Change detection for updates of vector database through region-based classification of VHR satellite data

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ORFEO accompaniment program

Belgian Science Policy

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Outline

- Introduction
- Objective
- Study zone and data
- Method
- Results
- Conclusions

The local geospatial databases need to be update

- **Interpretation of aerial photographs**
  - → expensive and time-consuming task

- **VHR satellite data (QuickBird, Ikonos, Pleiades HR data)**
  - → advantage of the satellite images
    - digital format
    - large spatial coverage
    - multispectral mode
    - …
  - → very high spatial resolution

Change detection methods

- **Image – Database change detection**

- **Image – Image change detection**
  - **change – no change detection**
  - **categorical change detection**

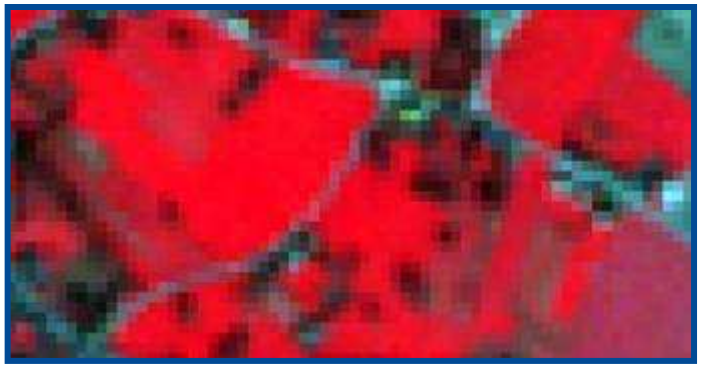
→ **VHR supervised classification**

→ **Two occurring problems with VHR data pixel-based classification**
  - **spectral variability**
  - **poor spectral resolution**

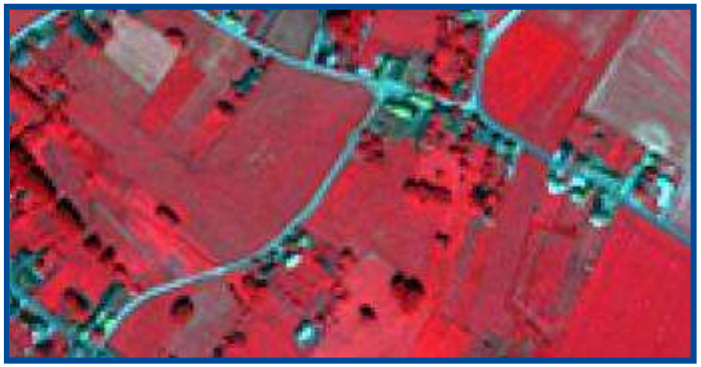
Spectral variability and spectral problems

→ **Decreases the spectral separability in the spectral space**

→ **Causes salt and pepper effect**



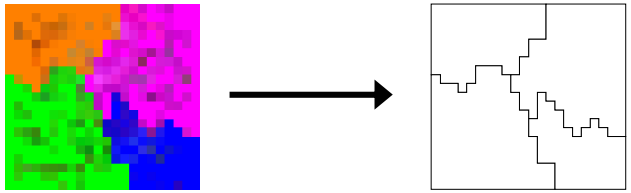
SPOT 5, 2004



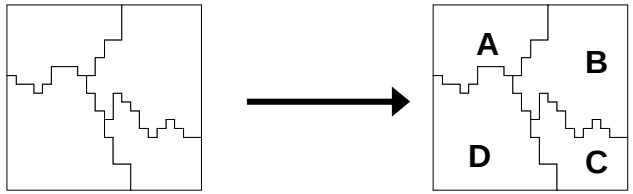
IKONOS, 2004

To overcome these problems, a region-based classification can be used

Segmentation



Classification



Advantages of the segmentation

- Avoids the “salt-and-pepper” effect
- Allows the use for a lot of features on top of spectral features
  - Textural features (without arbitrary neighbors)
  - Morphological features (shape, length, width,…)
  - Contextual features

Objective of the project

Study the potential of the Pleiades-HR data to detect change for updates of vector database through region-based classification

Research network

Royal Military Academy,
Signal and Image Centre

University of Liège,
Space Centre of Liège

ULB

End users

- **Belgian National Geographical Institute**

1/10000 topographic map (TOP10v-GIS)

Ambitious database updating policy

- **Road network each year**
- **Buildings each three years**
- **Complete database each six years**

→ Need of new update procedure

Selection of the study area and data collection

Data	Acquisition date	Scale	Spatial resolution (m)	OFF-nadir
QB Pan	12 May 2004		0.65	13°
QB XS	12 May 2004		2.58	13°
QB Pan	13 Sept. 2006		0.7	**22°**
QB XS	13 Sept. 2006		2.78	**22°**
PICC		1/1000		
LPIS	2004			
TOP10V-GIS	1999 - 2000	1/10000		

Geocoding and orthorectification of VHR images and co-registration with databases

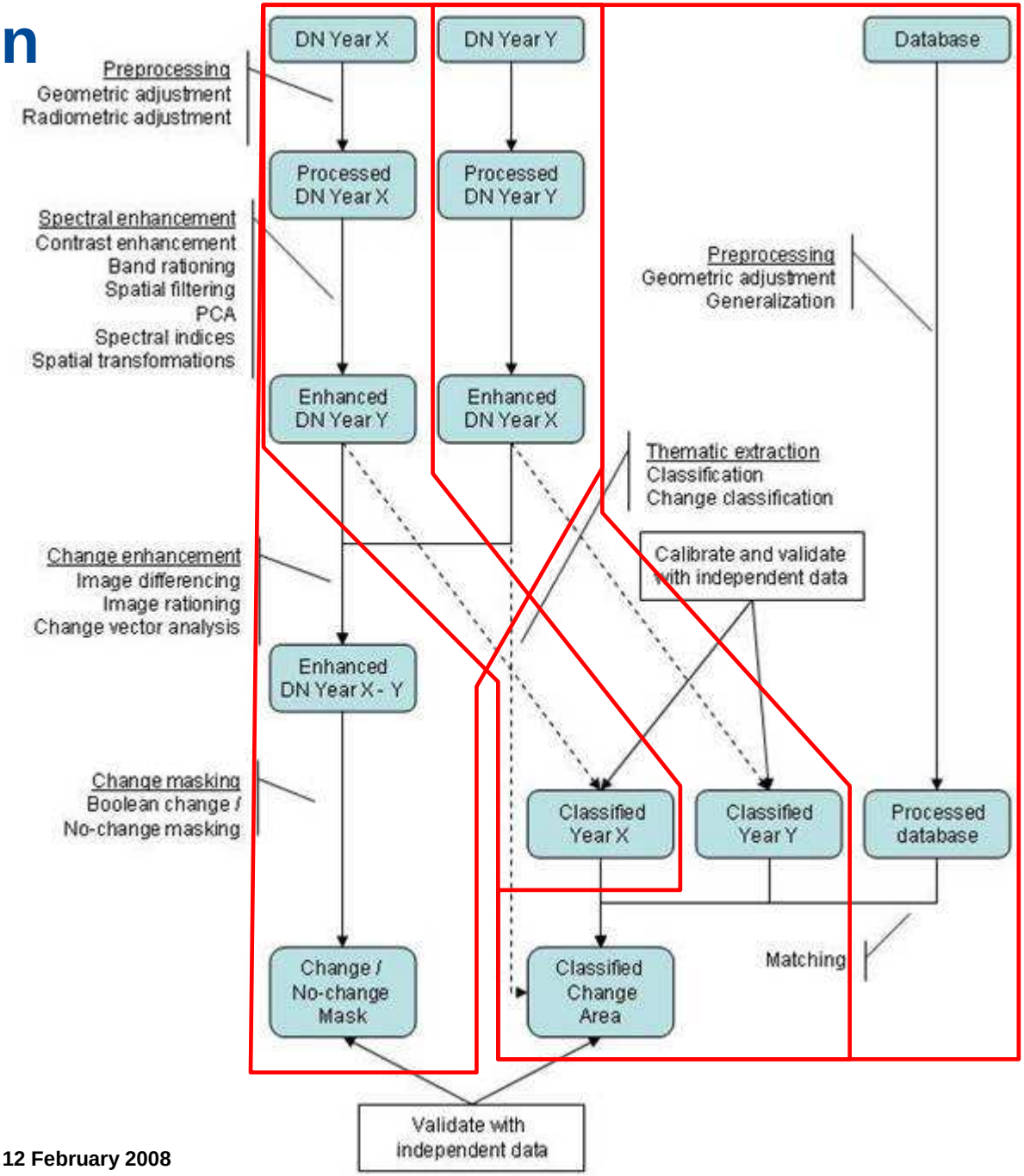
- **Othorectification**

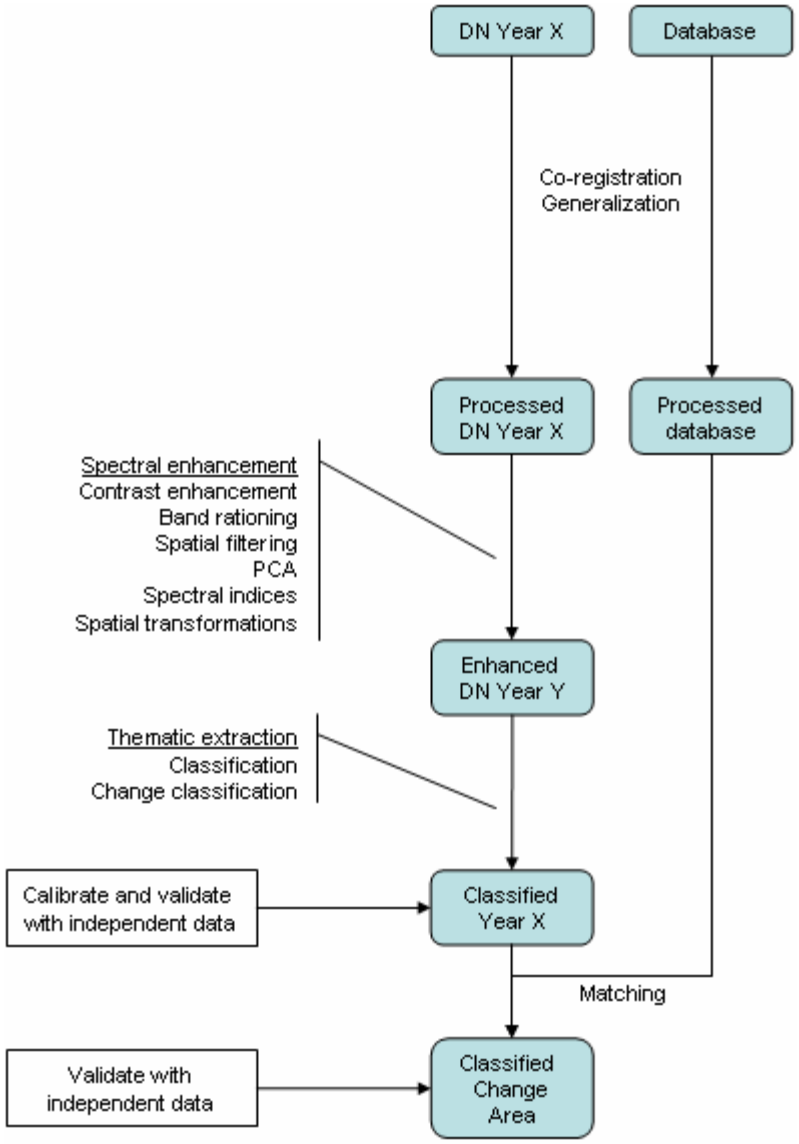
Image	Acquisition date	Nb GCP	Order	X RMSE	Y RMSE
QB Pan	12 May 2004	128	3nd	0,94	0,91
QB XS	12 May 2004	128	3nd	0,23	0,22

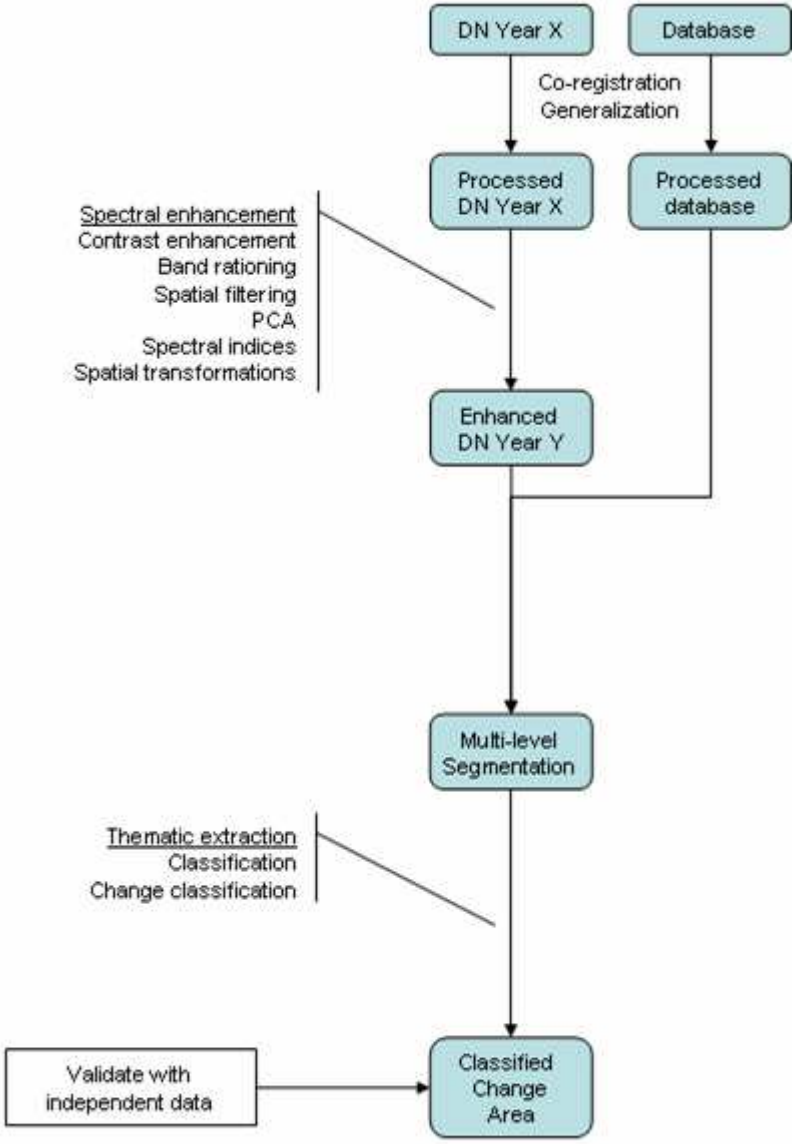
Study zone

- Road
- Building
- Vegetation
- Water

Change detection method







Adapted from Prenzel, 2004

Database segmentation

Database generalization

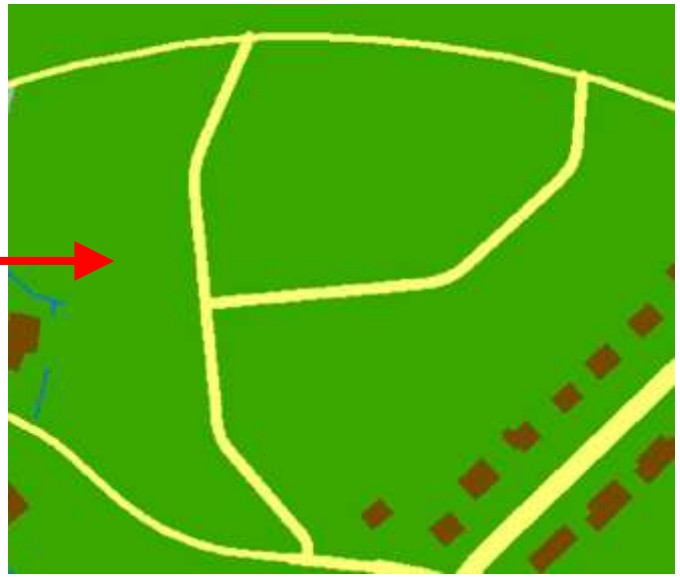


Image segmentation

Image classification

Level 1		Level 2	
Barren surfaces	1	Barren surfaces	11
		Shadow	11
		Building	12
		Road	13
		Vegetation	14
		Water	15
Building	2	Building	22
		Shadow	22
		Barren surfaces	21
		Road	23
		Vegetation	24
		Water	25
Road	3	Road	33
		Shadow	33
		Barren surfaces	31
		Building	32
		Vegetation	34
		Water	35
Vegetation	4	Vegetation	44
		Shadow	44
		Barren surfaces	41
		Building	42
		Road	43
		Water	45
Water	5	Water	55
		Shadow	55
		Barren surfaces	51
		Building	52
		Road	53
		Vegetation	54

Feature used for the classification

- **Vegetation** :

NDVI threshold

- **Shadow**:

panchromatic threshold

- **Barren surfaces, Road, Building, Water**:

Panchromatic and Red bands,

Contrast of Green and Red bands, Second angular moment of Panchromatic band,

Length / Width

Change detection assessment

Change error matrix

		Reference	
		No change	Change
Classification	No change	8853285	53638
	Change	3538499	514564

Change detection accuracy = **72 %**

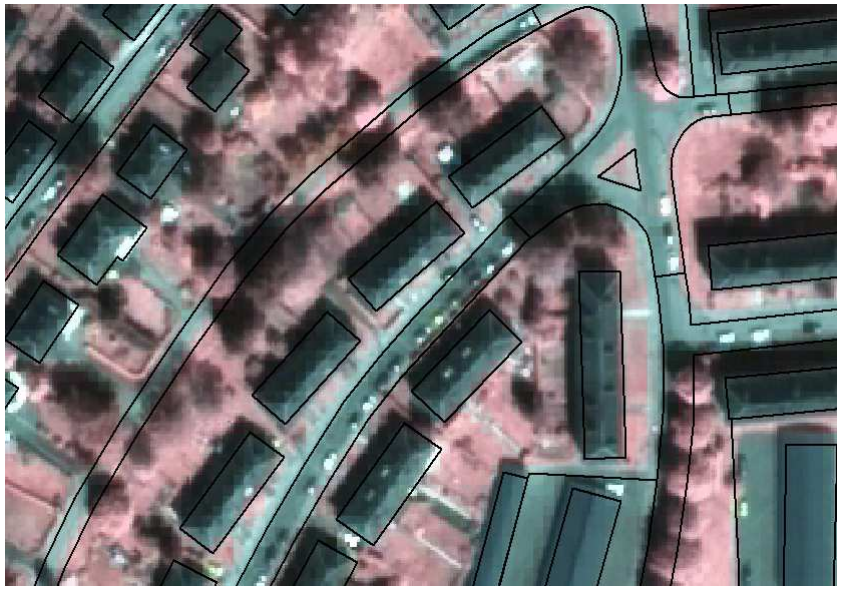
Transition error matrix

		Reference			
		No change		Change	
		Correct	Incorrect	Correct	Incorrect
Classification	No change	8853285	0	53638	
	Change	3538499		254731	259833

Transition detection accuracy = **70 %**

Classification detects **7 times more** change than the reference but detects **90.5%** of the true changes

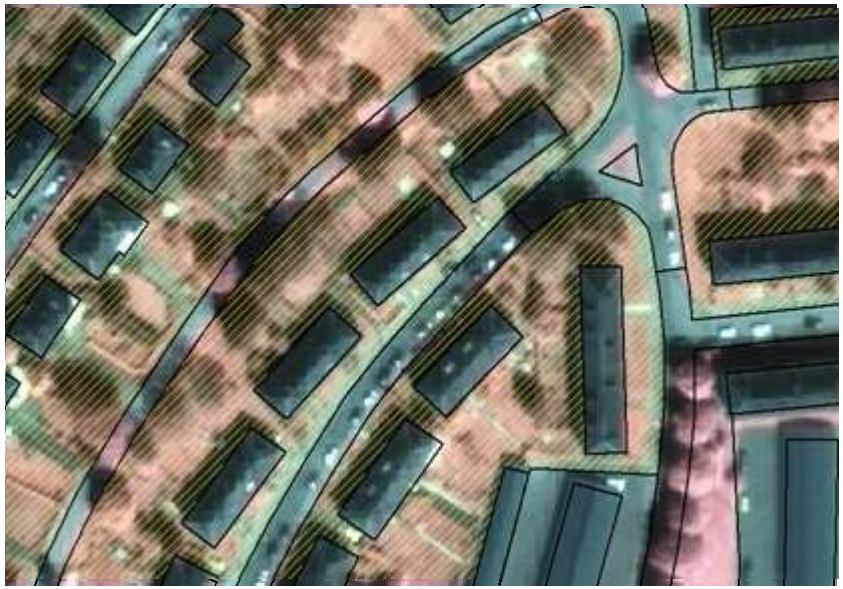
Occlusion



Occlusion of the Roads

Represents 2.4% of the false changes

Land-use Vs Land-cover



Some problems with the “Garden”

Land-use Vs Land-cover

Some problems with the “Crop fields”

Represent **72**% of the false changes

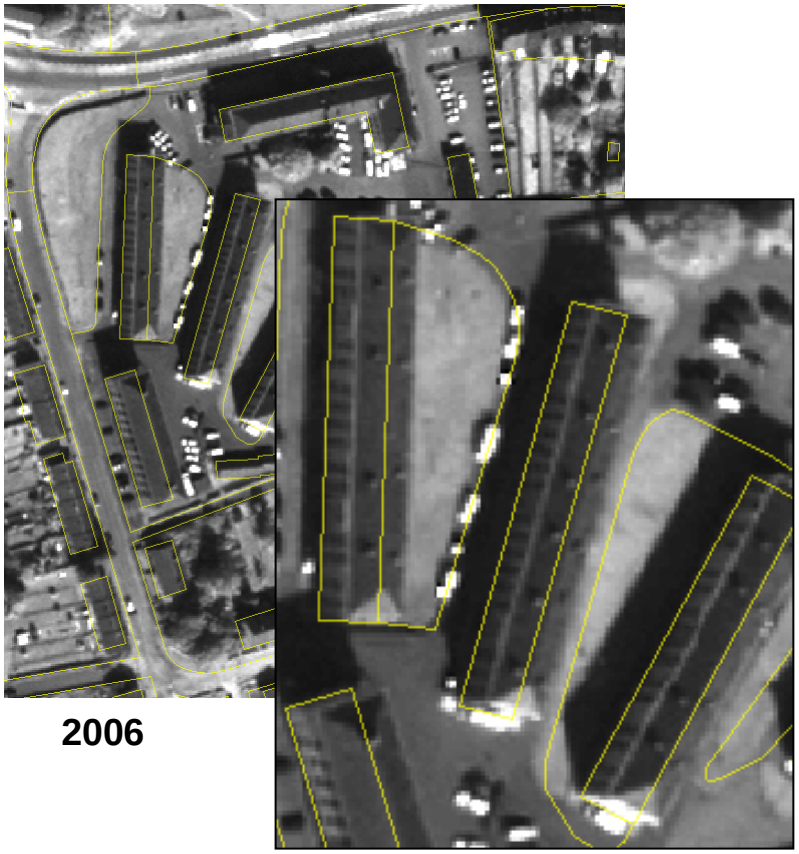
Conclusions

- This study highlights some problems
- Good results
- Data integration and matching
- A good co-registration / orthorectification is very important

Perspectives

- Overcome the occlusion problems
- Overcome the class definition problems
- Test other study zones
- Try to use the other QuickBird image (22° off-nadir)

2004



2006

Thank you for your attention

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