The First International Symposium on

Geo-information for Disaster Management

Hazard Assessment and Prediction with Quantitative Analysis of Large Geospatial Imagery

Dr. Martin C. Schodlok

March 22nd,2005

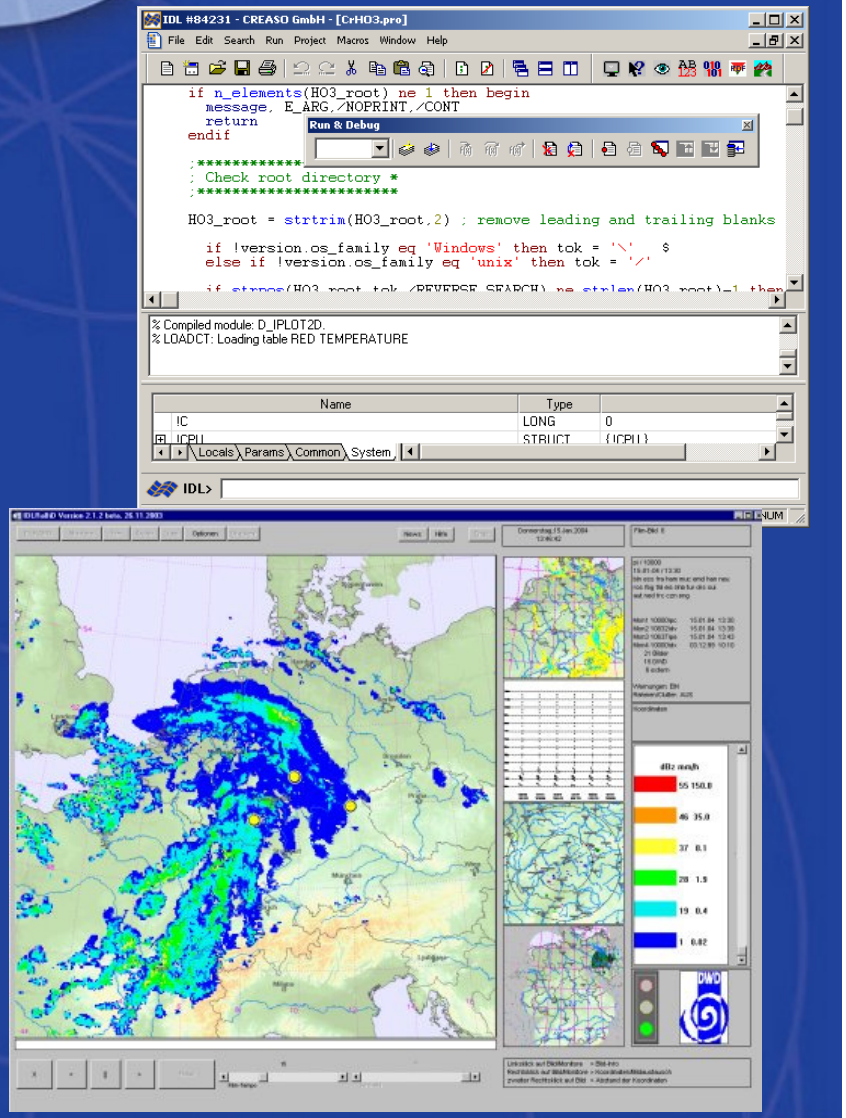
C R E A S O

CREASO

- CREASO has provided software solutions for data analysis and visualization for over 15 years.
- CREASO has consistently grown its Global Service Group capabilities since 1990.
- CREASO released ENVI, the remote sensing exploitation platform, in 1994.
- CREASO possesses exclusive selling rights for IDL and ENVI for Germany, Austria, Switzerland and the Netherlands and for all other products world-wide.

CREASO Business Activities

- CREASO & RSI develop and market high-end visualization and analyzing software for scientific data.
- CREASO provides custom software development, consulting services and training to government, commercial, research, and academic markets.
- Our software is proven, robust, flexible, platform independent, and rapidly deployable.



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CREASO User Community

CREASO's user community is comprised of over 200,000 users from 80 countries and a wide variety of industries including:

- Astrophysics
- Engineering
- Meteorology
- Defense & Security
- Medical Imaging
- Remote Sensing
- Earth Sciences
- Research & Development
- Academia
- Government
- Laboratory Sciences
- Natural Resources
- Aerospace
- Manufacturing

CREASO Products & Services

- IDL (Interactive Data Language)
  - A complete, integrated software environment for scientific visualization, data analysis, rapid prototyping, and application development

- ENVI (Environment for Visualizing Images)
  - A full-featured image processing and image analysis application for remotely sensed data, including panchromatic, multispectral, hyperspectral, radar, thermal and terrain data
  - Add-on modules: AsterDTM, FLAASH, NITF/NSIF, OrthoTool Sat/Stereo/Photo, SARscape

CREASO Products & Services

IAS

- Image Access Solutions
  - Complete on-demand interactive software delivery of imagery and metadata to users, with high performance storage of dynamic large imagery

Global Services

- CREASO Global Services Group
  - Consulting, Custom Application Development, System Integration Project Management, Contracting and Training Services

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References

- BGR –remote sensing department
- DLR
- DWD - German Weather Forecast
- EADS Astrium GmbH
- EADS Dornier GmbH
- ESA/ESTEC
- ESOC –
  European Space Operations Centre
- EUMETSAT
- GFZ Potsdam - National Research Centre for Geosciences
- GKSS – Research Centre Geesthacht GmbH
- HLUG – Hessisches Landesamt für Umwelt und Geologie
- IABG
- IFM-Geomar Leibnitz Institute für Meereswissenschaften an der Universität Kiel
- Infoterra GmbH
- ITC – Intern. Inst. f. Geo-informatics, Science & Earth Observation
- Jet Propulsion Laboratory
- KNMI - Royal Netherlands Meteorological
- MPI
- NASA
- Naval Research Labs
- NLR - National Aerospace Laboratory
- NOAA / NIST
- PIK – Potsdam Institute for Climate Impact Research
- RWE-DEA
- SRON - Space Research Organization Netherlands
- U.S. Space Command
- Universities

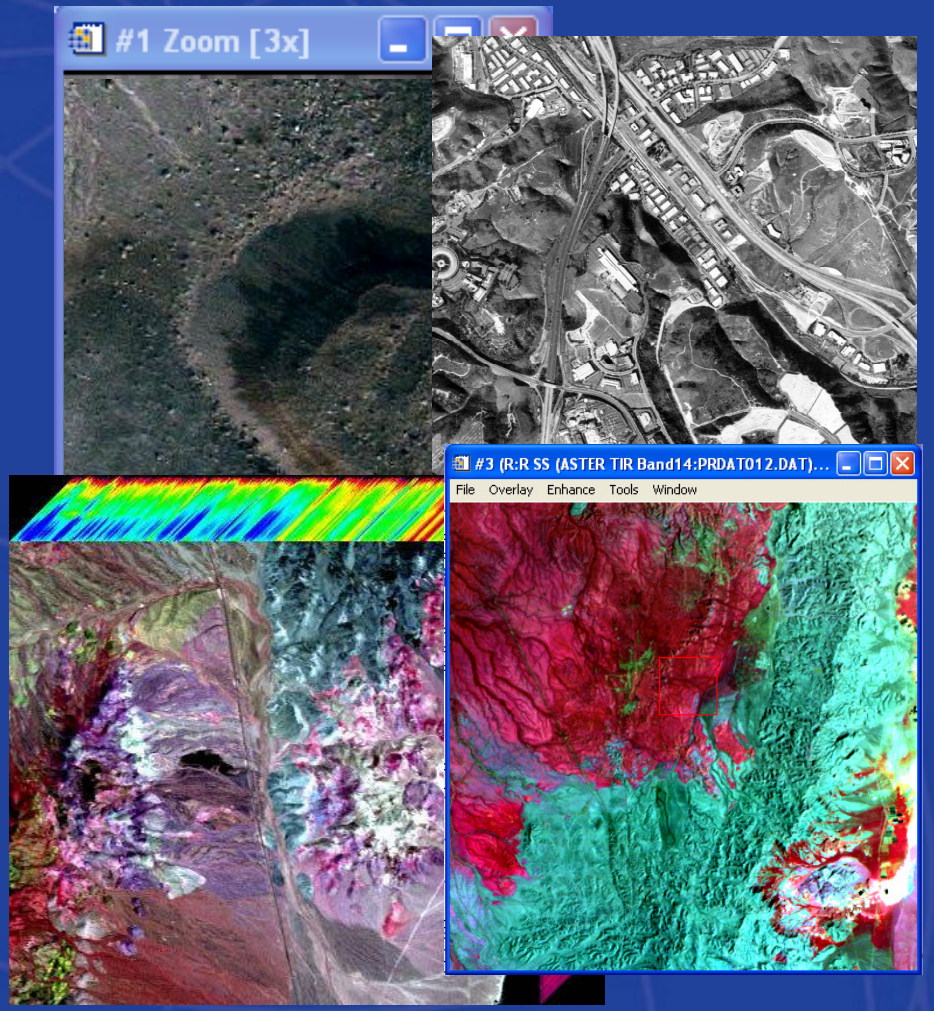
Hazard Assessment and Prediction with Quantitative Analysis of Large Geospatial Imagery

The First International Symposium on Geo-information for Disaster Management, Delft, The Netherlands March 21-23, 2005

CREASO

Quantitative Earth Observation

- What kind of data is available for analysis?
- What algorithms, or software packages are available to produce accurate results from your acquired data?
- Successful earth observation is a blend of these two factors!



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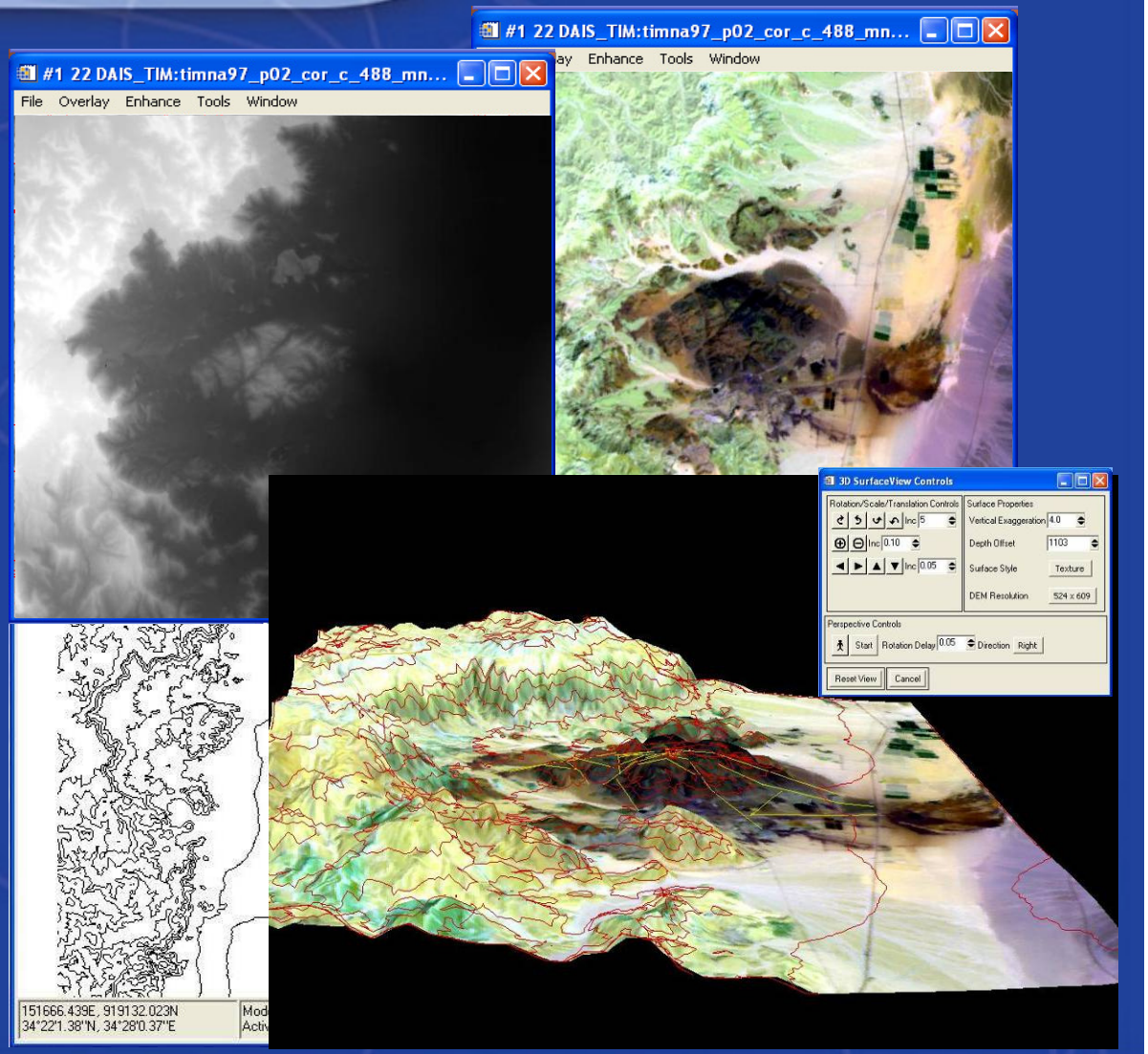
Multispectral Data & Topography

- Generation of contour lines, slope, aspects ... from digital elevation data
- Merging of satellite data, elevation data, vector data ...
- Example: Mt. Timna, Israel (ASTER)



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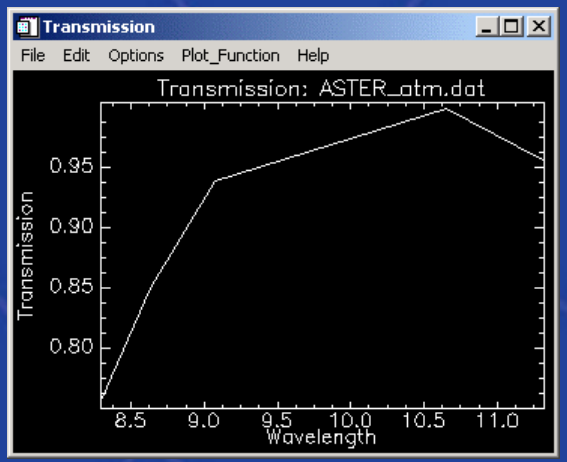
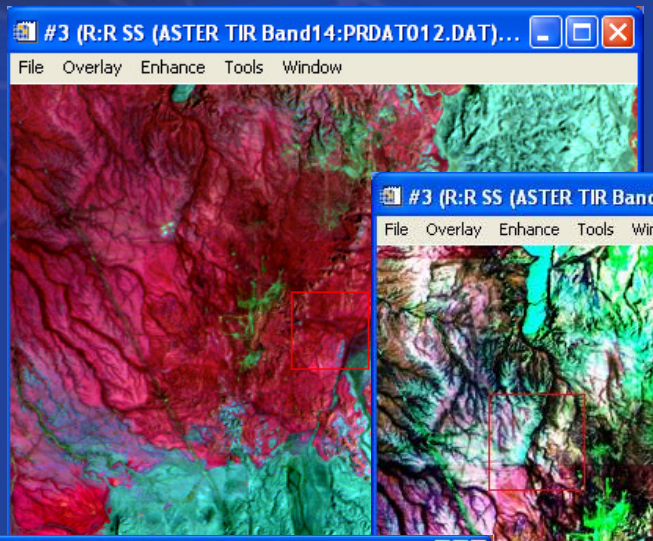
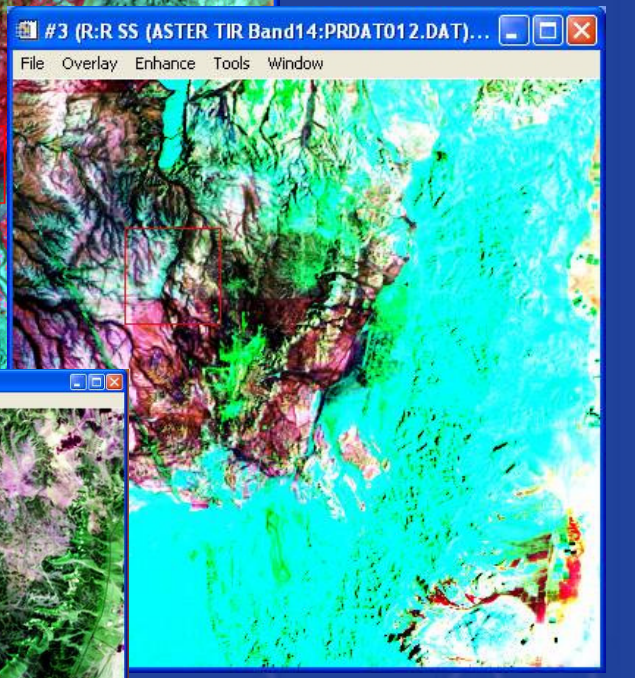
Thermal Data

- Detection of thermal anomalies to distinguish surface materials
- Environment monitoring by detecting exothermic processes







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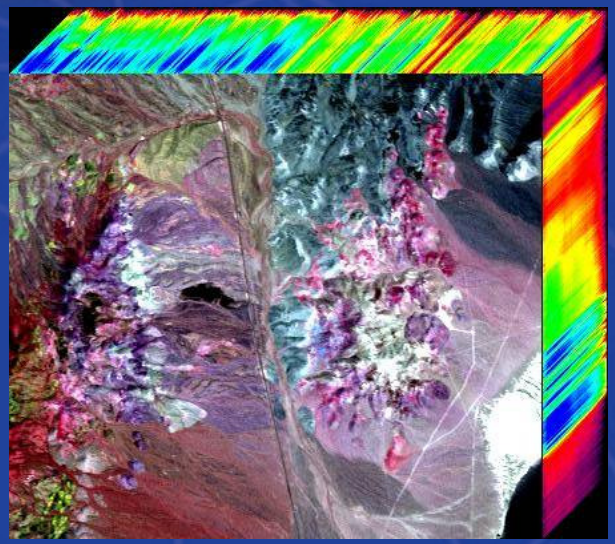
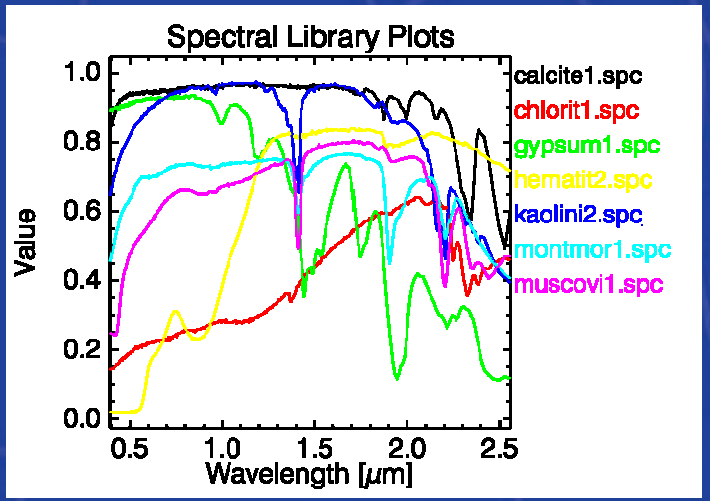
Hyperspectral Data

- Each material has a unique spectrum
- Using the spectral information in the images helps to identify materials or material compositions
- Even at sub-pixel level
  ➔ very small targets can be successfully resolved and identified





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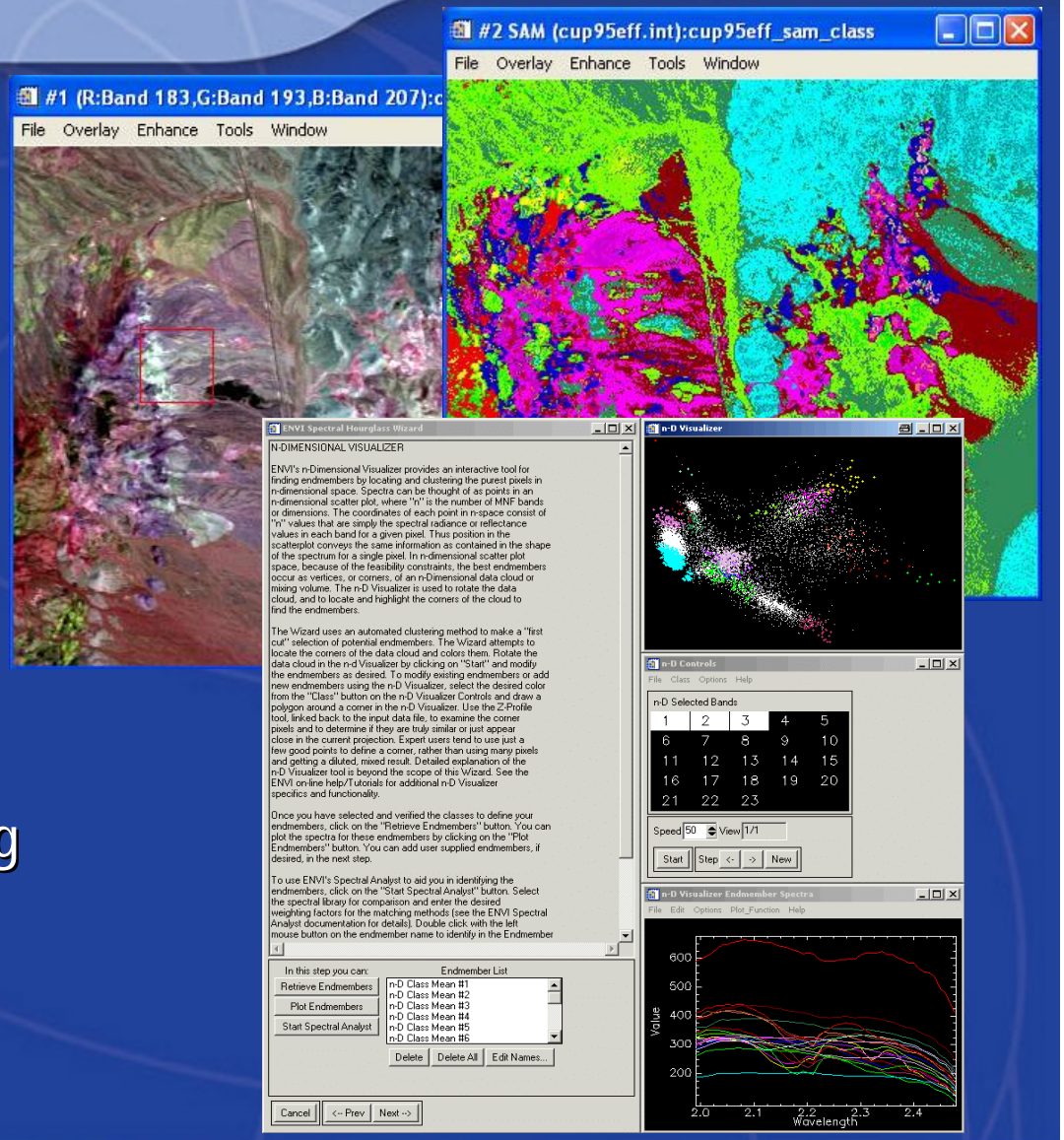
Algorithms

- Automatic material detection and identification using ENVI's hyperspectral tools in pixel and subpixel range:
  - Spectral Angle Mapper
  - Mixture Tuned Match Filtering
  - Linear Spectral Unmixing
  - BandMax
  - ...



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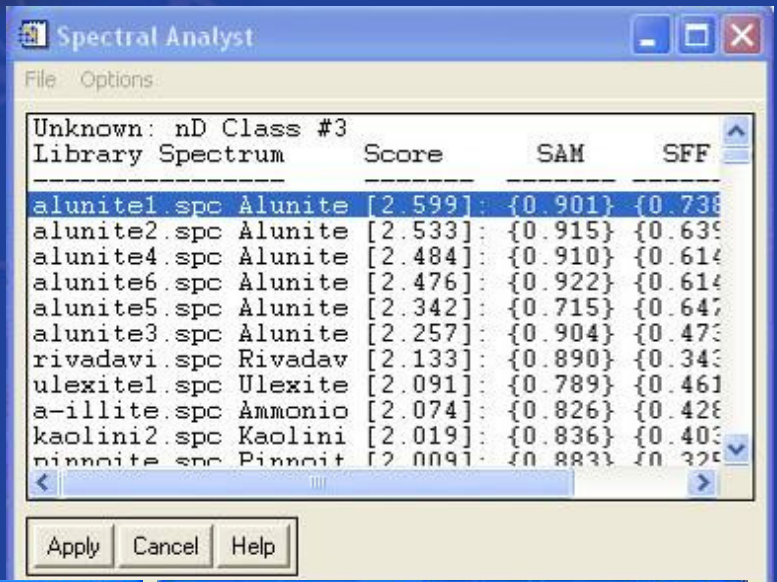
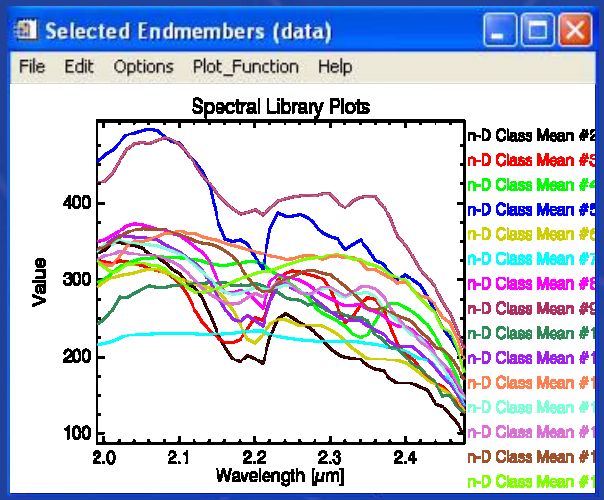
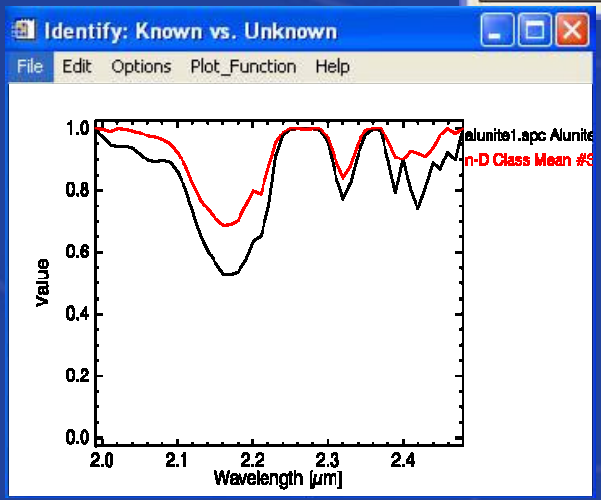
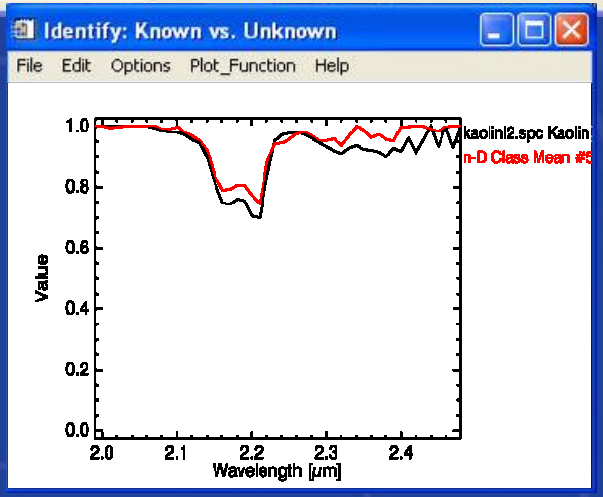
Algorithms

- Building spectral libraries of known and unknown spectra
- Increasing accuracy of identification using Spectral Analyst





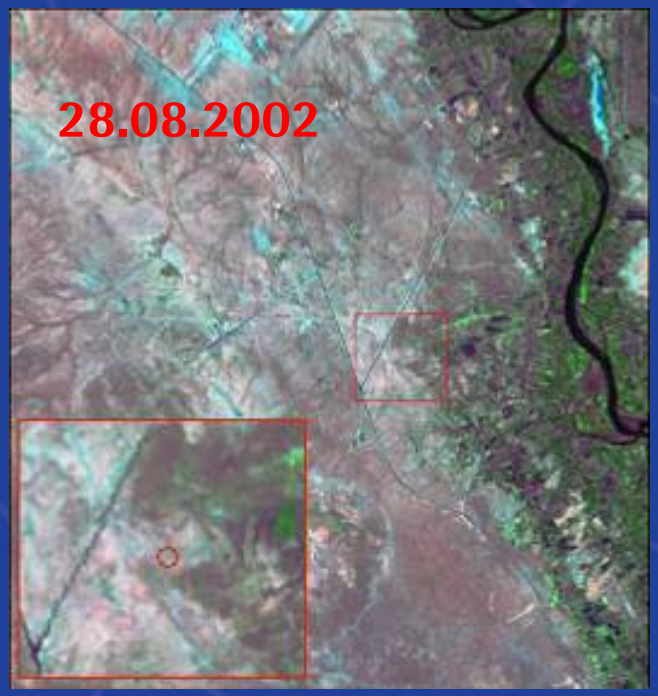


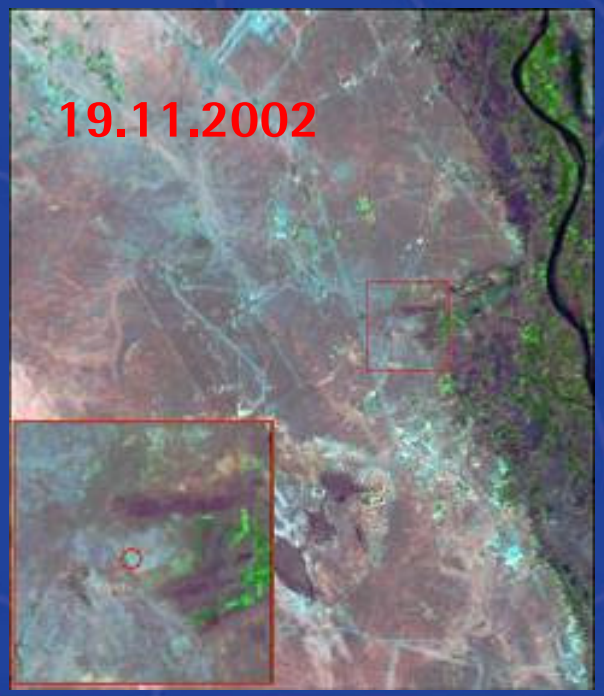


C R E A S O

Disturbed Soil Analysis

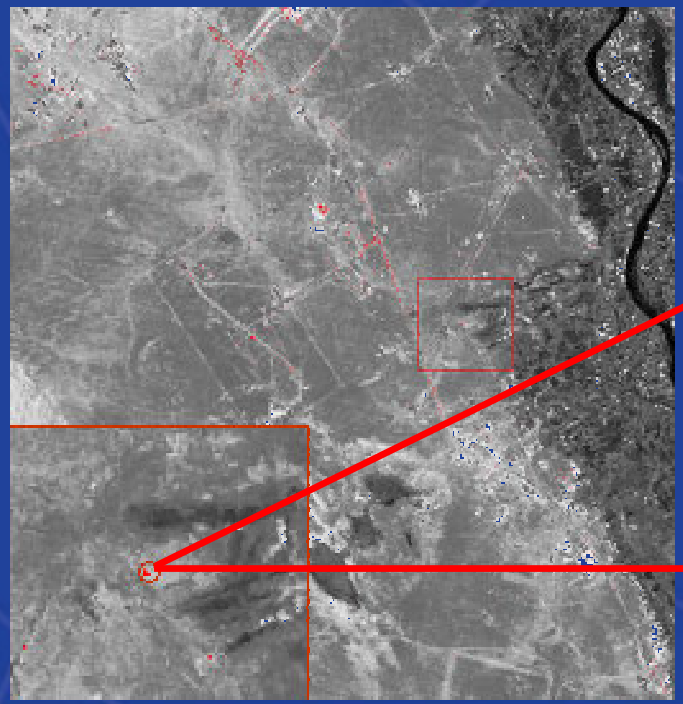
- Disturbed Soils Analysis AL Hillah, IZ – finding common graves
  - Landsat data used to find evidence of recently disturbed soils
  - ENVI's hyperspectral tools analysing multispectral data
  - Change detection method





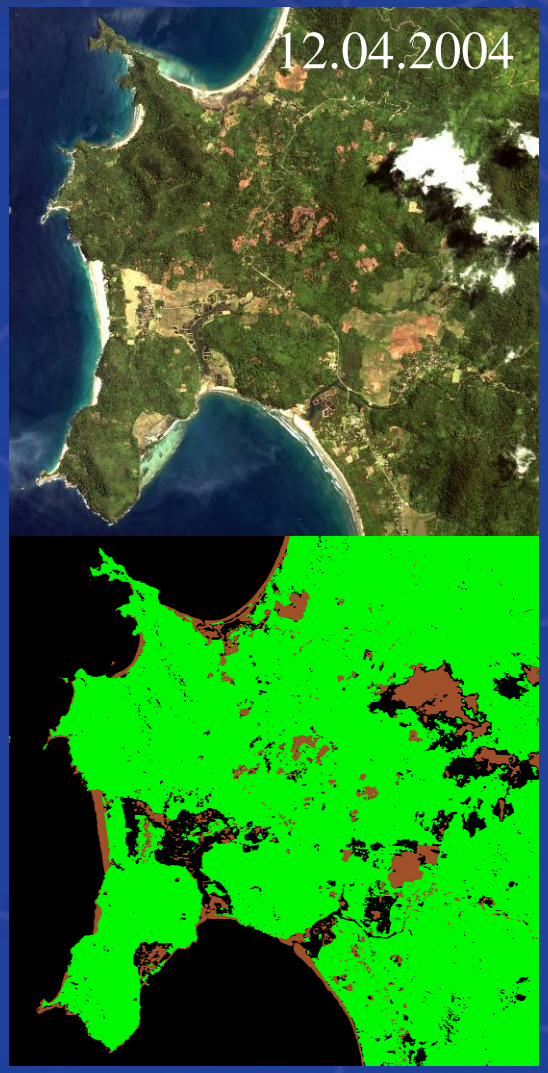
Disturbed Soil Analysis

- Areas with disturbed soil are identified, geo-located and investigated.
- Result: common graves sites, hidden by the former Iraqi Government



Damage Assessment

- Damage estimation at the coast of Indonesia after the South Asian Tsunami 2004/2005
- Based on Quickbird images
- Classification of vegetation and bare soil



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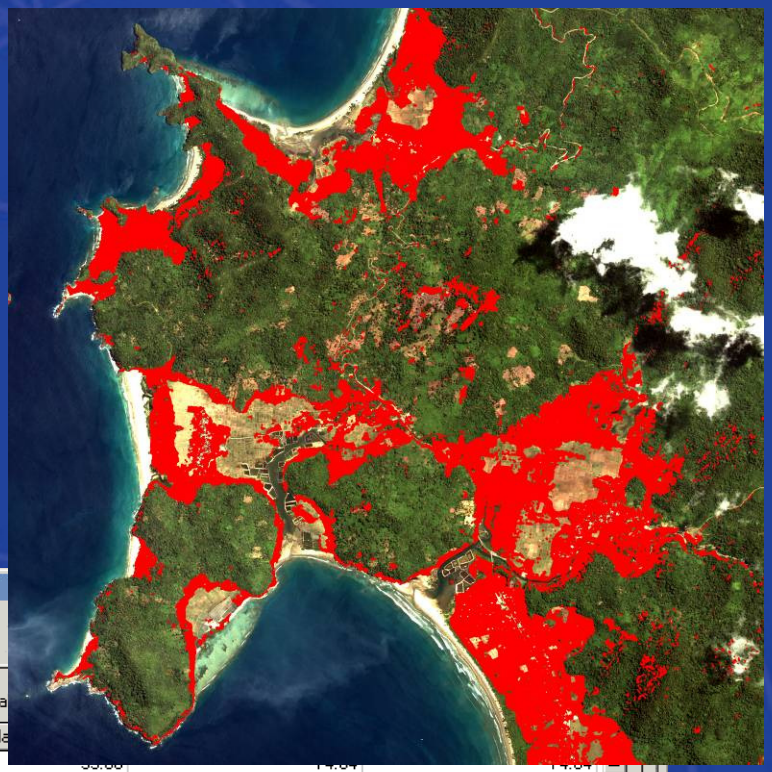
Damage Assessment

- Extraction of distribution of damages using change detection
- Result: affected areas are red colored.



Change Detection Statistics (Initial State: before_sam_maj.dat, Final State: after_sam_maj.dat)

File Options Help

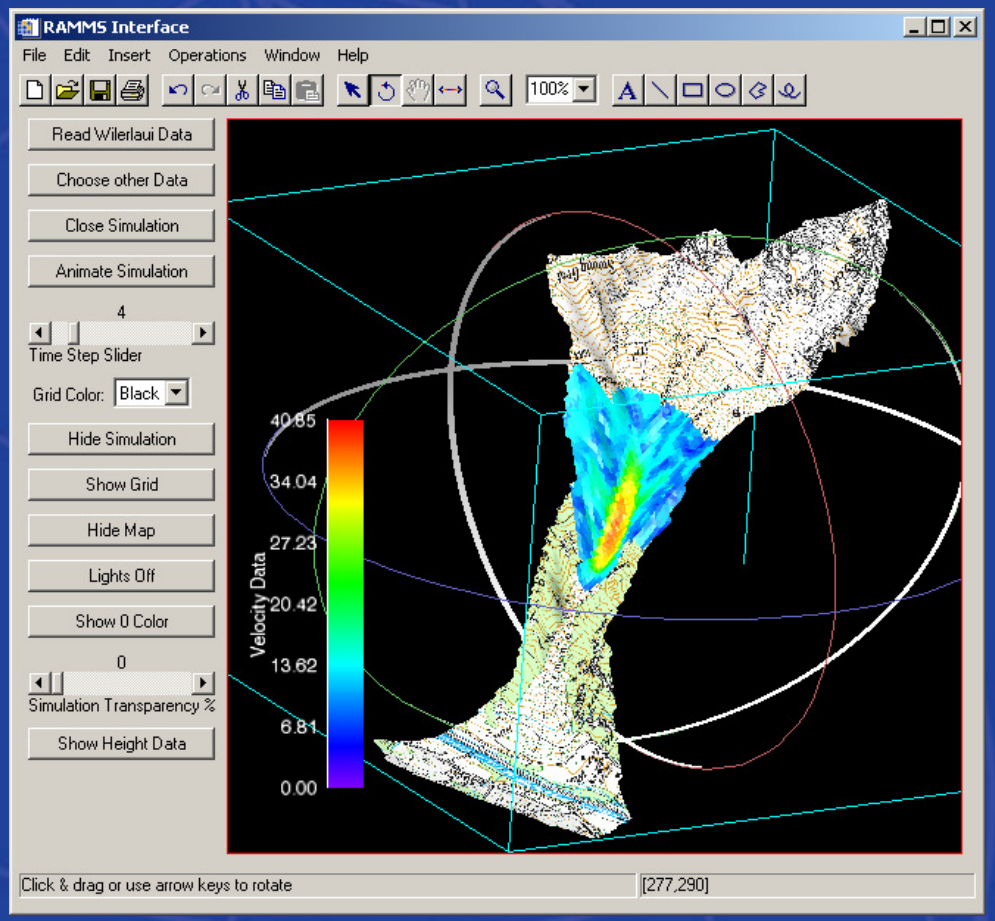
Pixel Count | Percentage | Area (Square Km) | Reference

Initia

Final State	green veg [Green] 17476 points	bare [Sienna] 7421 points	Uncla		
Unclassified	12.98	1.20			
green veg [Green] 17476 points	32.75	0.62	1.21	34.59	34.59
bare [Sienna] 7421 points	12.14	1.61	2.80	16.56	16.56
Class Total	57.87	3.44	63.88		
Class Changes	25.12	1.83	4.01		
Image Difference	-23.29	13.12	10.17		

Hazard Assessment

- RApid Mass MovementS (RAMMS)
- Commercial application for visualization and analysis of debris flows, rock fall, snow cover and avalanches
- Combine with digital elevation models and maps
- Develop a fast, stable, good and user friendly GUI
- Animation of simulation data



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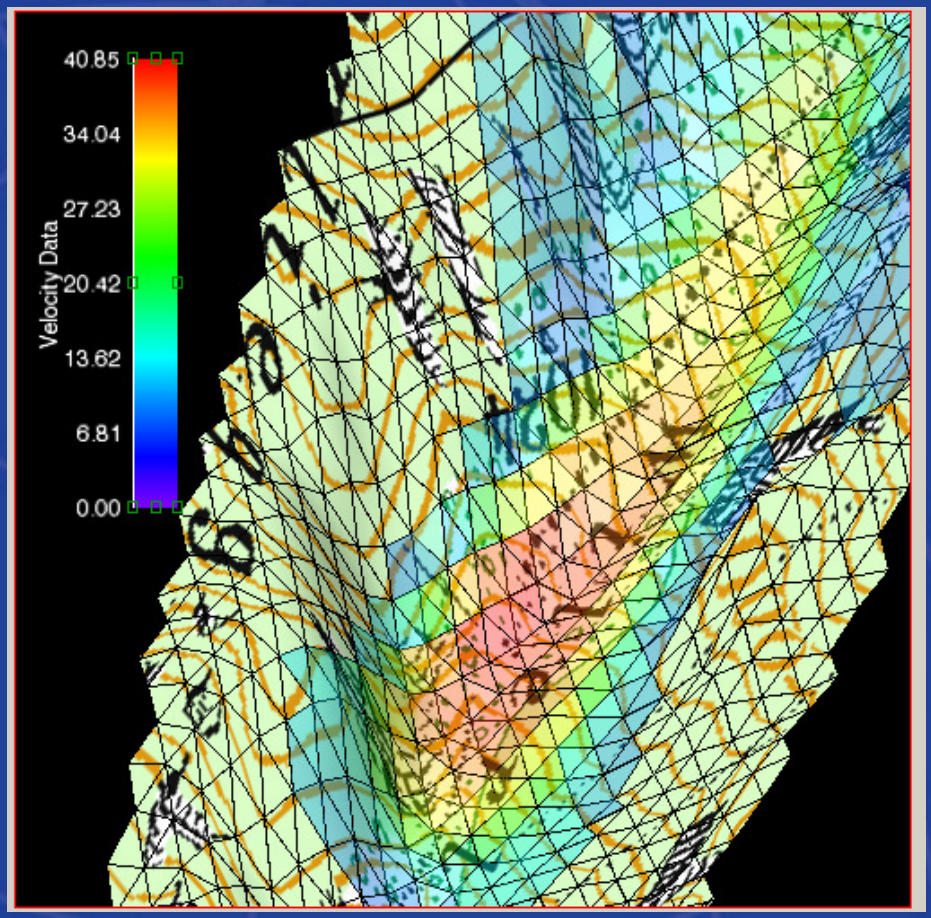
Hazard Assessment

- RApid Mass MovementS (RAMMS) approach
- Based on the IDL Intelligent Tools (iTool) framework
- Create a new iTool, iTool data readers, manipulators and visualizations
- 3 days prototyping



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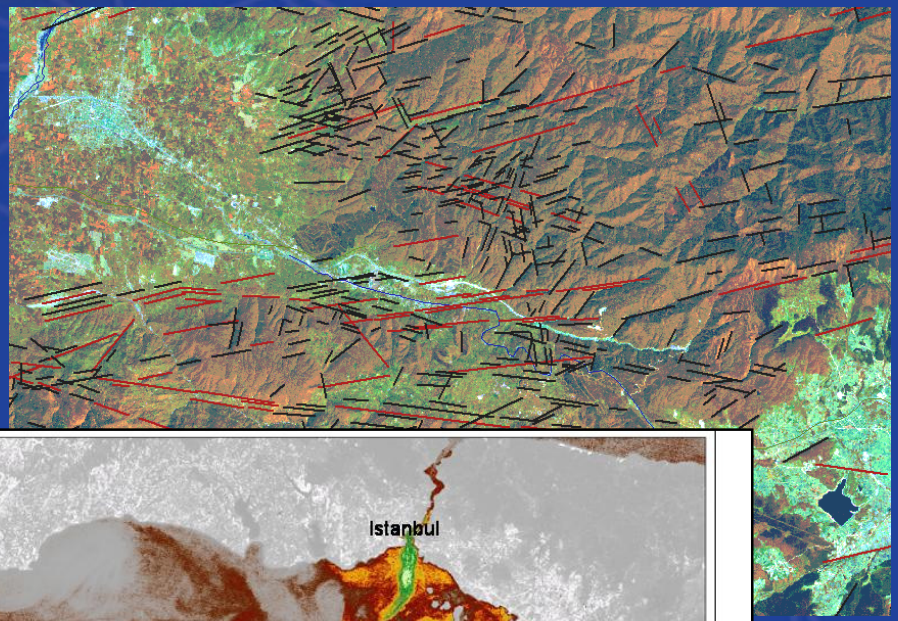
Hazard Assessment

- Assessment of earthquake and Tsunami hazard in North West Turkey using ENVI & GIS
- Based on Landsat ETM, ERS SAR, and ground truth data
- Structure analysis by lineament mapping
- Estimation of current flow behaviour within Marmara Sea



Colour Coding of the LANDSAT ETM image (2.7.2000)

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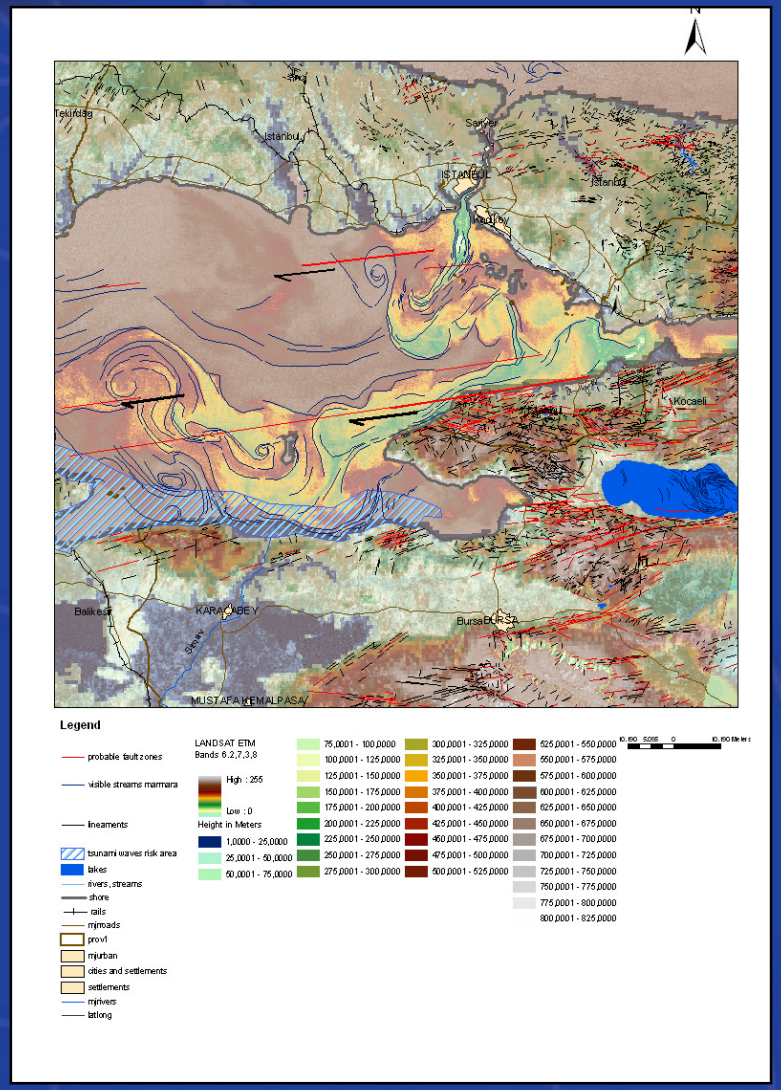
Hazard Assessment

- Result:
  Hazard assessment map for Marmara Sea with regard to Tsunamis triggered by earthquakes

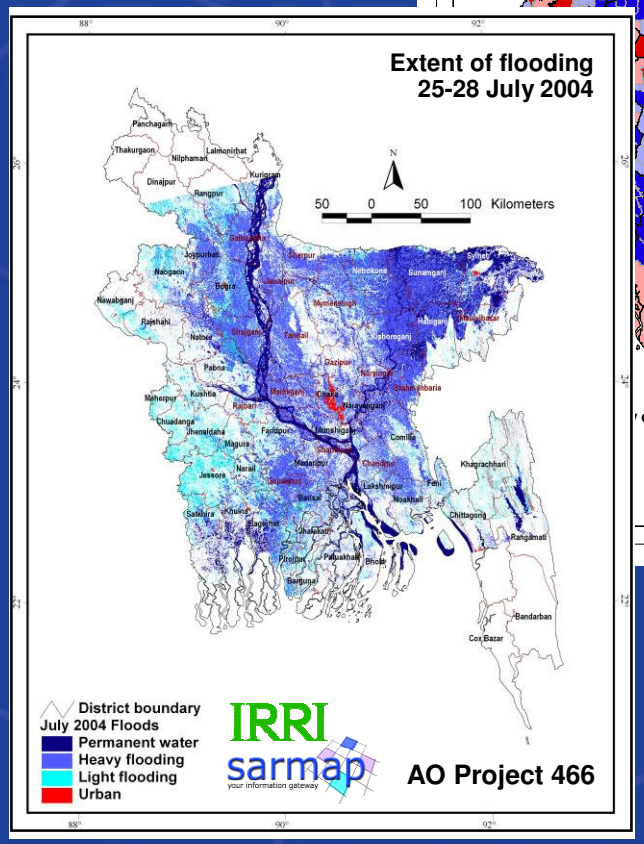


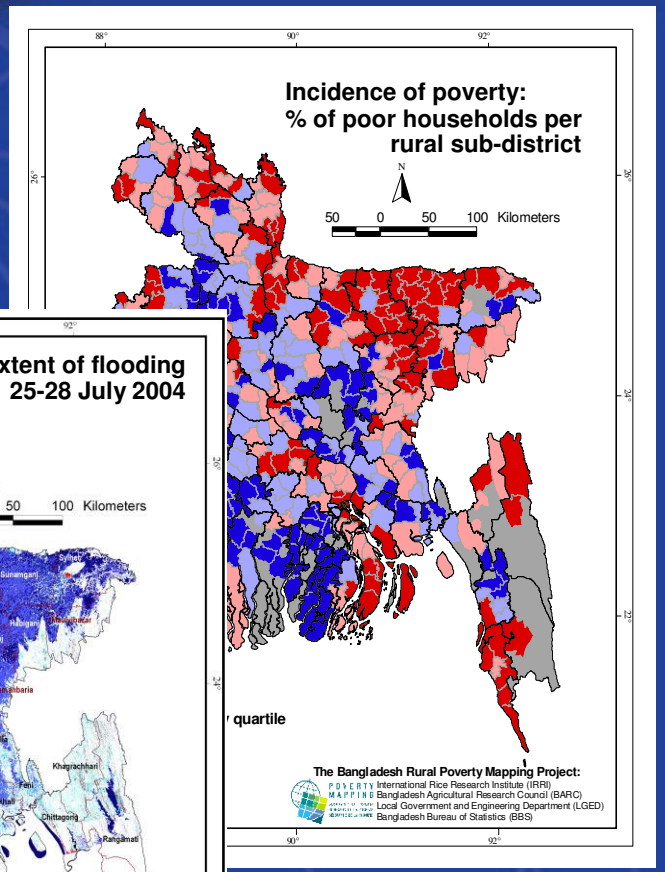
- PD Dr.habil.Barbara Theilen-Willige

  Office for applied remote sensing (BAGF), Birkenweg 2, D-78333 Stockach, E-mail: Barbara.Theilen-Willige@surf24.de

Disaster Monitoring

- Flood of Bangladesh July 2004
- SAR to the aid of vulnerability and food security monitoring
- ENVISAT ASAR Data
- 26,000 sq km in 40 of the country's 64 districts have been inundated





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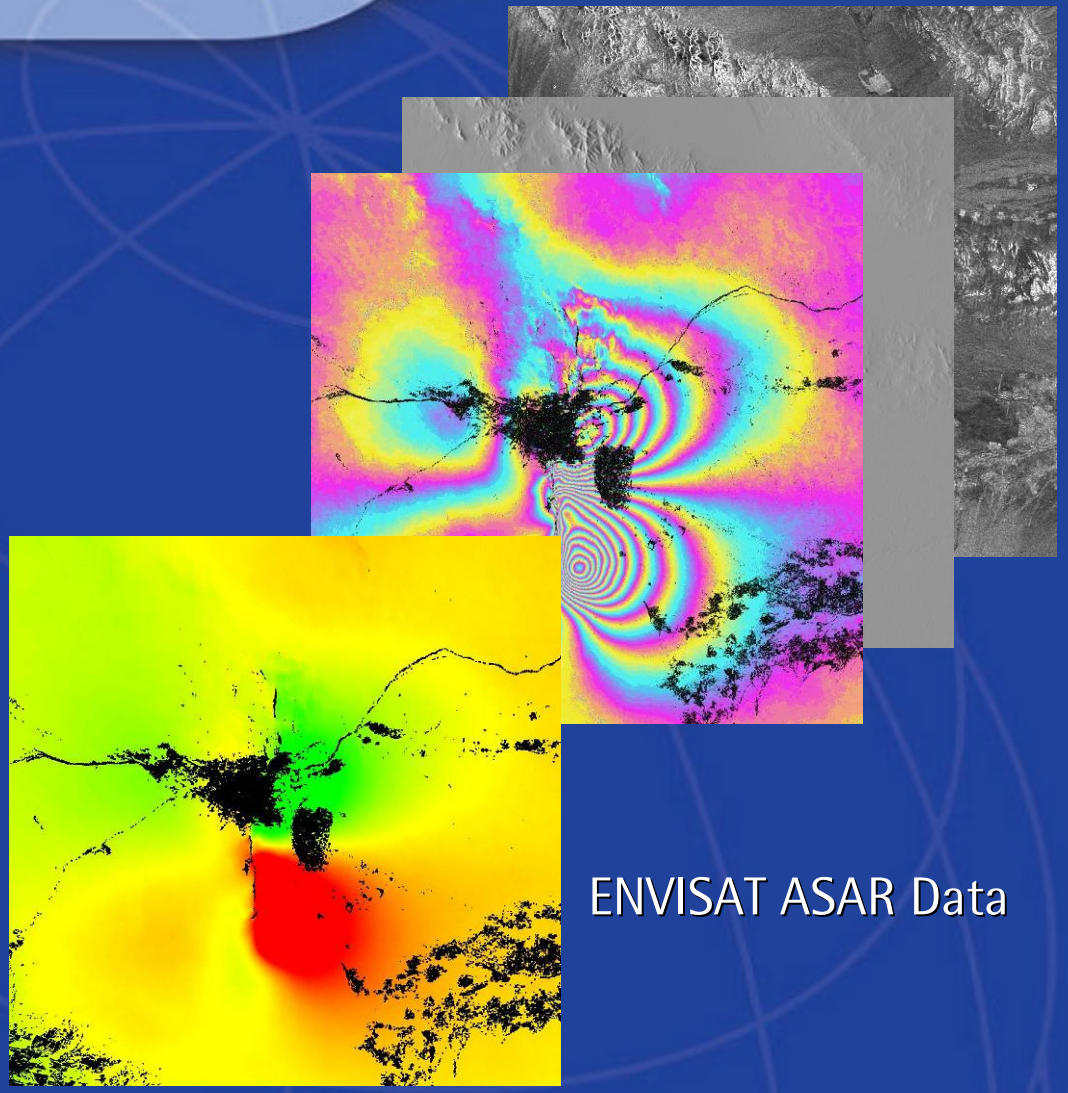
Disaster Monitoring

- Land displacement estimation after Bam earthquake 2003, Iran, using DInSAR
- Red and green tones: areas of largest deformation
- The deformation field is calculated as generated from a N-S oriented strike-slip fault.
- Max deformation ~ 48cm



ENVISAT ASAR Data

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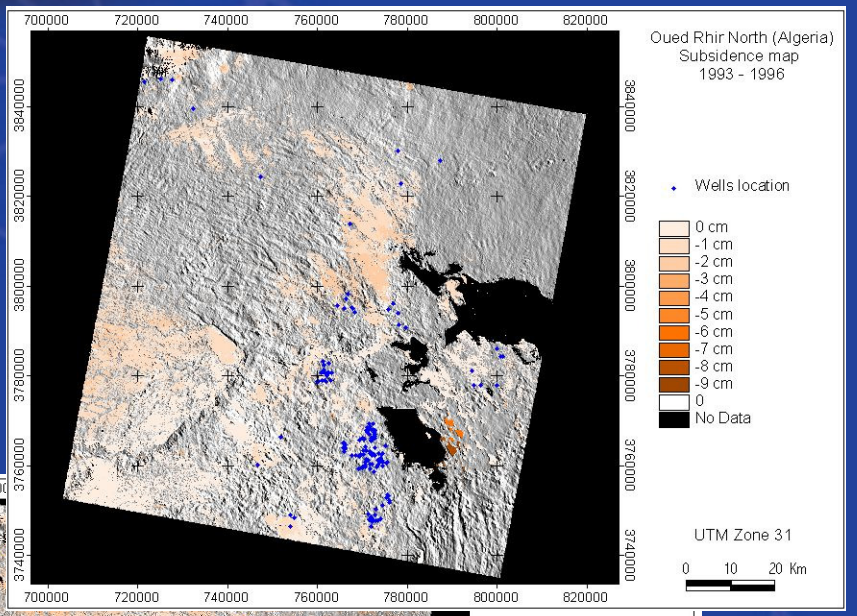
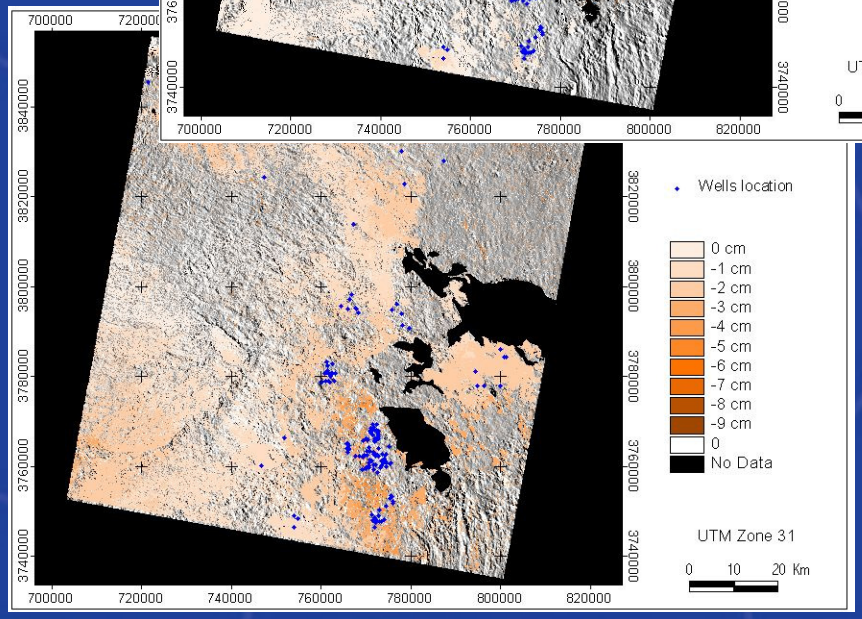
Environmental Monitoring

- Land displacement due to groundwater exploitation
- Hazards assessment using multitemporal data analysis
- Qued Rhir North (Algeria)

1993-1996



1996-2000



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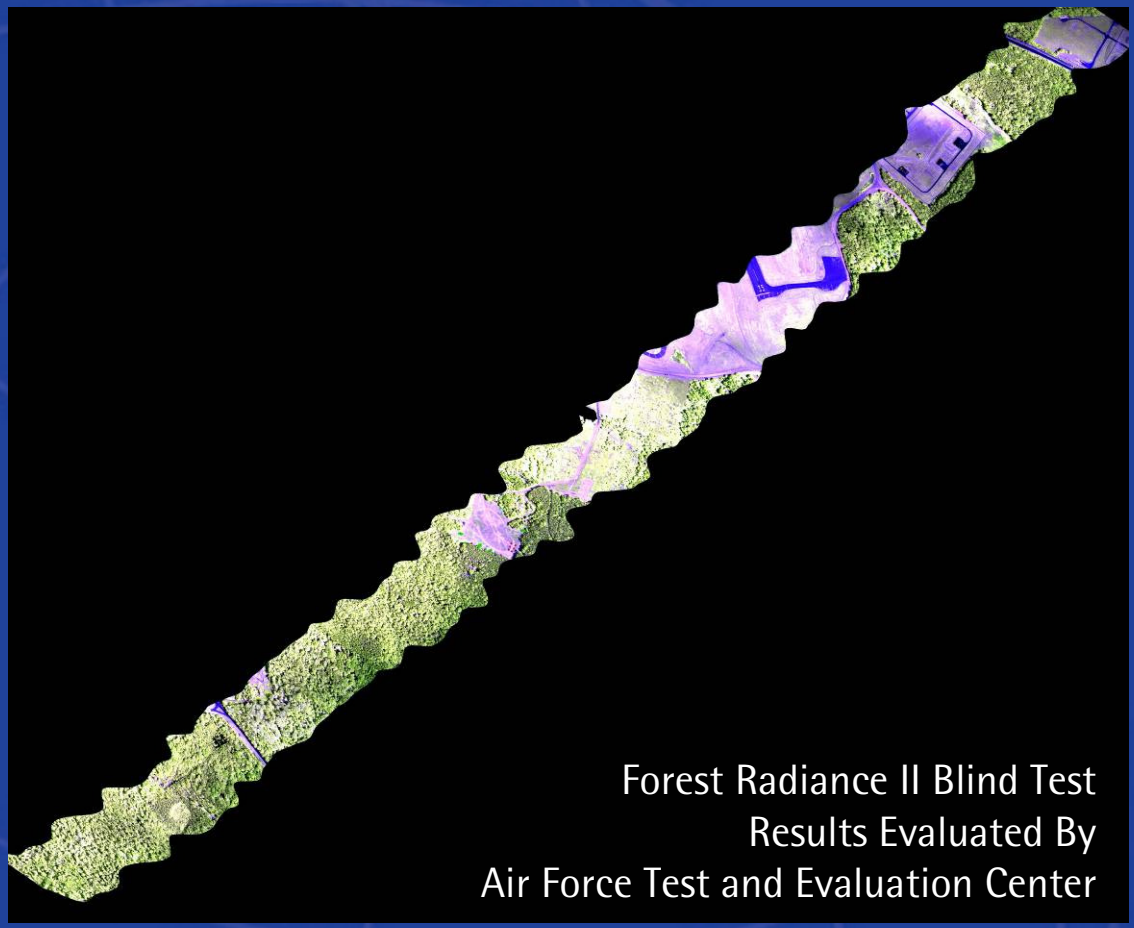
Disaster Management

- NITF images created in < 90 minutes
- Analysis and report acquired in < 90 minutes



Forest Radiance II Blind Test
Results Evaluated By
Air Force Test and Evaluation Center

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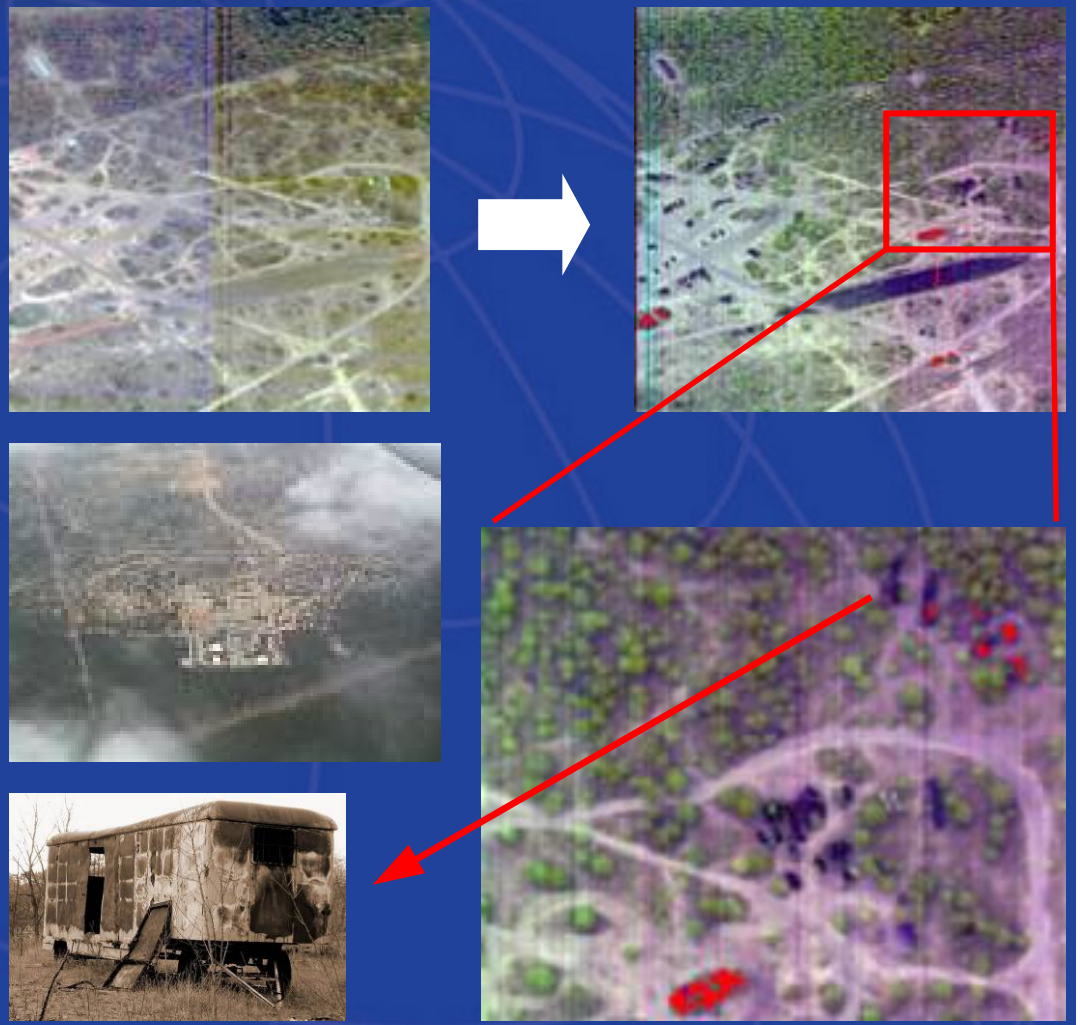
Disaster Management

- Spectral target detection using both in-scene derived spectra and spectral libraries
- Data was atmospherically corrected to remove effects of water vapor and other aerosols in scene.
- Processed using ENVI's Mixture Tuned Match Filtering algorithm.



CREASO

Providing information

- For all applications
  - Operation planning
  - Operation execution
  - Result checking
  - ...

Using IAS – Image Access Solutions

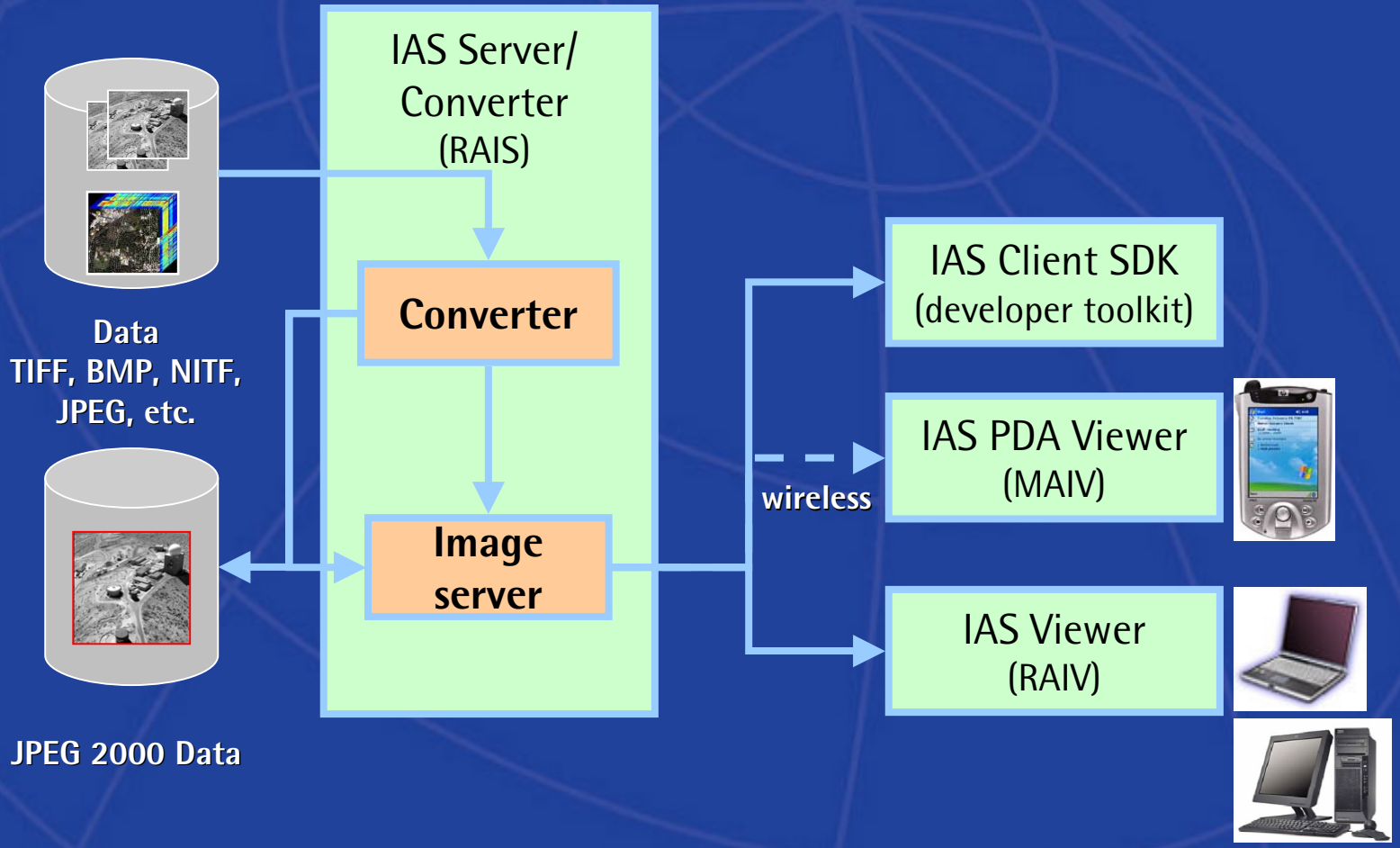
CREASO

IAS – Image Access Solutions

- Solution for imagery compression, dissemination, and visualization
  - IAS Server/Converter (RAIS) v2.0
  - IAS Viewer (RAIV) v2.0
  - IAS PDA Viewer (MAIV) v2.0
  - IAS Client SDK v2.0 (C++)

- Supports Windows & Solaris (RAIS), Windows (RAIV), MS PocketPC 2003 (MAIV)

IAS 2.0 Architecture



CREASO

R4 image displayed (999KB / 1.8%)

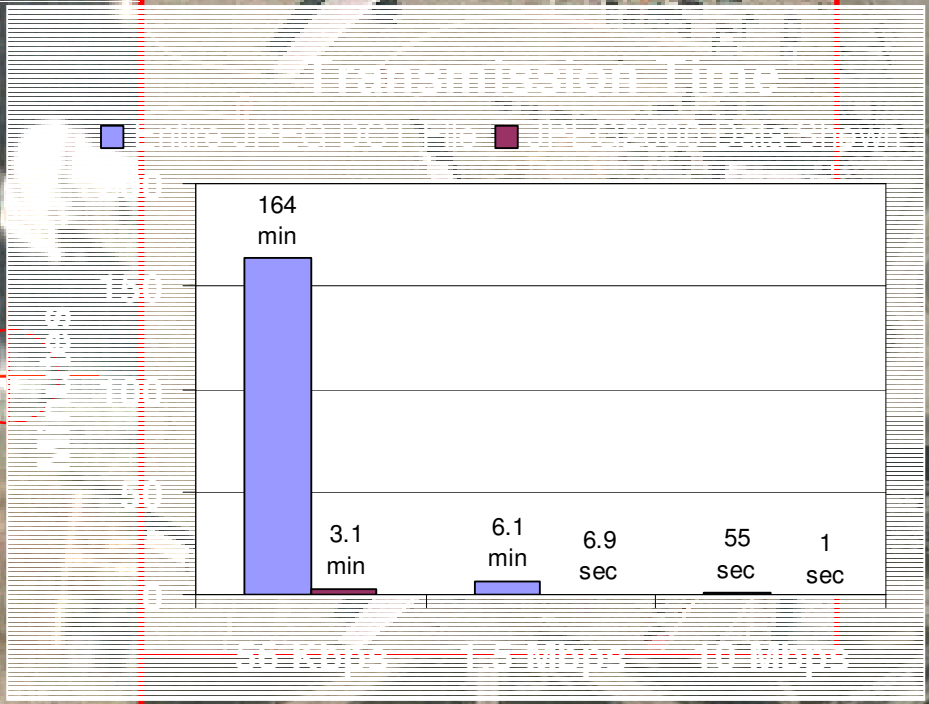
How IAS Client/Server Leverages JPEG 2000:

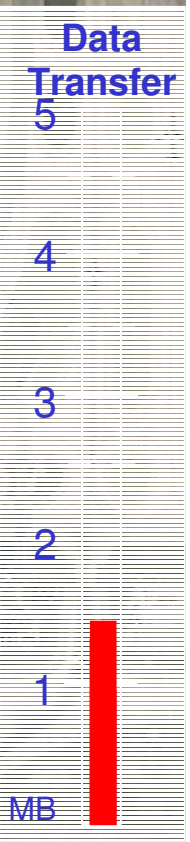
- Original image (JPEG) = 13.5K x 13.5K x 24 bits/pixel (530MB)
- Using IAS JPEG 2000, compressed to 10:1 (53 MB)

R2 image sub-frame (295KB / 0.5%)

IAS reduces the total data transmitted to 1,324 KB (2.4%)

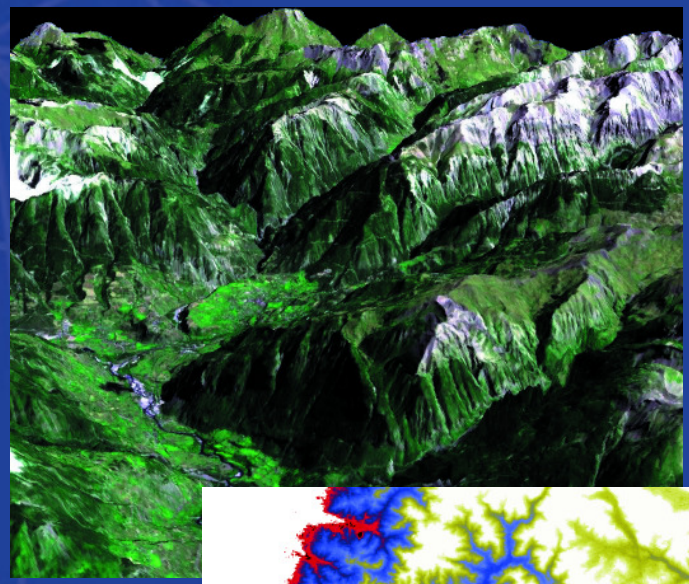
R0 image sub-frame (30KB / 0.06%)

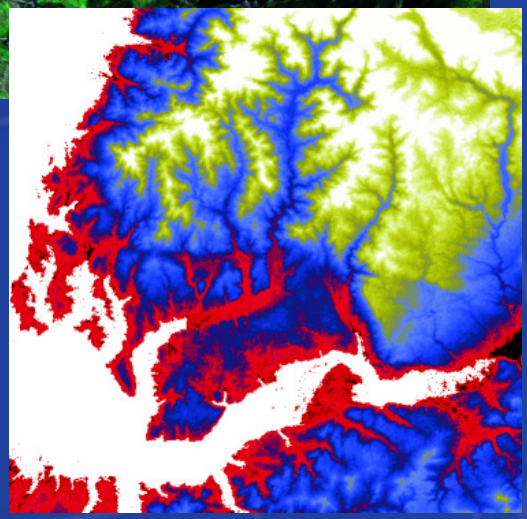




AsterDTM for ENVI

- Extract relative or absolute DTMs from Aster 1A or 1B images
- Create ortho-corrected images
- Batch capability
- Exceptional geometric precision: xy error < 50 m, z error < 10 m
- Inexpensive ASTER images available by FTP download for $ 60

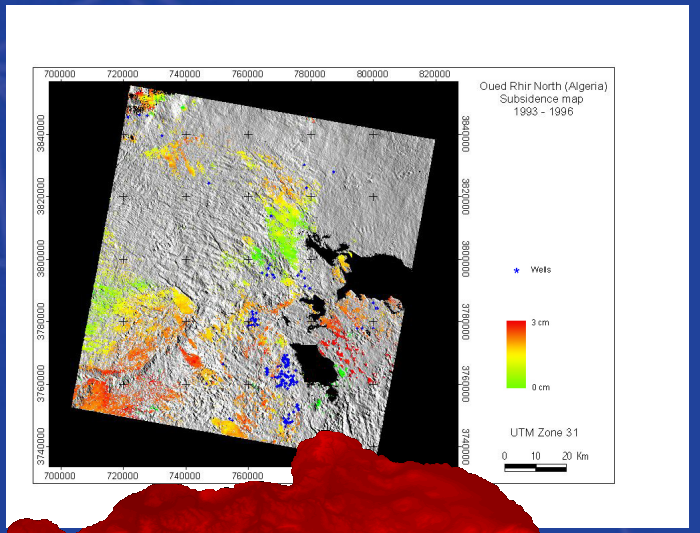




C R E A S O

SARscape for ENVI

- Generate high accuracy DEMs from SAR data with SAR Interferometry
- Calculate land displacements using Differential SAR Interferometry
- Supports ERS-1/2, JERS-1, RADARSAT-1, ENVISAT-ASAR
- Simple to use - integrated, interactive or in batch mode



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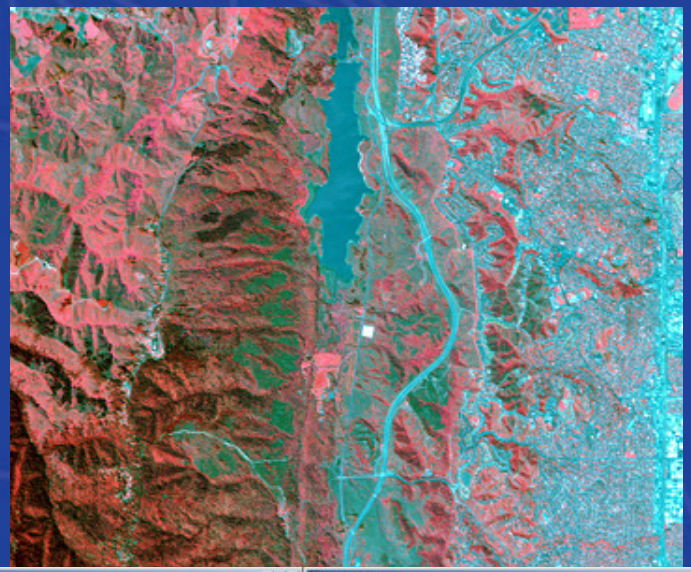
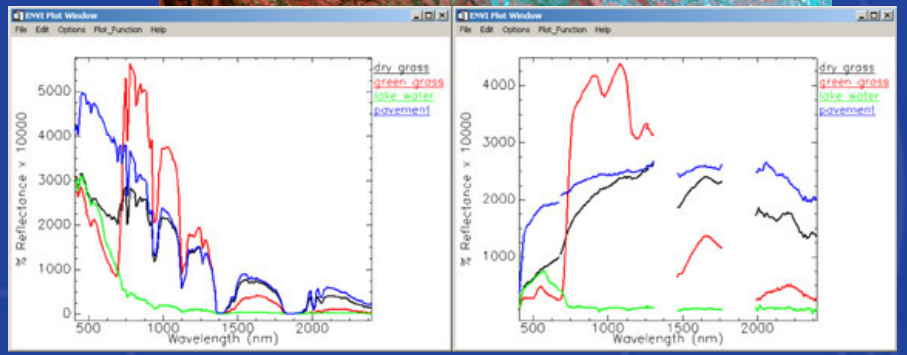
ENVI FLAASH

- **F**ast **L**ine-of-sight **A**tmospheric **A**nalysis of **S**pectral **H**ypercubes
- Professional atmospheric correction plug-in for ENVI including MODTRAN in the code
- Removes atmospheric water vapor, oxygen, carbon dioxide, methane, ozone and molecular and aerosol scattering
- Imperative for high precision image evaluation
- For multi- & hyperspectral data





C R E A S O

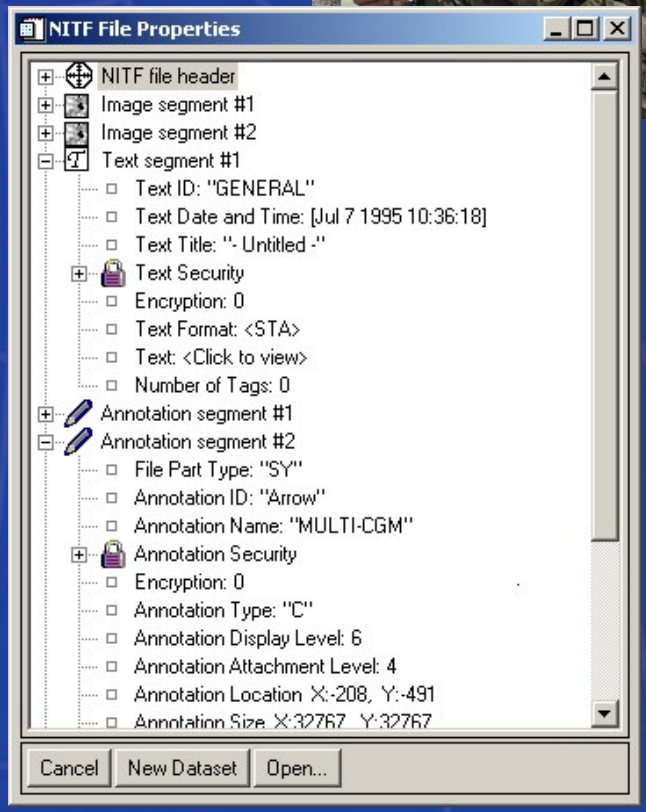
OrthoTool for ENVI

- **OrthoTool Sat**
  High precision ortho-rectification of satellite data
- **OrthoTool Stereo**
  Automatic DEM generation using IKONOS, Quickbird or SPOT 5 image pairs
- **OrthoTool Photo**
  Ortho-rectification of aerial photos

C R E A S O

ENVI NITF/NSIF Modul

- National Imagery Transmission Format / NATO Secondary Image Format
- Standard image formats of U.S. Military and NATO
  - Certified up to Level 7 by the Joint Interoperability Test Command
  - Certified for JPEG 2000 compression (read and write)
  - Reads NITF 1.1, 2.0, 2.1 and NSIF 1.0
  - Writes NITF 2.0, 2.1



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ENVI / RemoteView Link

- Generates a simple socket connection for
  - data transmission
  - use of file utilities
  - initializing customized or standard workflows in ENVI
- Classification, feature extraction and change detection using multi- and hyperspectral data without additional ENVI training!