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RapidEye Change Detection Services

Harout Jerkizian | Product Development
2011-10-26

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Change Detection Core Issues

- Change detection is a statistical analysis term often applied to digital signal processing
- In remote sensing it is difficult to speak only of change detection
- Many remote sensing projects detect and analyze changes but under different titles

Change Detection Core Issues

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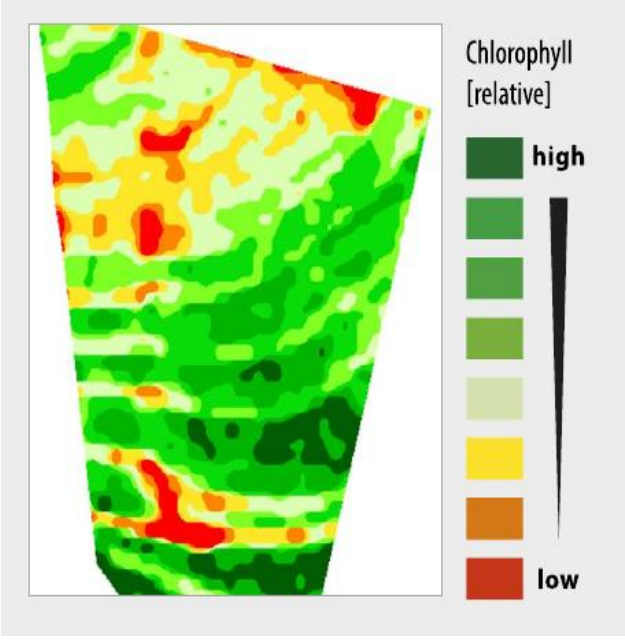
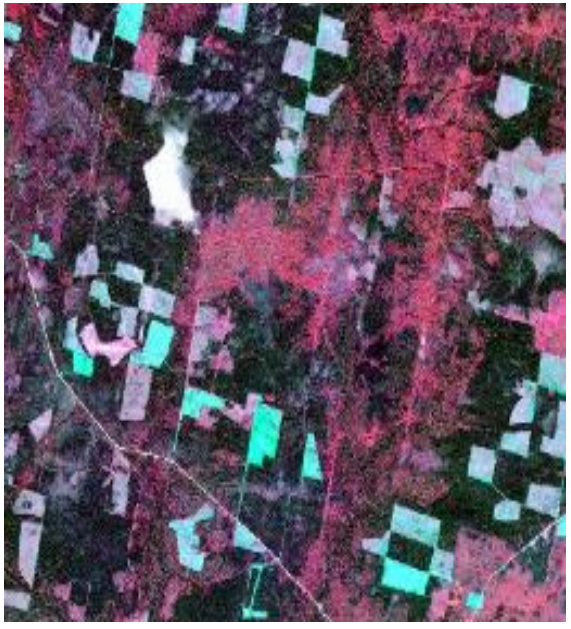
Change detection applications under different designations



Monitoring Crop Health



Logging Monitoring

Pipeline Monitoring

Change Detection Core Issues

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- Raw Change Detection maps do not have much value for non-mapping commercial enterprises
- Has little added value for mapping/GIS companies
- End users need ready and interpreted information
- The “Analysis” part is often unique for every application

Change Detection Core Issues

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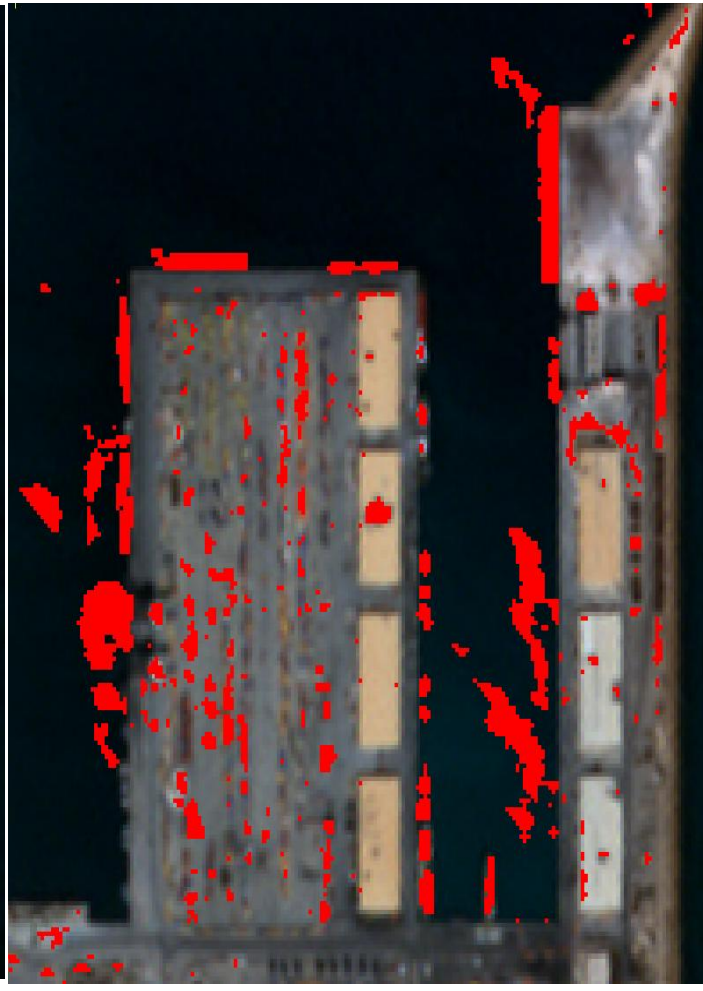
Misrata Port
2010-05-29

Misrata Port
2011-09-14



Automatic Change Detection
MAD + Threshold 0.95

Change Detection Core Issues

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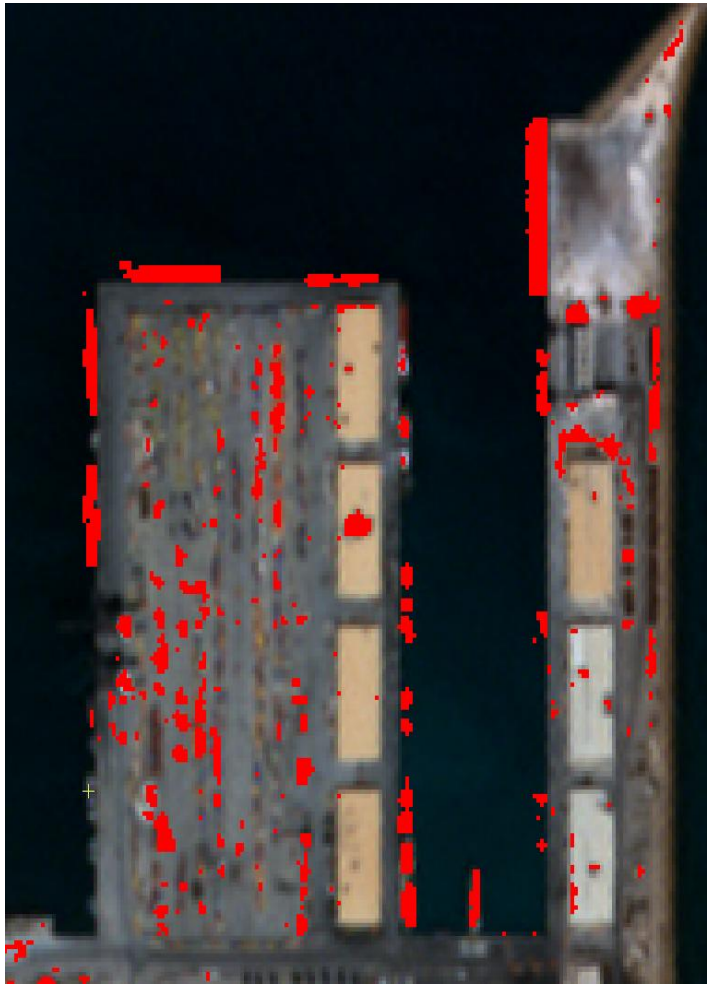
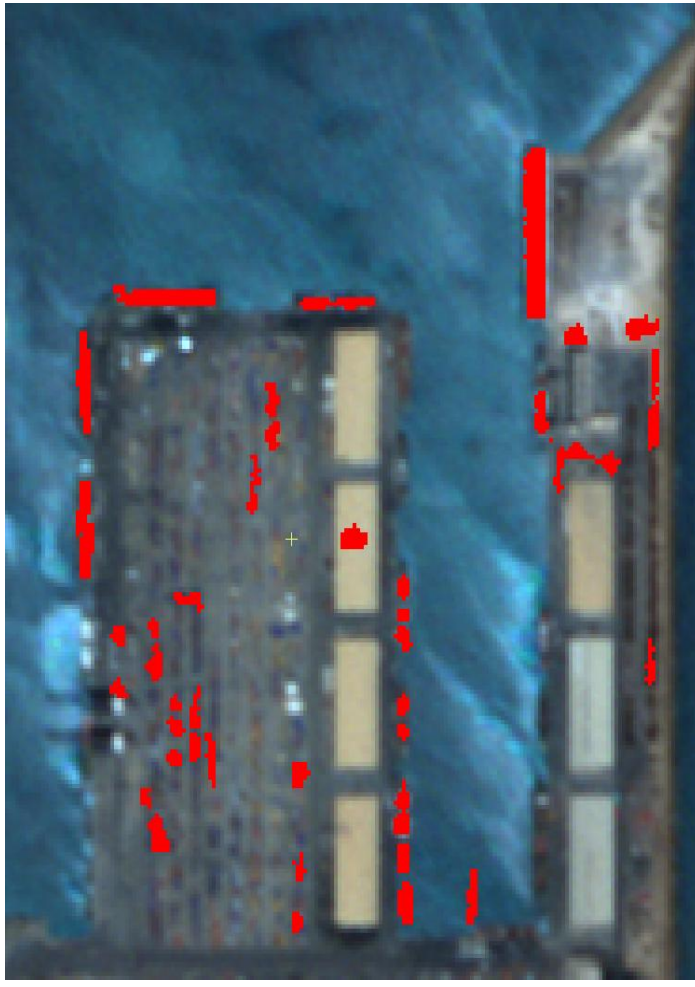
Raw Change Pixels

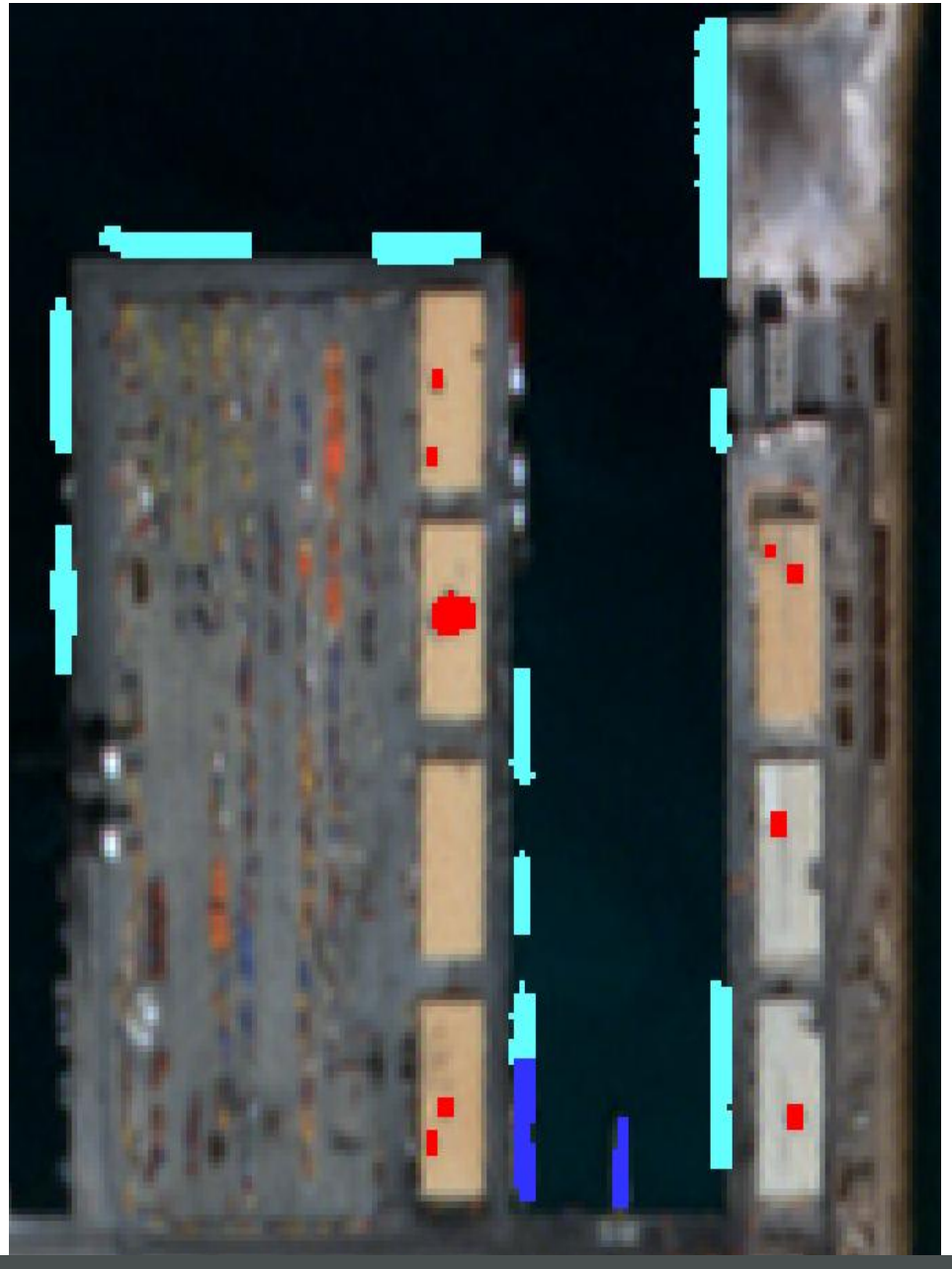


Water masked out



Small objects (< 10pixels) sieved out

Change Detection Core Issues



Assessment of War Impact

Port Gasr Ahmed
Misrata, Libya

Vessels before war

Vessels after war

Structural damages

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- From Change Detection to War Impact assessment is a long path to travel
- Analysis of “port damage” different than “airport damage”, “oil refinery”, “residential damage” etc.
- The question of Auto analysis versus Human interpreter? Or combined?

Change Detection Core Issues

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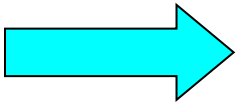
- Find a robust change detection application
- Is the data resolution good enough to detect the changes?
- Is there a market?
- Is the service profitable? For the service provider as well as the client?
- Technical interface integration between service provider and user

Methods

Main change detection methods:

- Image Difference / Ratio
- Change Vector Analysis (CVA)
- Principal Component Analysis (PCA)
- Multivariate Alteration Detection (MAD)
- Post Classification Change Detection (PCCD)

RapidEye Focus



Methods

Image Differencing / Ratioing

- Usually performed on Vegetation Indices
- Pros:

Simple / Can fix viewing geometry problems

- Cons:

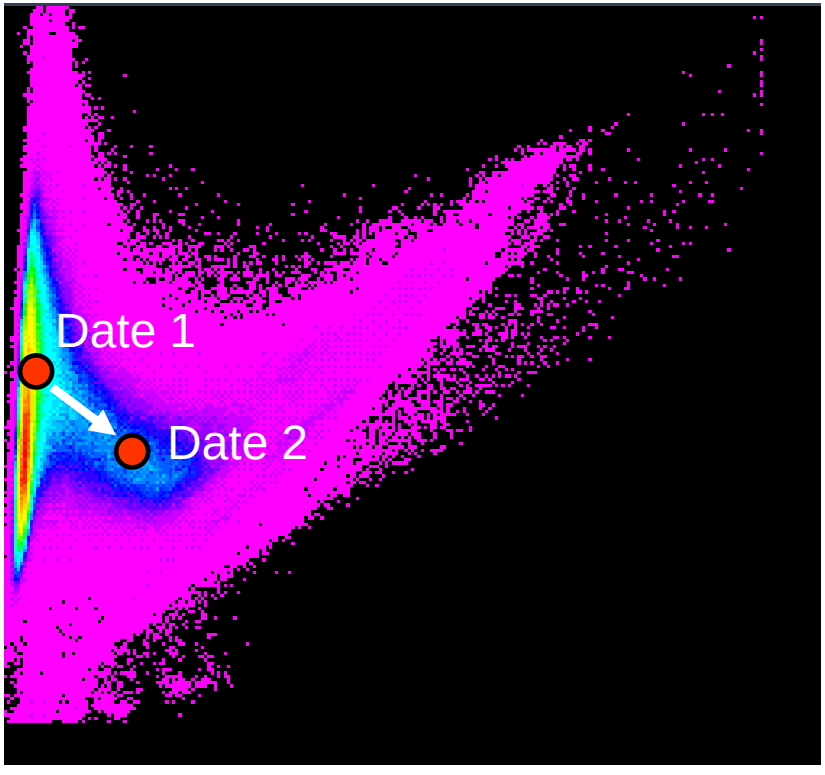
Absolute values need calibration / Variable score for same change magnitude (20/40 = 0.5 ; 40/20 = 2)

Methods

Change Vector Analysis

In n-dimensional spectral space, determine length and direction of vector between Date 1 and Date 2

Direction and Magnitude of Change can be interpreted



Methods

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Multivariate Alteration Detection:

- MAD is based on a canonical correlation analysis
- The changes detected are invariant to
  1) changes in gain and offset of measuring device
  2) linear data calibration schemes and atmospheric corrections
  3) orthogonal or principal component transformations
- Inverse gamma function converts Chi2 distribution to Probabilities 0 to 1
- Shown to be better than PCA (A Nielsen 1998)

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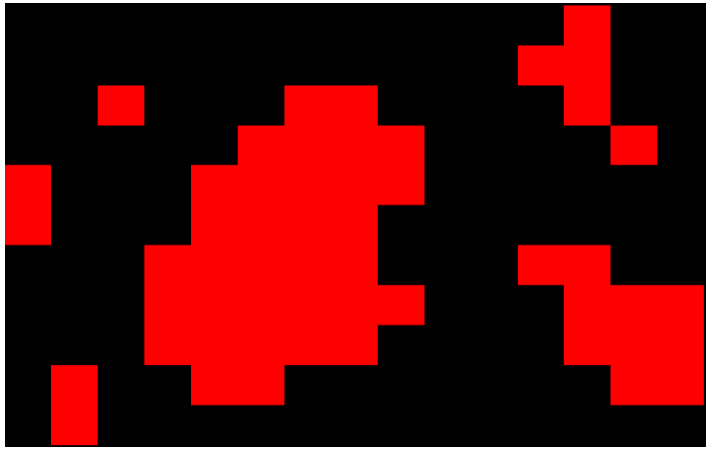
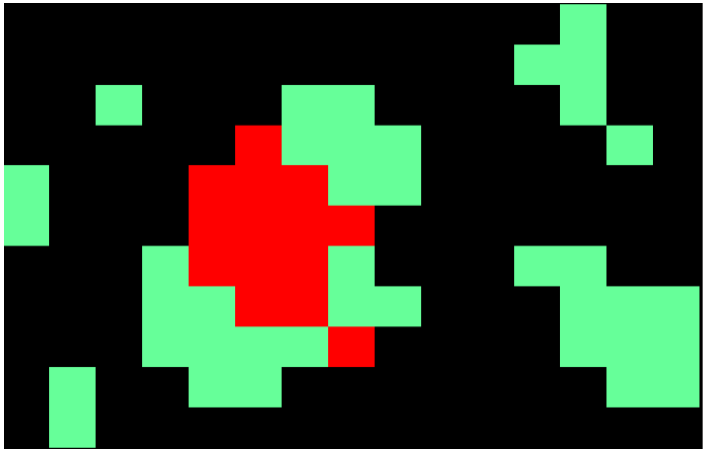
Thresholding

- Always risk of under/over inclusion of changes
- Binary Thresholding takes an upper and lower threshold
- Hysteresis Thresholding spatially connects the weak change pixels to strong changes

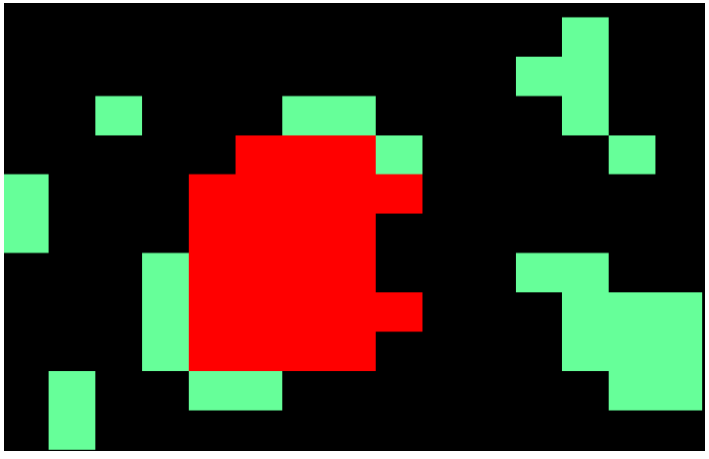
Hysteresis demo



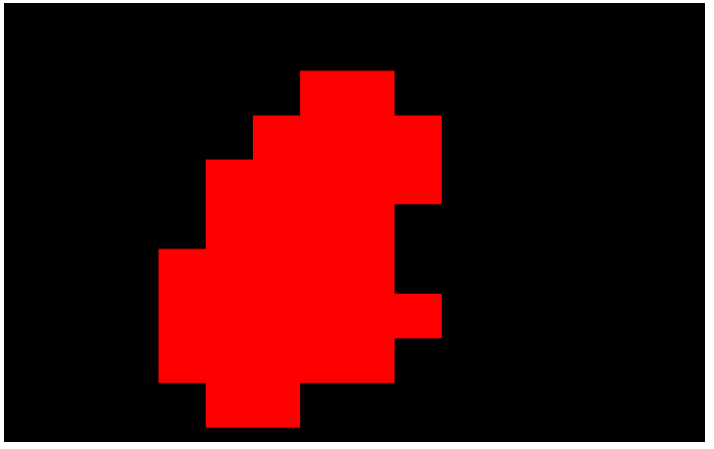
Single threshold T > 0.7



Stong change T > 0.9 (green)
Weak change T > 0.7 AND T < 0.9

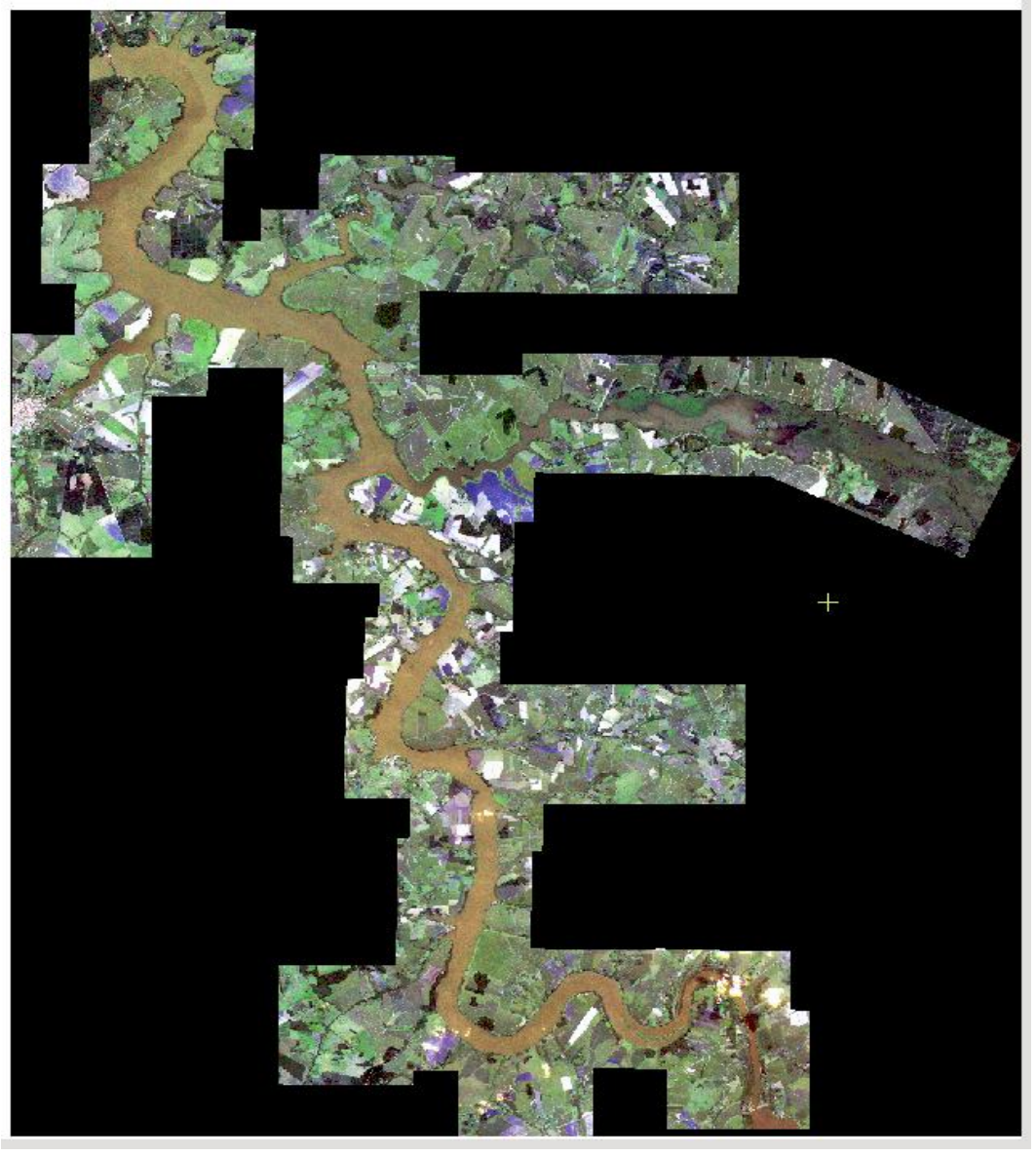


First iteration results



Final result (2 iterations)

Change Detection Service at RapidEye



End user is an Energy company

Goal is to detect urban encroachment around the water reservoirs

Total Area approx 12,500 SqKm

Four times per year

Change Detection Service at RapidEye

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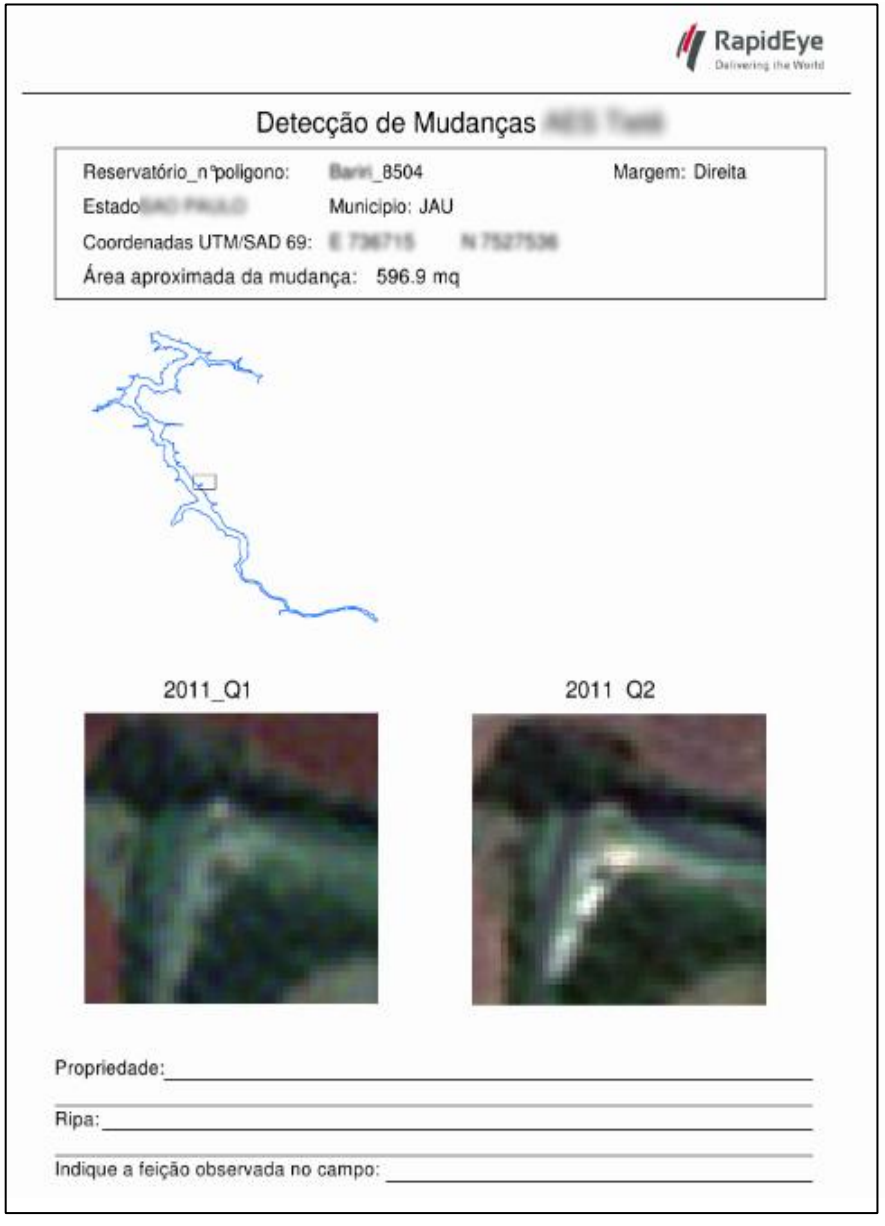
System Components:

- Image Acquisition and Management System
- Preprocessing:
  - Co-registration
  - Data clipping to AOI
  - Noise Reduction
- Multivariate Alteration Detection + Thresholding
- Ground Cover Change Analysis + Binary Merging
- Vectorization
- Quality Control
- PDF Report Generation

Change Detection Service at RapidEye



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Detecção de Mudanças

Reservatório_nºpoligono: _8504 Margem: Direita
Estado Municipio: JAU
Coordenadas UTM/SAD 69:
Área aproximada da mudança: 596.9 mq

2011_Q1

2011 Q2

Propriedade:

Ripa:

Indique a feição observada no campo:

Sample delivery product

Overview Image Concepcion - Chile 22-01-2010

Overview Image Concepcion - Chile 27-02-2010

Overview Area Affected

Image Date:
2009-04-26

Location:
Washington DC

Product Level:
L3A

Image Size:
1000x1000 pixels

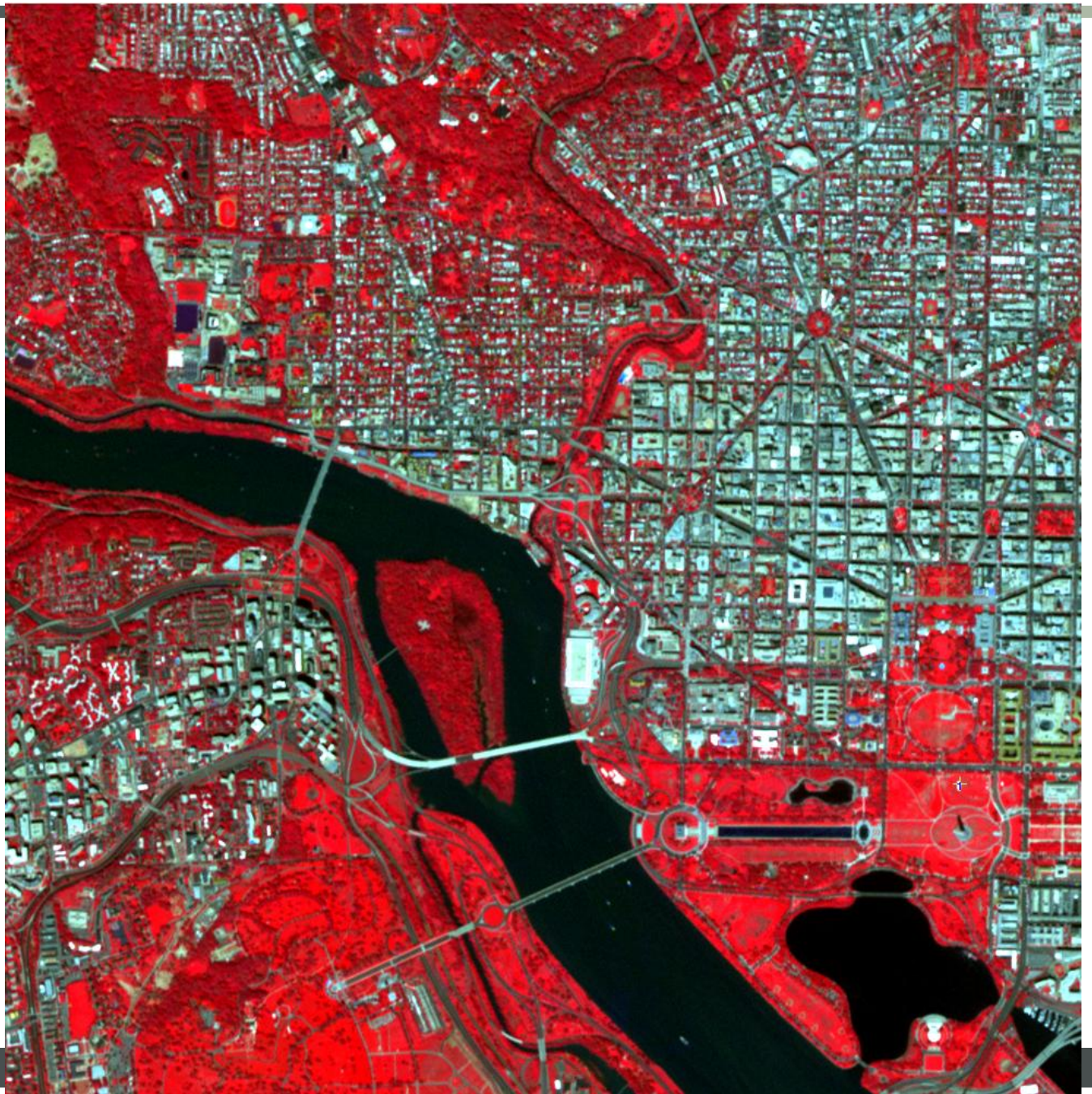


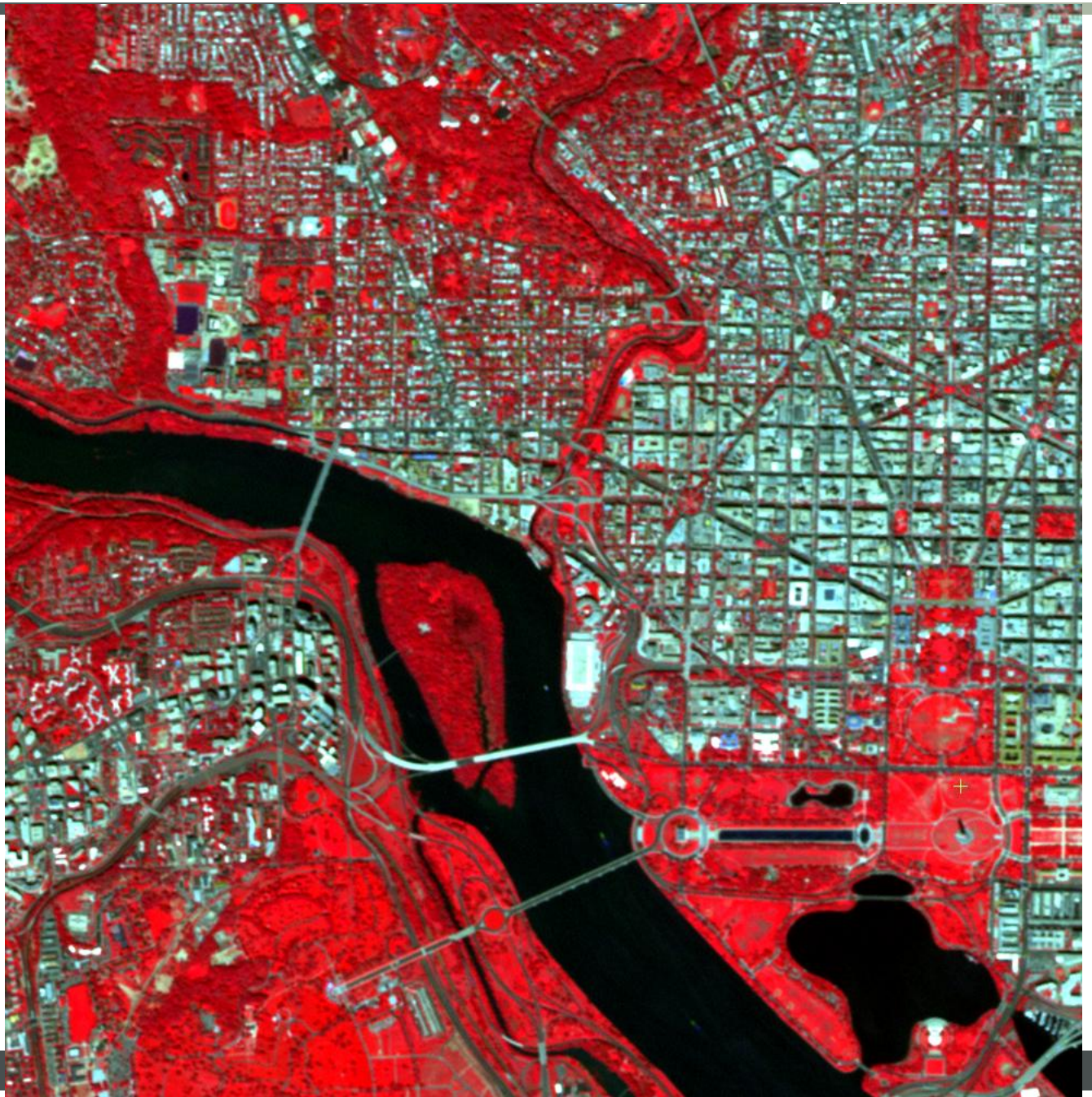
Image Date:
2009-04-27

Location:
Washington DC

Product Level:
L3A

Image Size:
1000x1000 pixels

Relative Image to
Image accuracy
Approx. 1 pixel



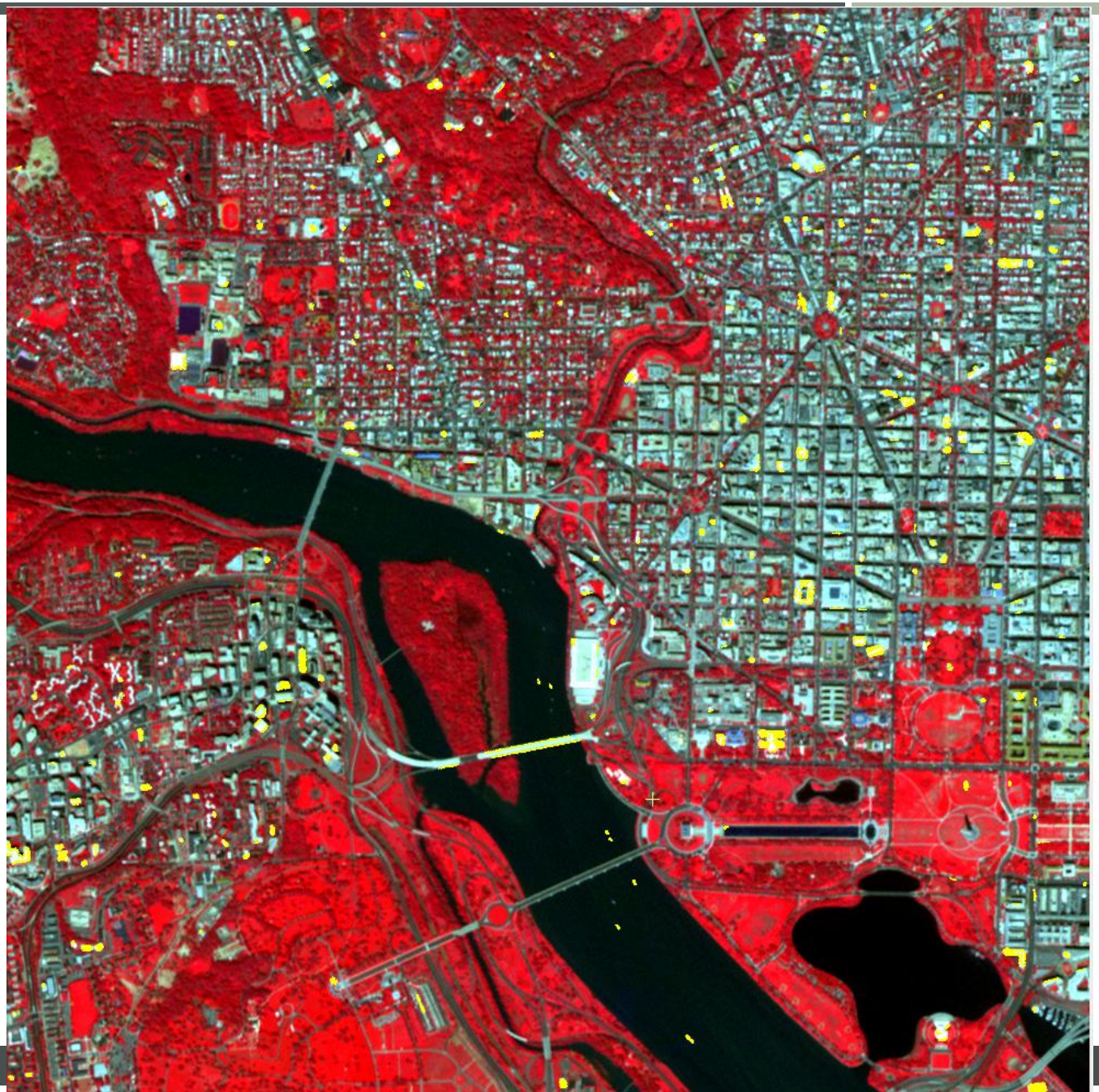
Product:
Basic Change Information

Effort:
Full automatic

Issues:
Many artifacts also
Categorized as change
e.g.
1. View angle differences
Generates false change
Information.

2.noise and non-linear
Radiometric errors will also
Result in false change
information

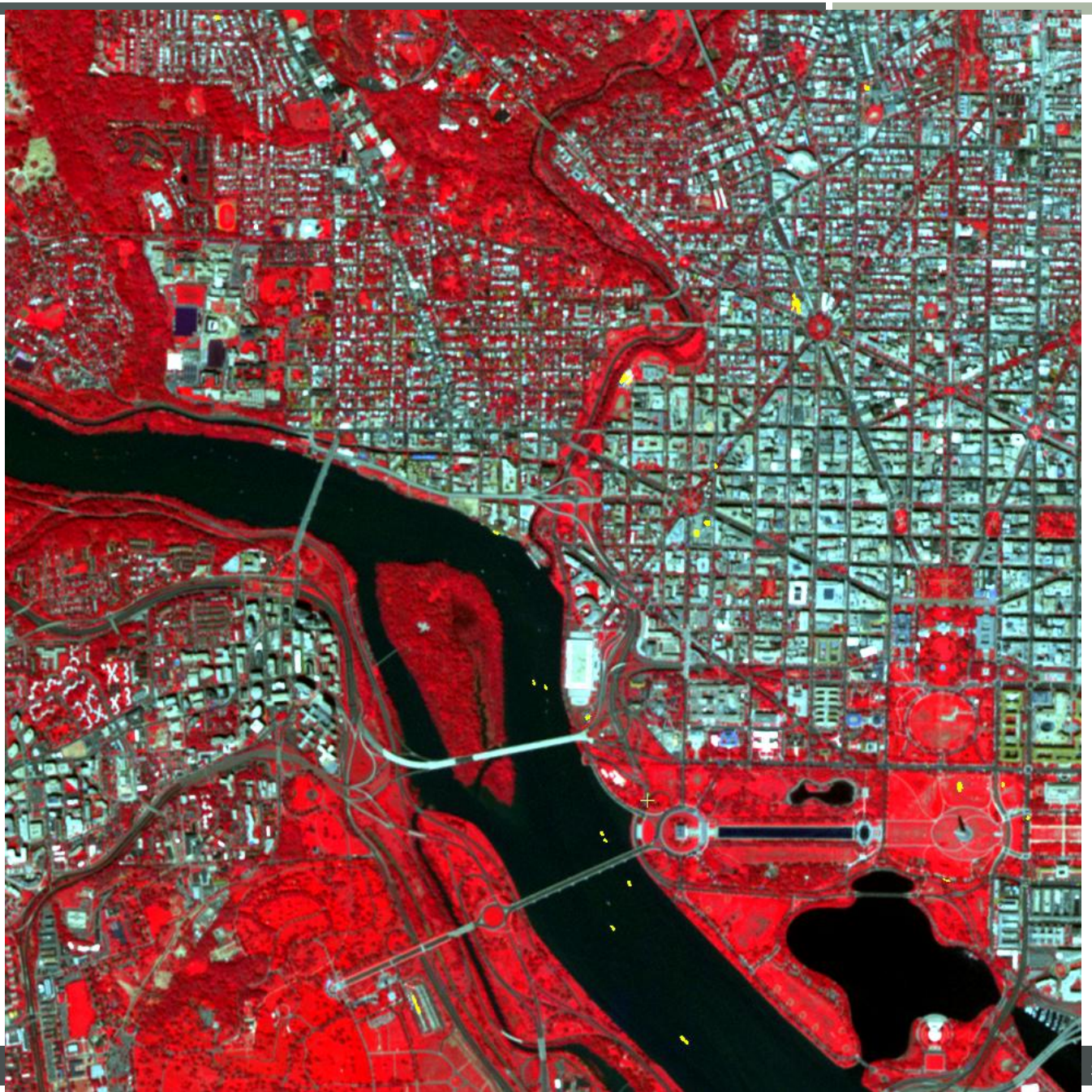
Uninteresting change data:
e.g. Car traffic



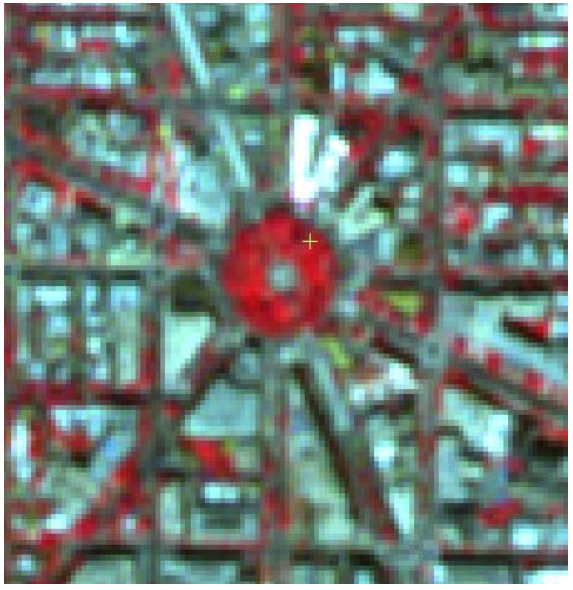
Product:
Refined Change Information

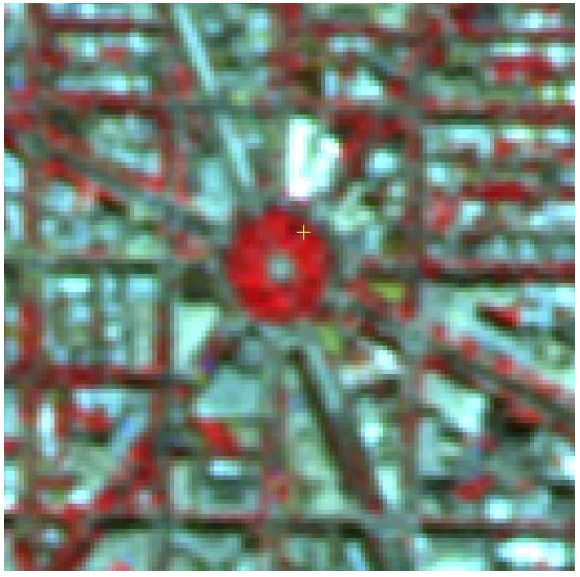
Effort:
Manual and/or semi-auto postprocessing
Customized change objects identification

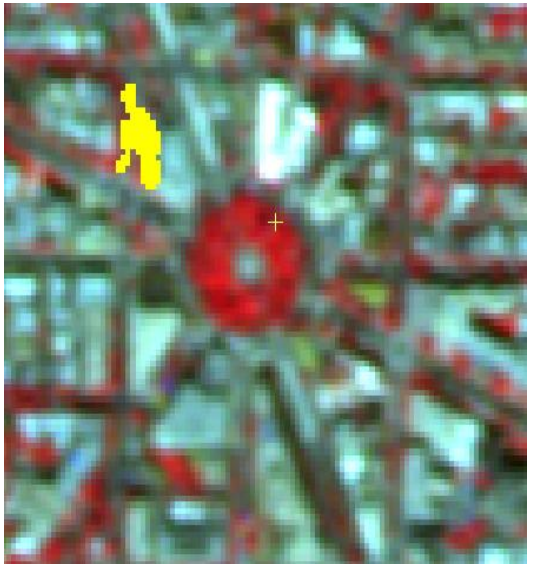
In this case, only false change pixels were Manually eliminated.



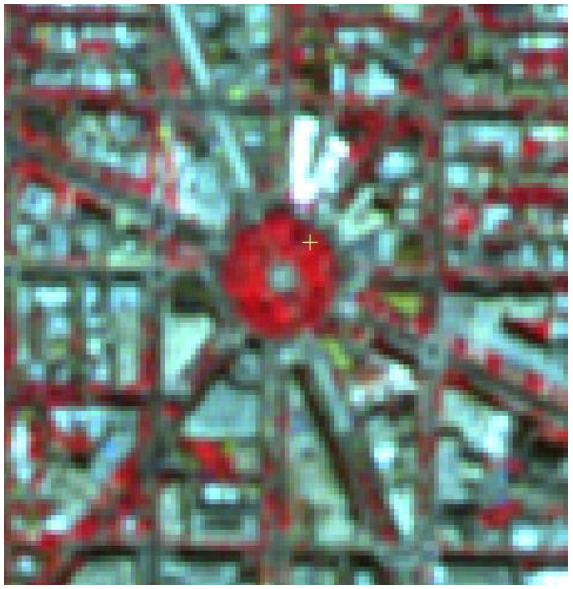
Close Up 1

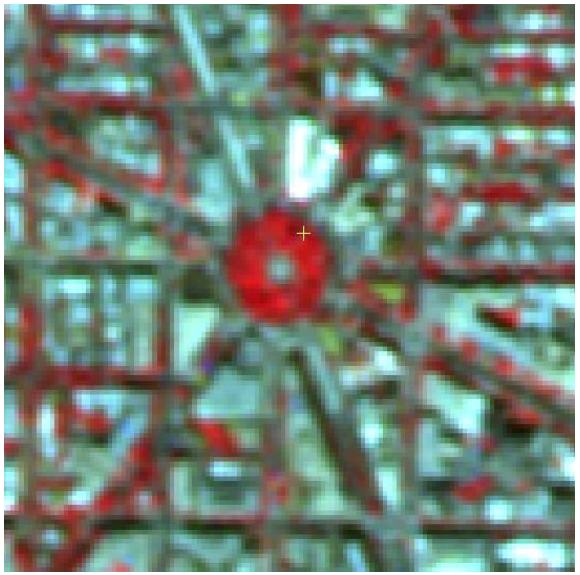






Close Up 1

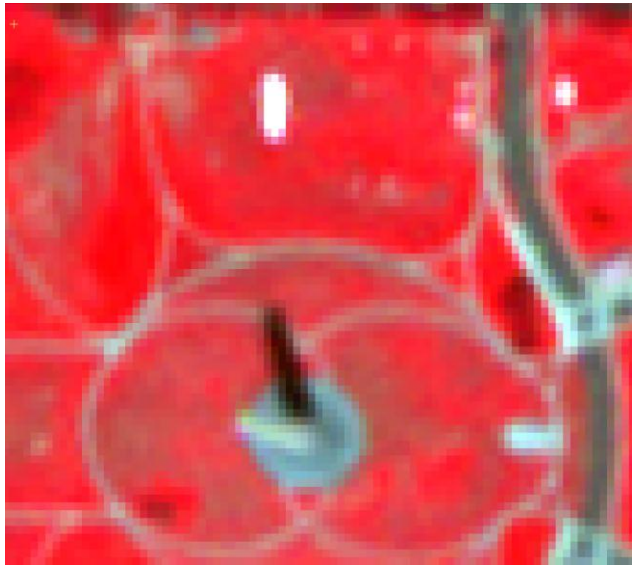


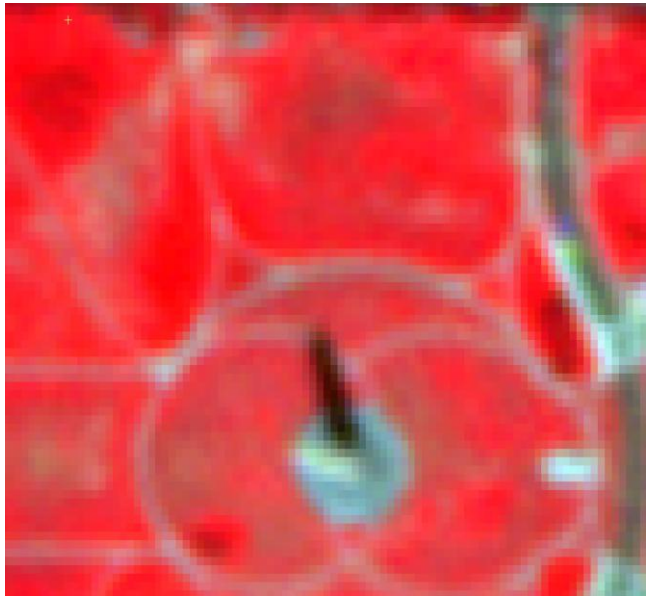


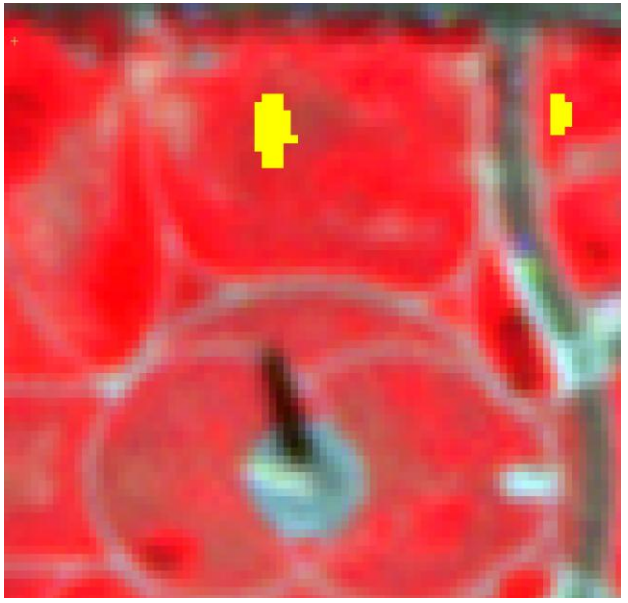
Park space of PNC bank
Image 26-04 sunday (empty)

Image 27-04 monday (full)

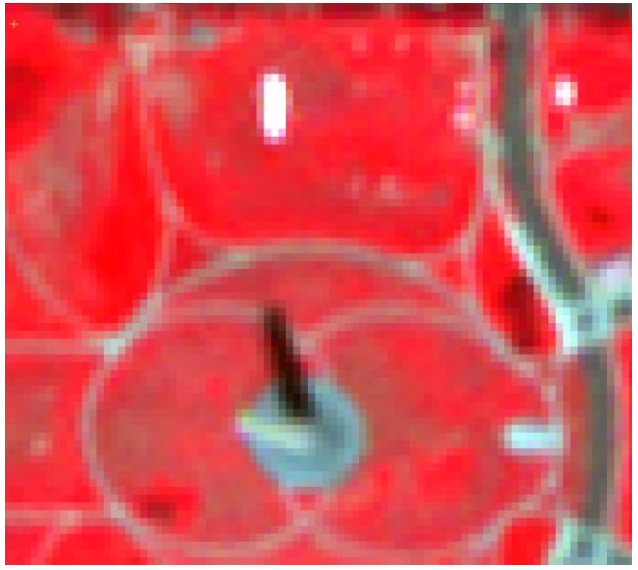
Close Up 2

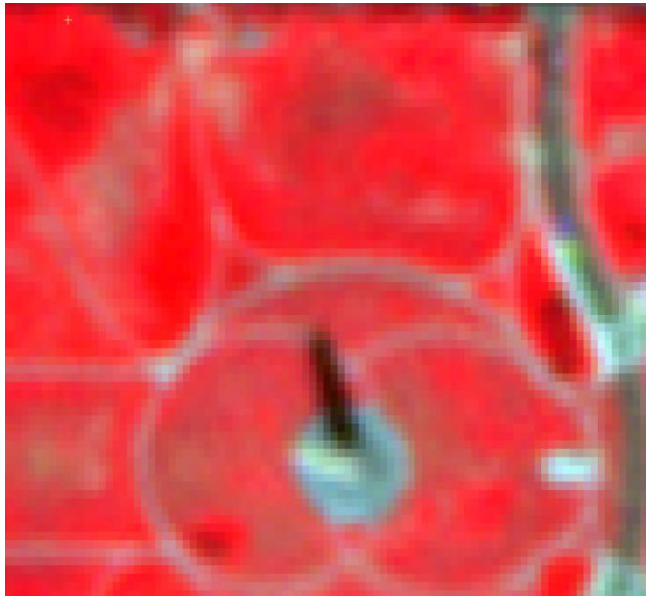


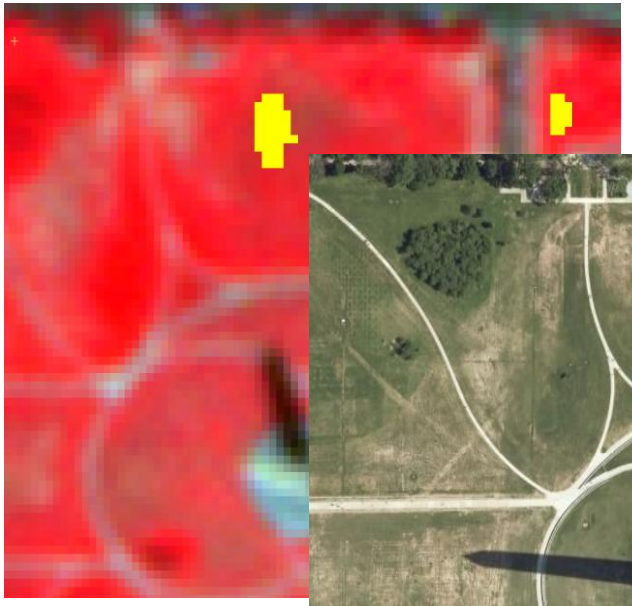




Close Up 2

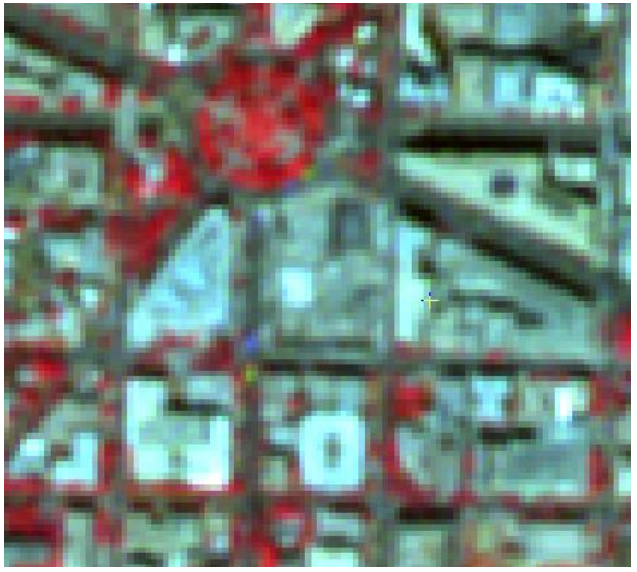


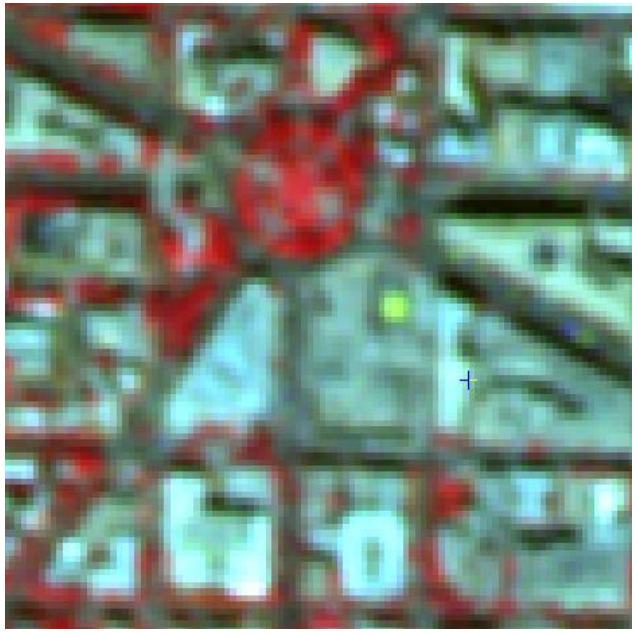


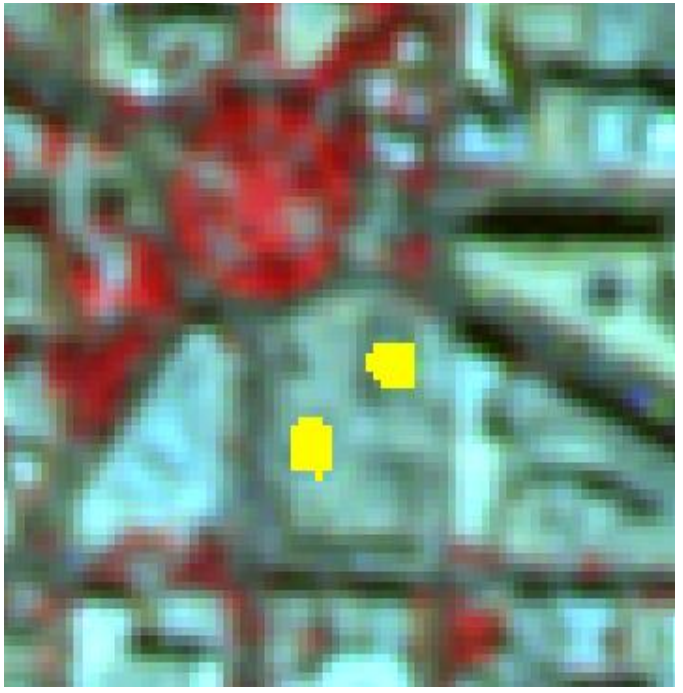


Mystical emergence of vegetation within one day or sunday morning event, tents were raised removed on monday

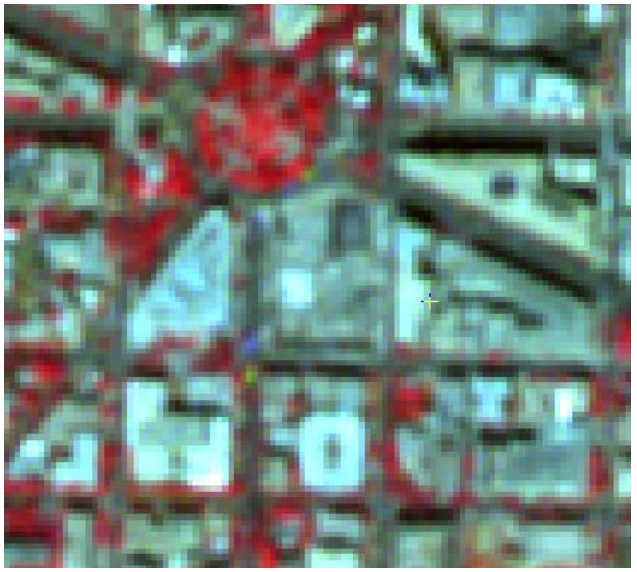
Close Ups 3

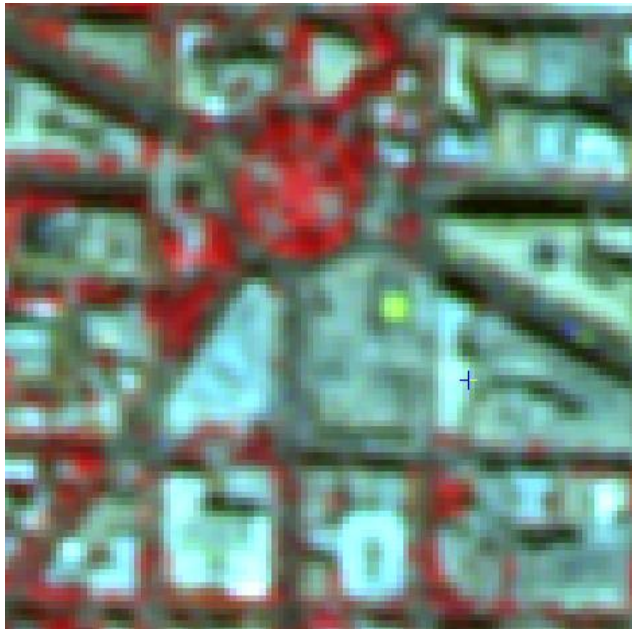






Close Ups 3





Construction site
(many things happen)

Logging Monitoring

Illustration 20: IRS LISS III image 2007, resampled to 5m res.

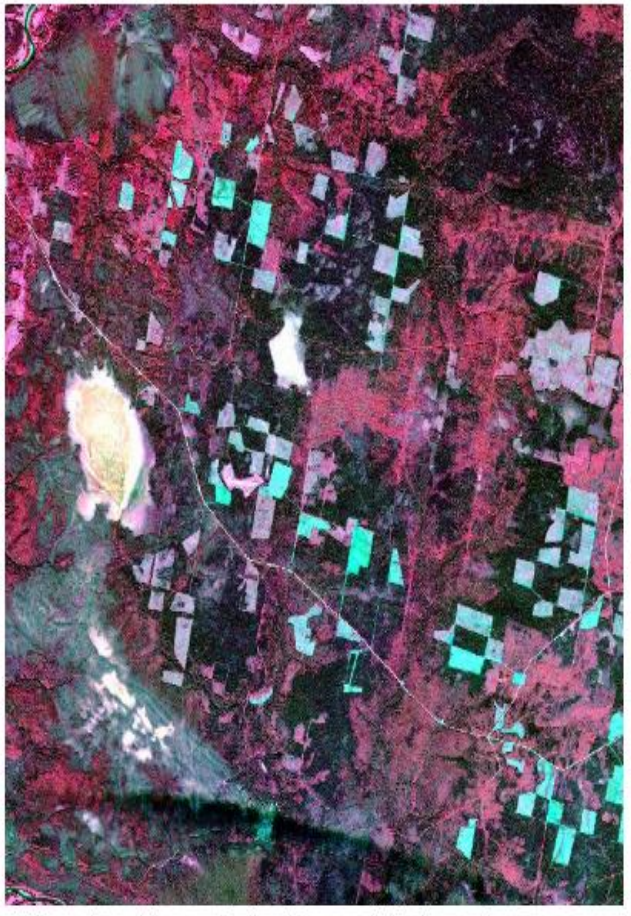


Illustration 21: RapidEye image 2009, 5m res.

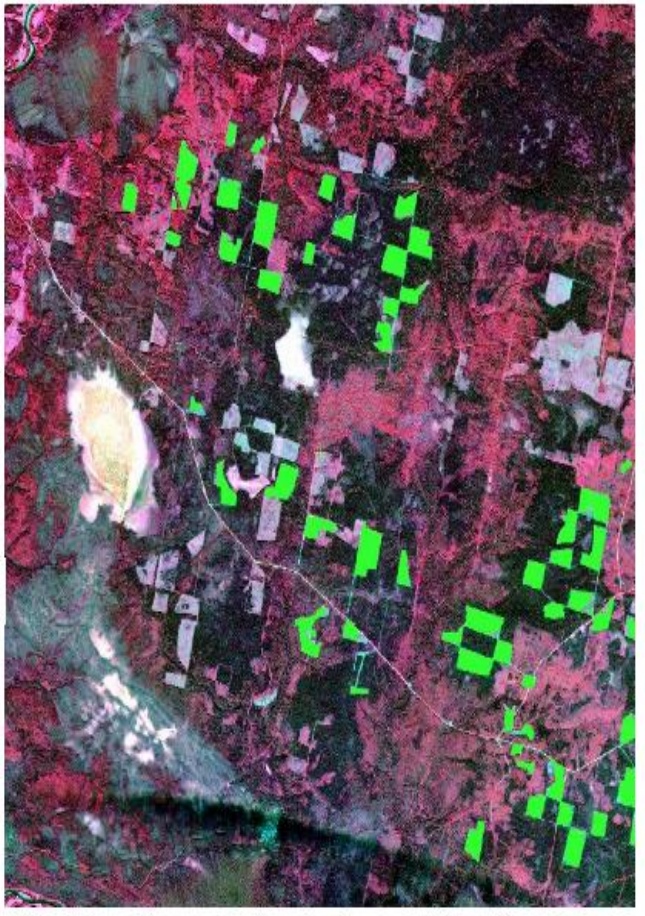
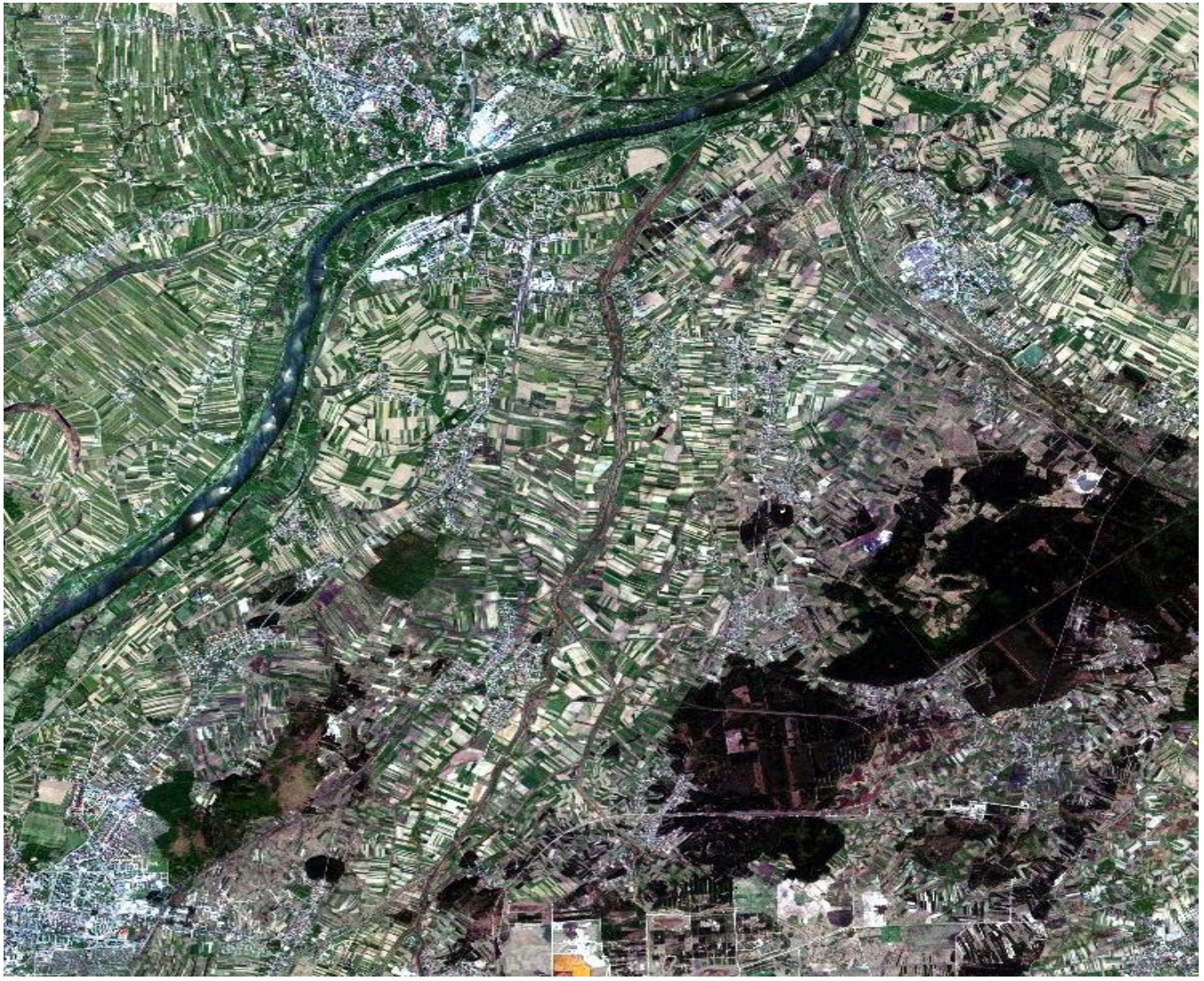
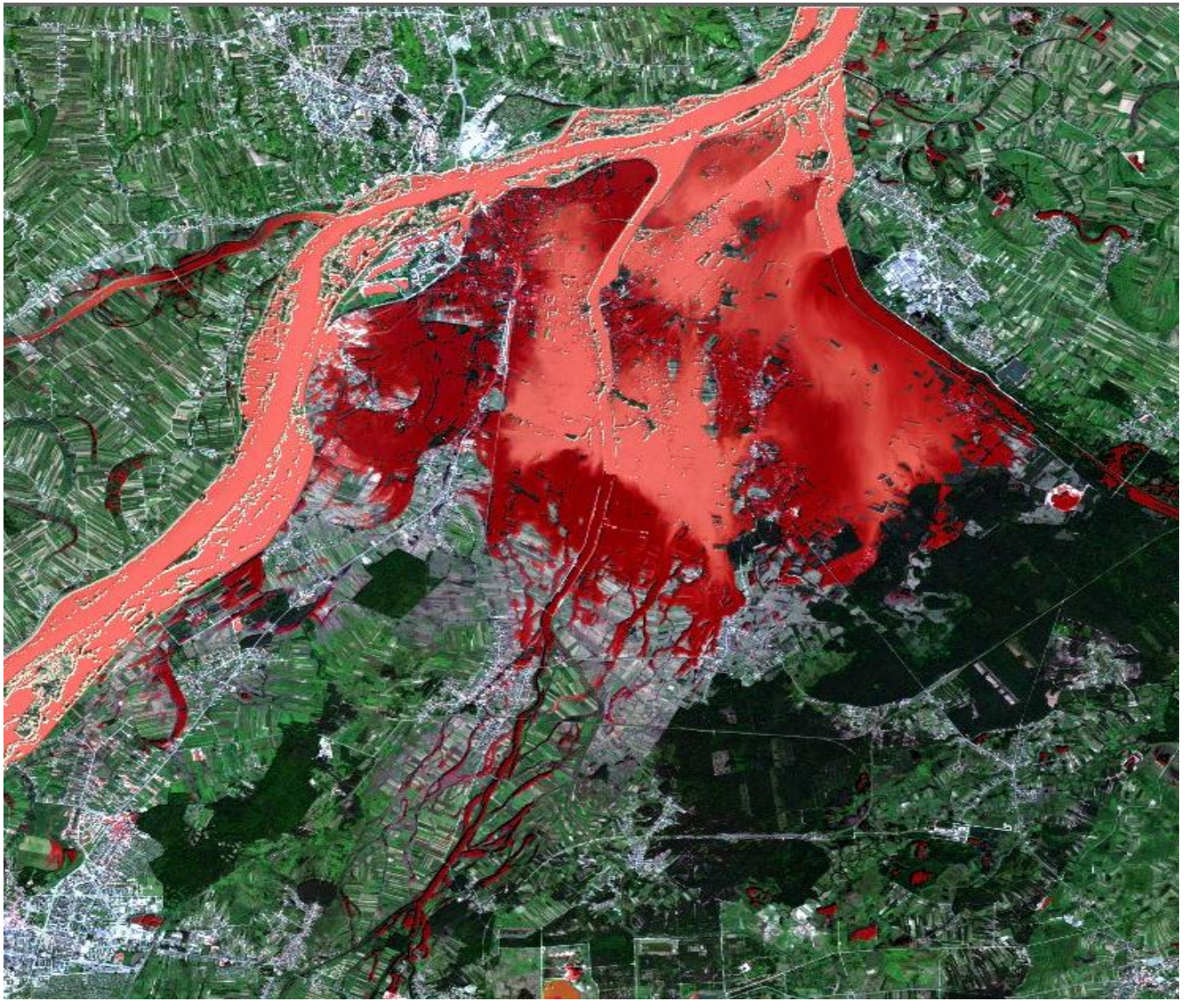


Illustration 22: automatically extracted change polygons

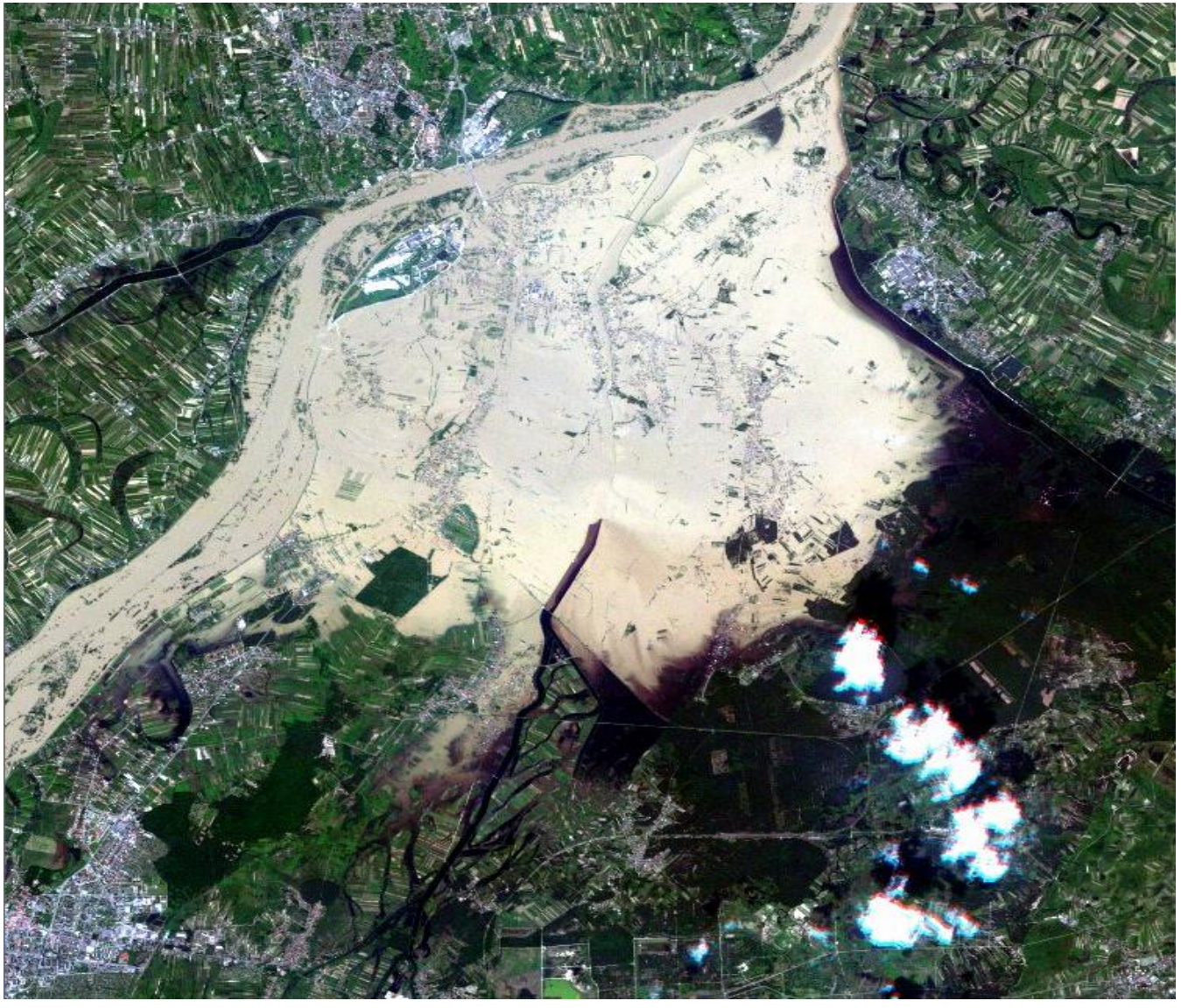
Flooding



Flooding



Flooding



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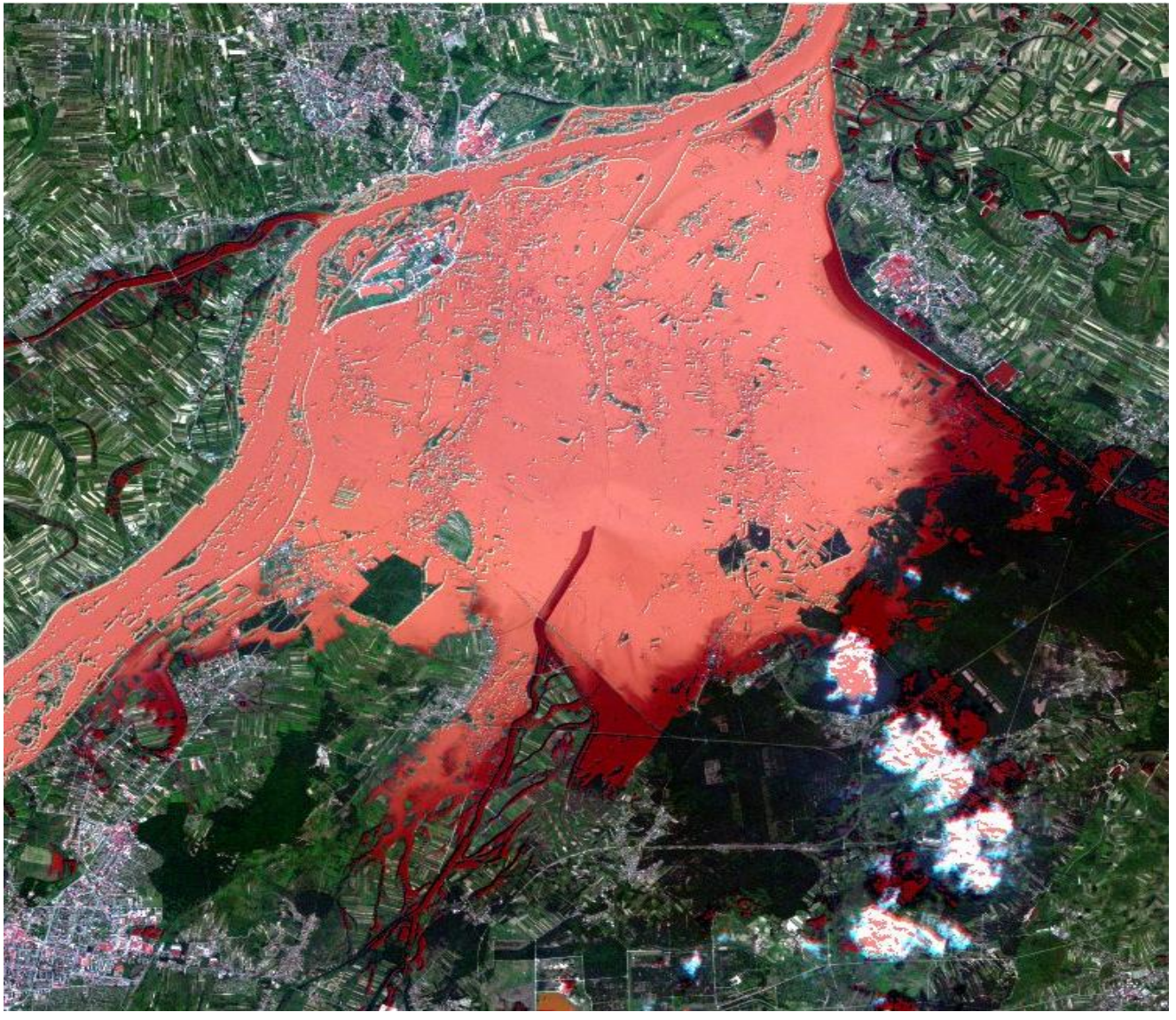

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Thank You