------------------------------|--------------------------|
| 2-goethite; muscovite | 7-halotrichite               | 16-unknown salts?                | 30-???salts; jarosite; muscovite | geothite around tailings |
| 3-hematite; muscovite | 8-io?jarosite                | 17-goethite; muscovite; sandbank | 32-hydrated io; muscovite        | 05salts in pond          |
| 4-goethite; muscovite | 9-hematite; jarosite         | 18-muscovite                     | 34-gypsum                        | 09goethite around waste  |
| 5-rozonite            | 12-copiapite; ferricopiapite | 19-hematite                      | water                            | 99-goethite-river-dumps  |
| 6-veg dry?            | 15-small goethite; muscovite | 20-dry veg; muscovite            | goethite in tailings             |                          |

German Remote Sensing Data Center



CSIRO Exploration & Mining



**Area mapped: 131,376 m<sup>2</sup>**

Using Buckby, et. al. (2003) on Rio Tinto  
~0.05m depth, 25% porosity, 2.65 g/cm<sup>3</sup> density,  
7043 mg/kg Zn, 5376 mg/kg Cu

**Results in 13,055,490 kg precipitates with  
91,950kg Zn; 75,200kg Cu**

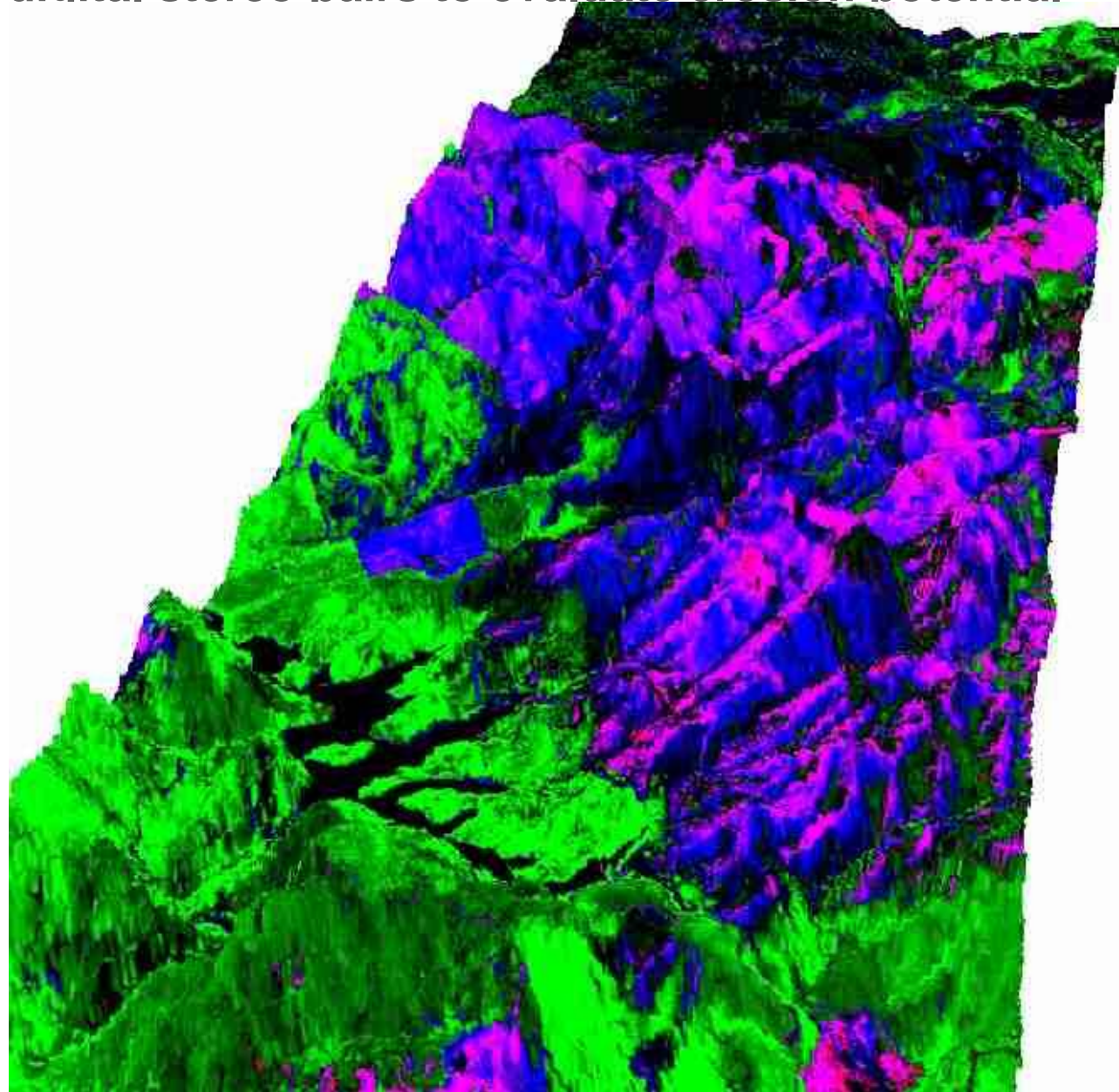


DLR

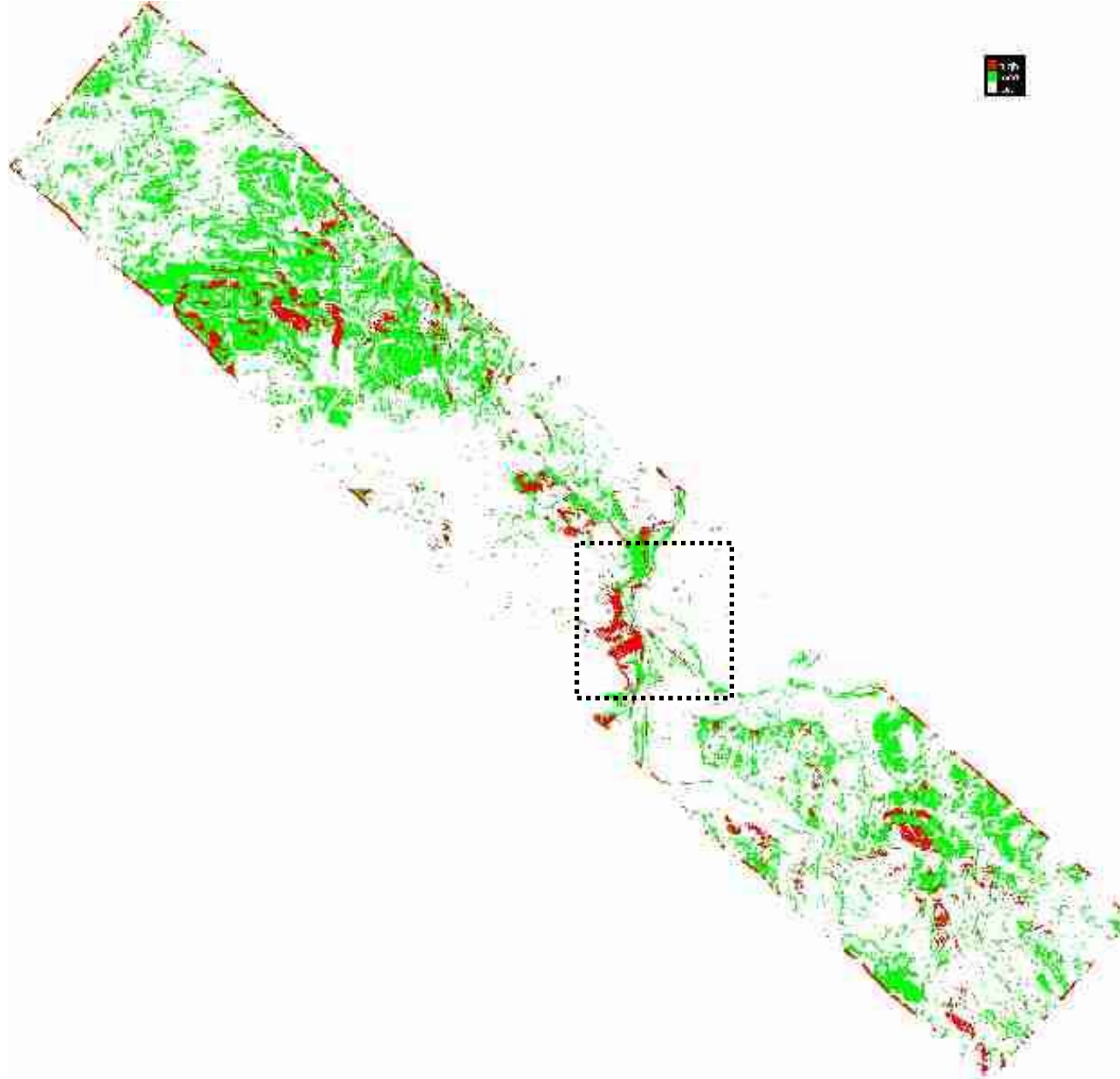
Soil & vegetation information products from hyperspectral data to characterise the landscape, integrated with DEM from digital stereo pairs to evaluate erosion potential



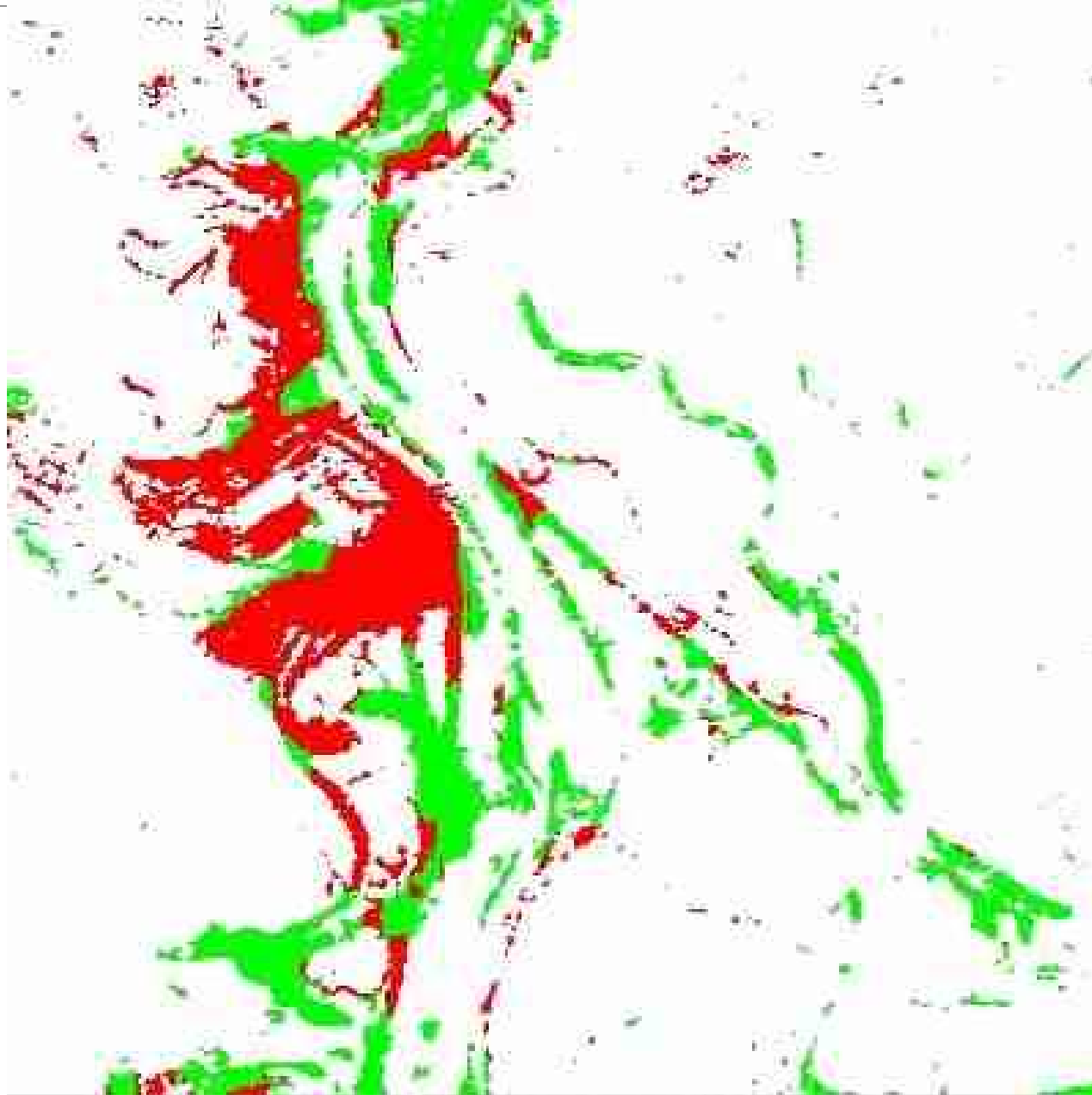
CSIRO



# Erosion potential map



## Erosion risk map

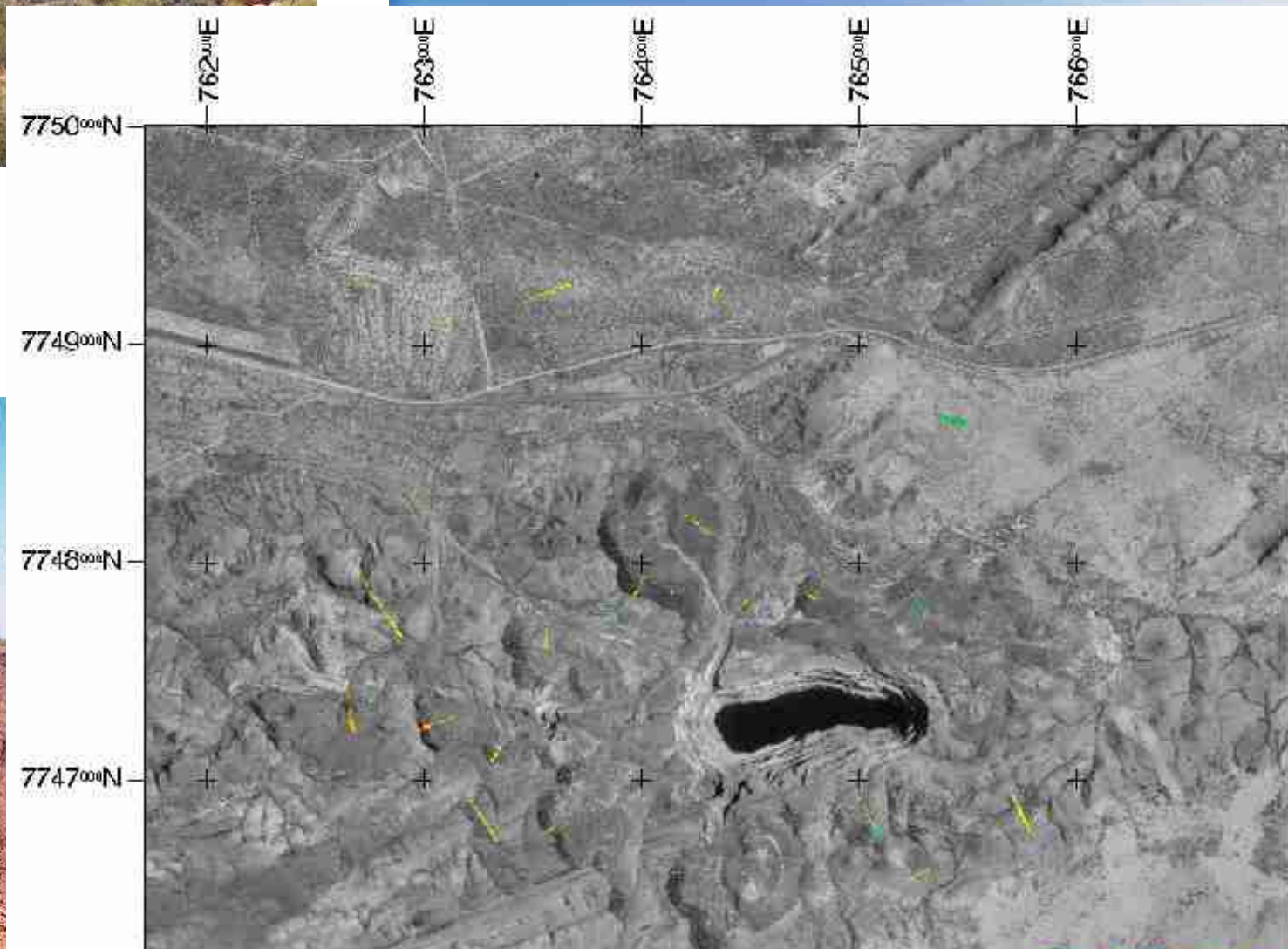
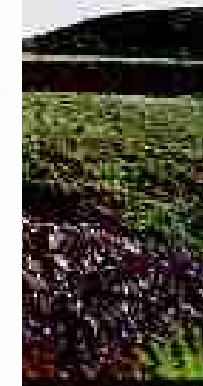




# Monitoring of rehabilitated lands: A substantial regulator's challenge, linked to environmental bonds, performance monitoring and closure criteria



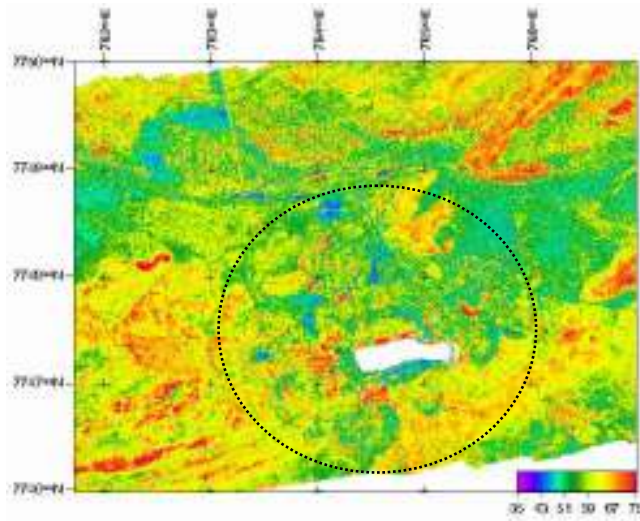
# Rugged, inhospitable environment



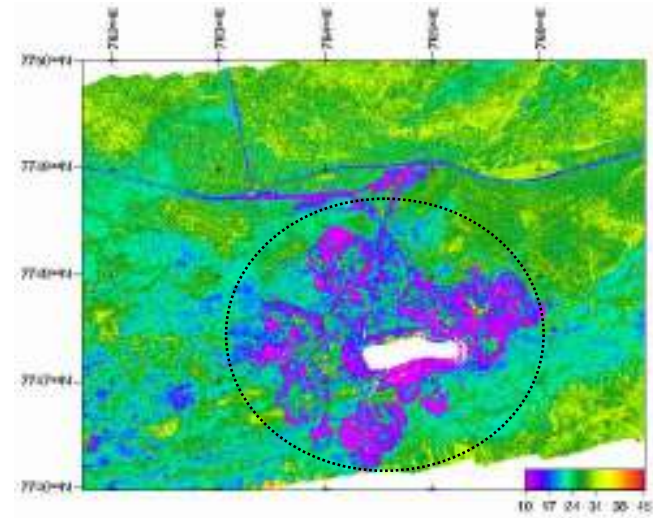


## Stability

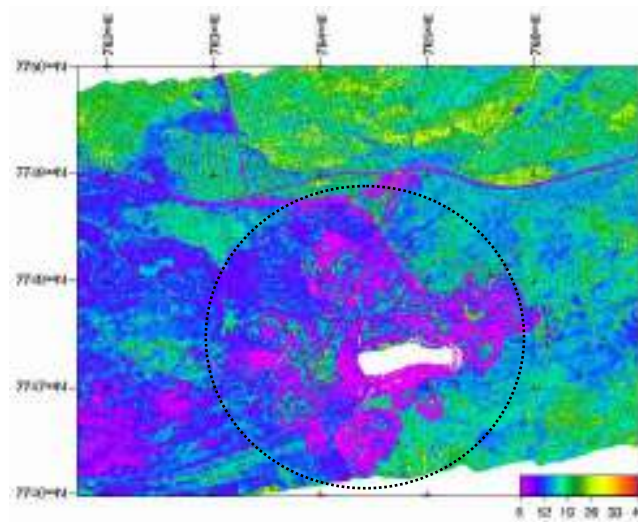
## Infiltration



**2002**



## Nutrient Cycling



# Dust: Topical issue that threatens to close down operation



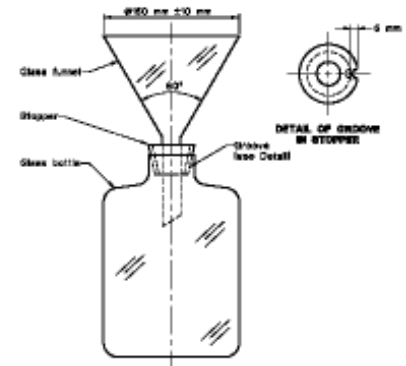


FIGURE 1 TYPICAL STANDARD DEPOSIT GAUGE



German Remote Sensing Data

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	Year	Maximum	Minimum	Average	Variance
7.1 NP TS505 10m	1996	14.1	5.7	9.8	18.86
	1997	15.8	5.4	8.7	10.32
	1998	31.7	0.0	12.1	133.07
7.2 NP TS505 50m	1996	8.5	4.2	6.8	3.33
	1997	9.3	2.2	5.1	4.40
	1998	21.5	0.0	8.2	67.24
7.3 BHPT Slipway East 15m	1996	15.4	0.8	6.6	39.81
	1997	398	0.8	44.6	>1000
	1998	6.7	0.4	2.3	6.24
7.4 7.5 BHPT Slipway West 15m	1996	3.6	1.5	2.5	0.87
	1997	5.0	0.2	1.8	1.91
	1998	25.8	0.9	7.4	89.49

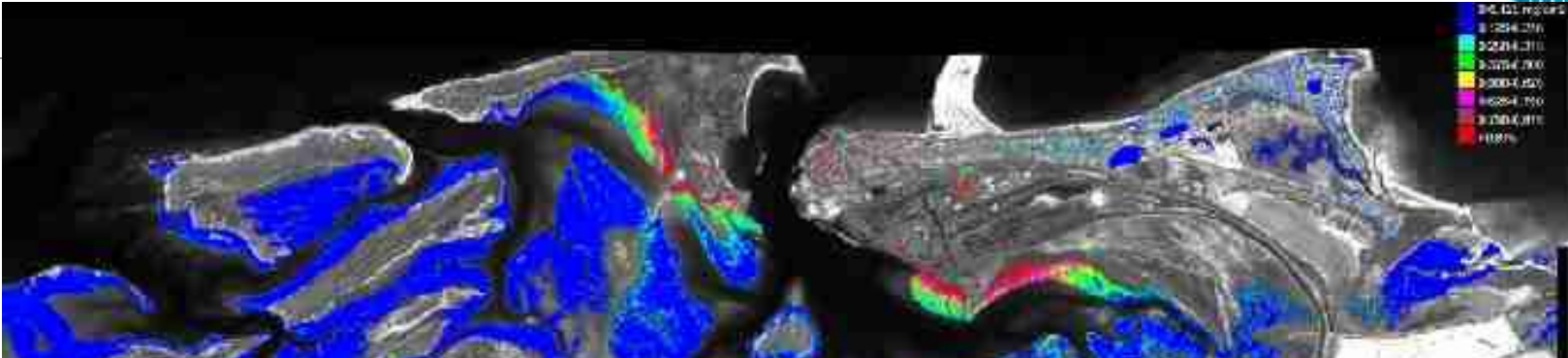


# Multi-temporal map of iron oxide dust on mangroves



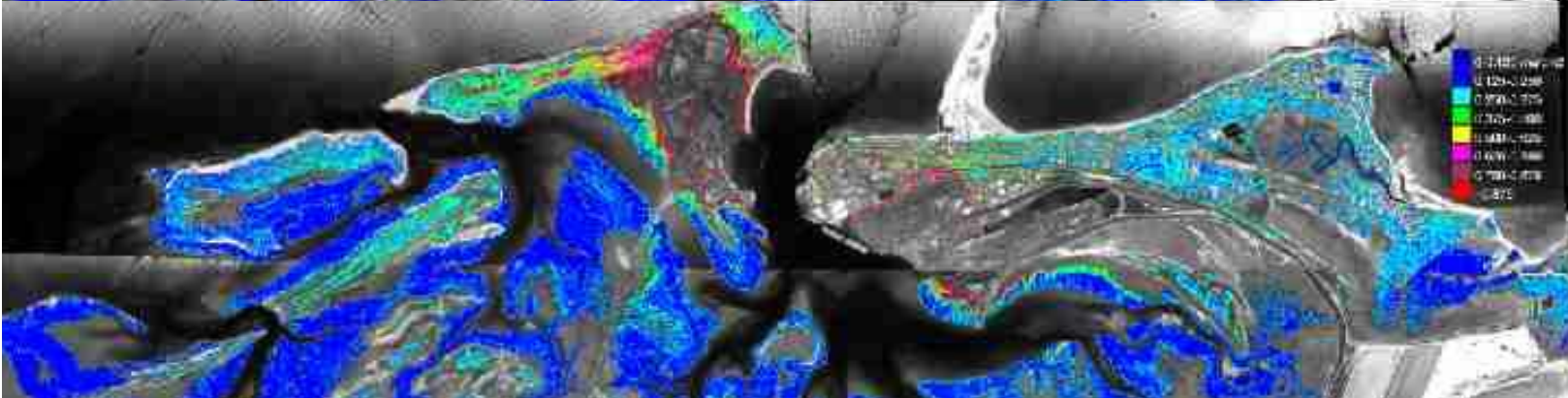
**1998**

Pre-wet



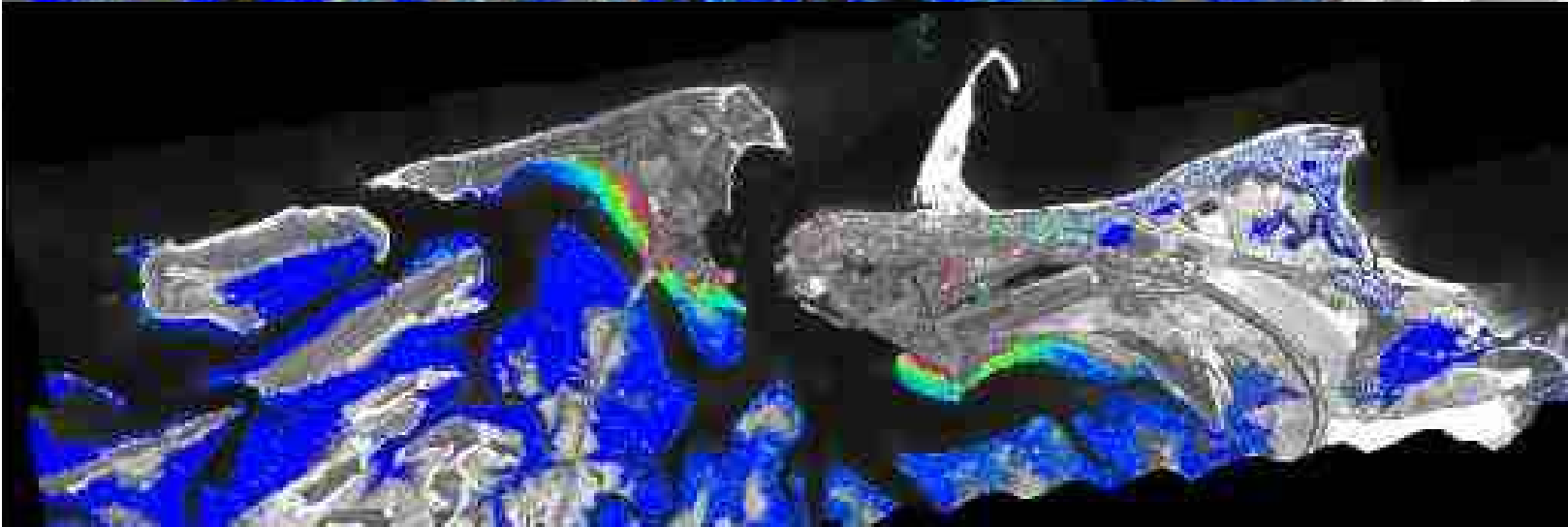
**1999**

After cyclone



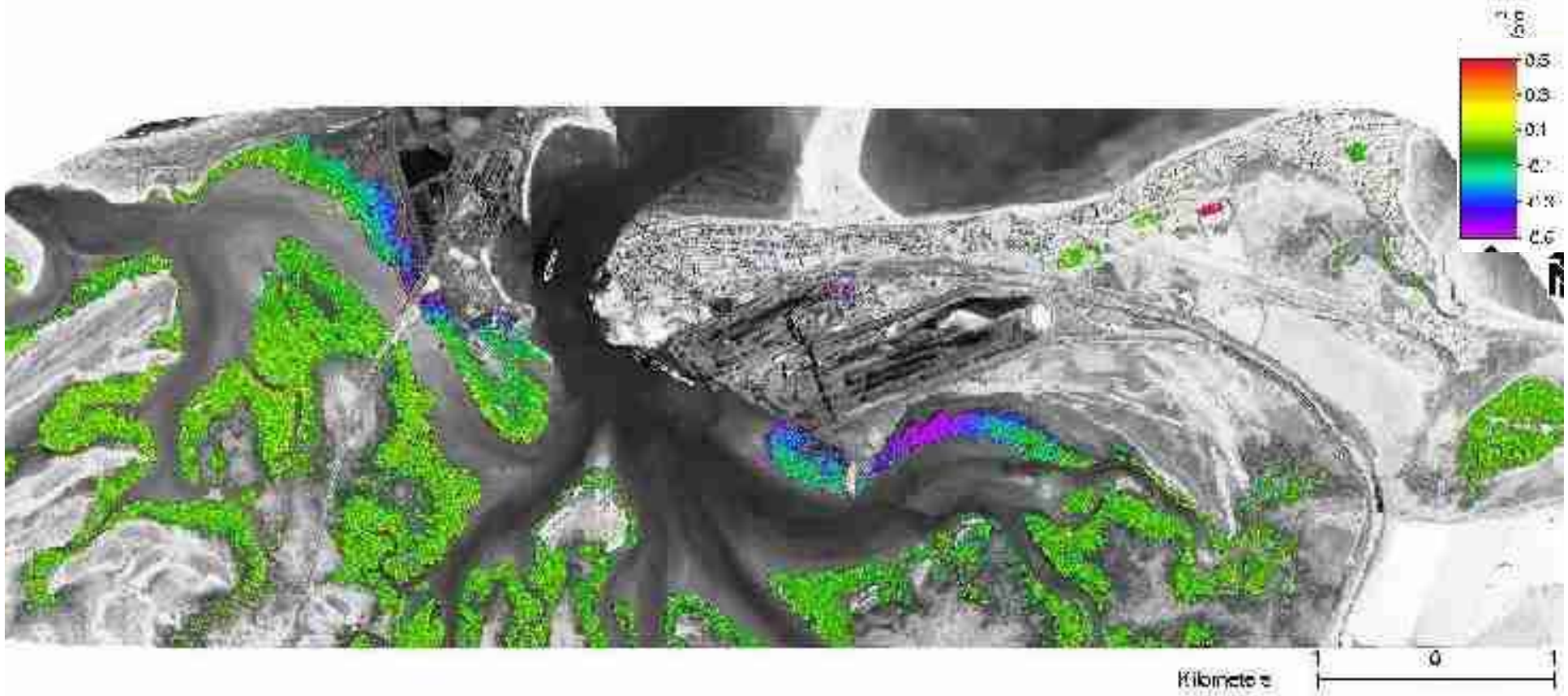
**2002**

Pre-wet





# Impact of cyclone "Gwenda"



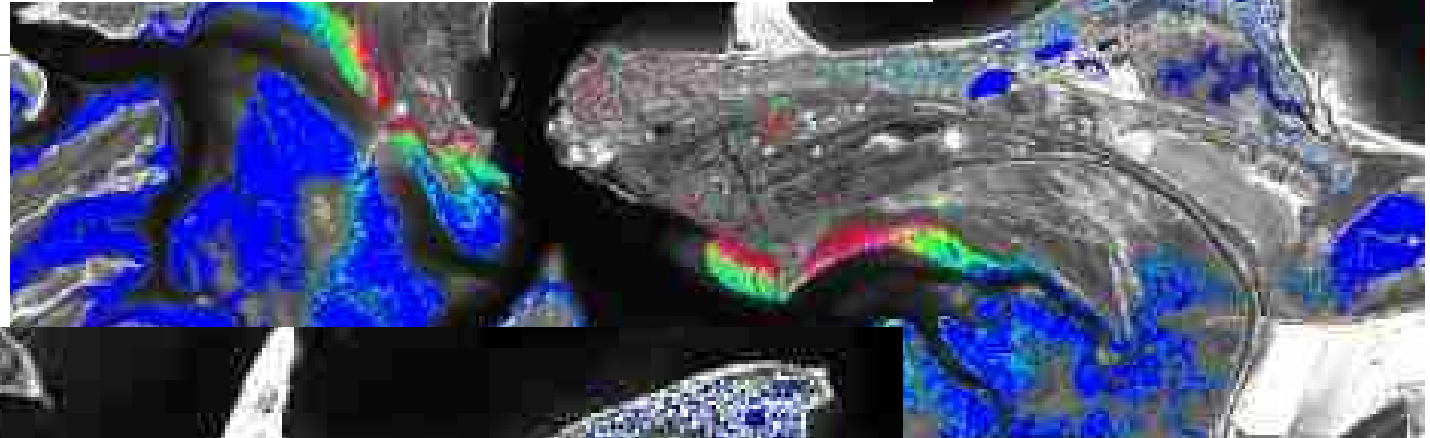
German Remote Sensing

CSIRO Exploration &

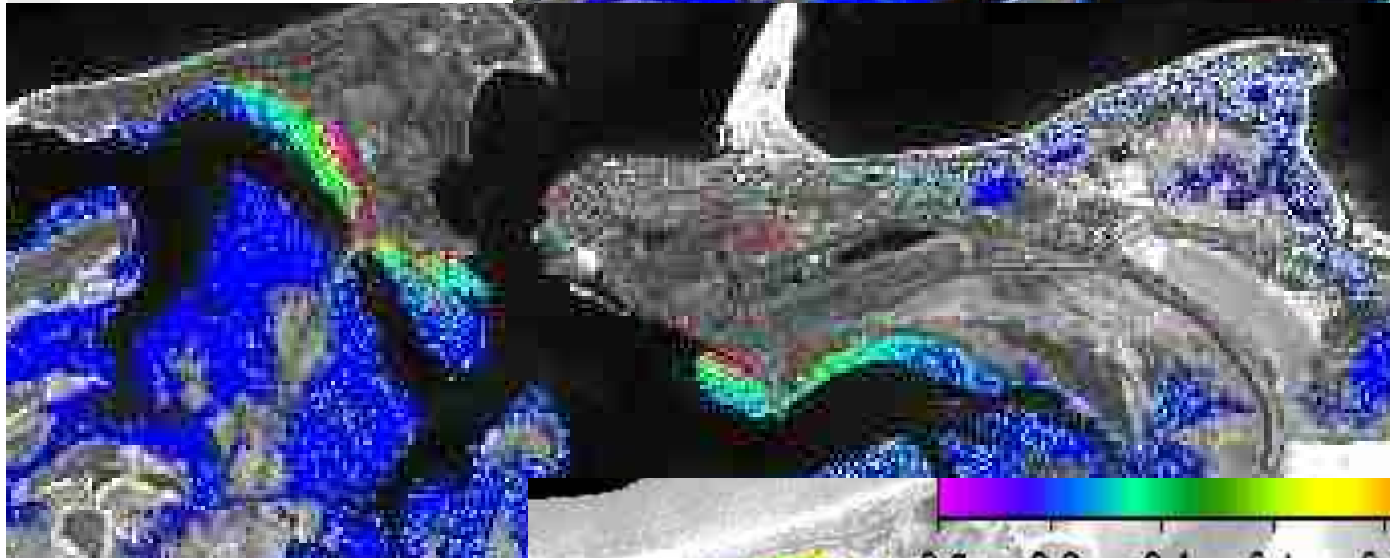


# Impacts of dust management

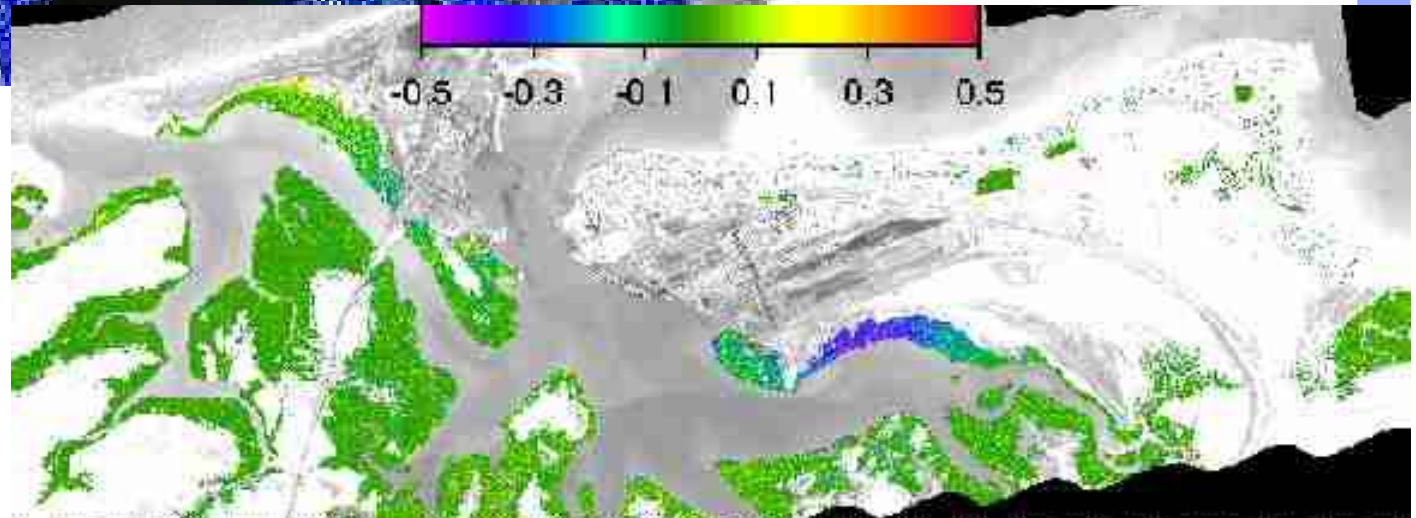
Pre-wet 1998

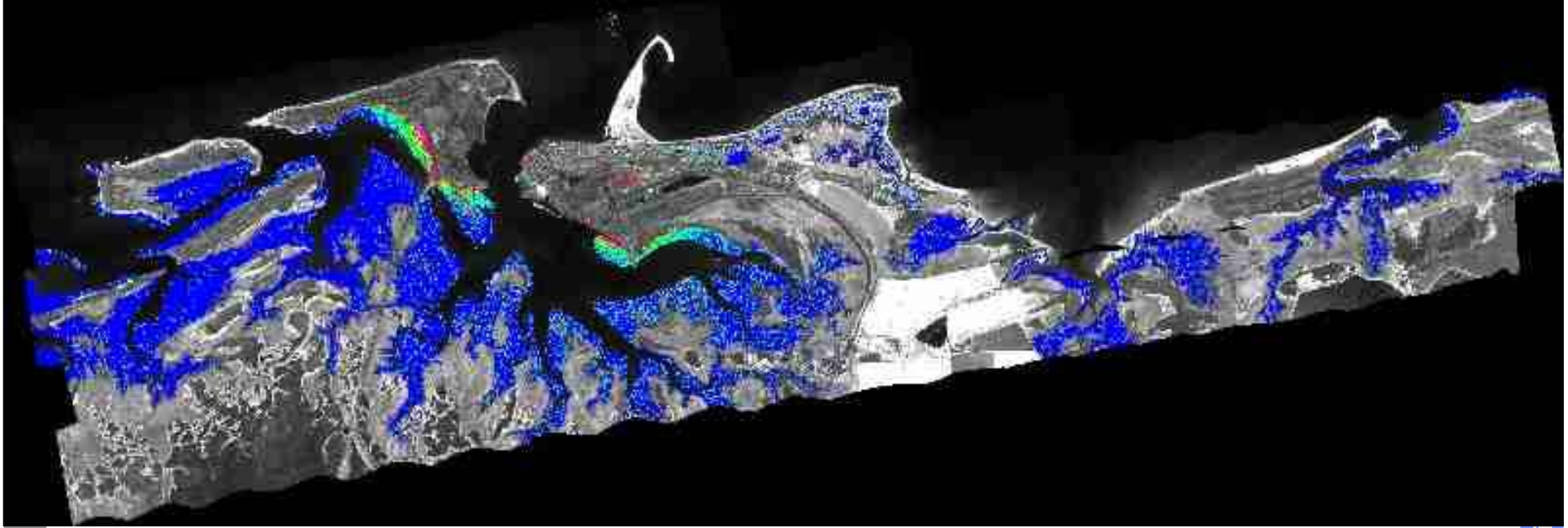


Pre-wet 2002



Change between years





## INDUSTRY

- Incorporation into environmental management plan;
- Applying for inclusion into Ministerial agreement;

## REGULATORS

- Endorsement from regulators, environmental groups, industry and community







# The next dream .....

