

# Design and Use of Earth Observation Image Content Tools

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# How Can We Identify Images By Content

## Satellite images

- optical images (spectral channels, resolution)
- SAR images (bands, polarization, resolution)

## Applications

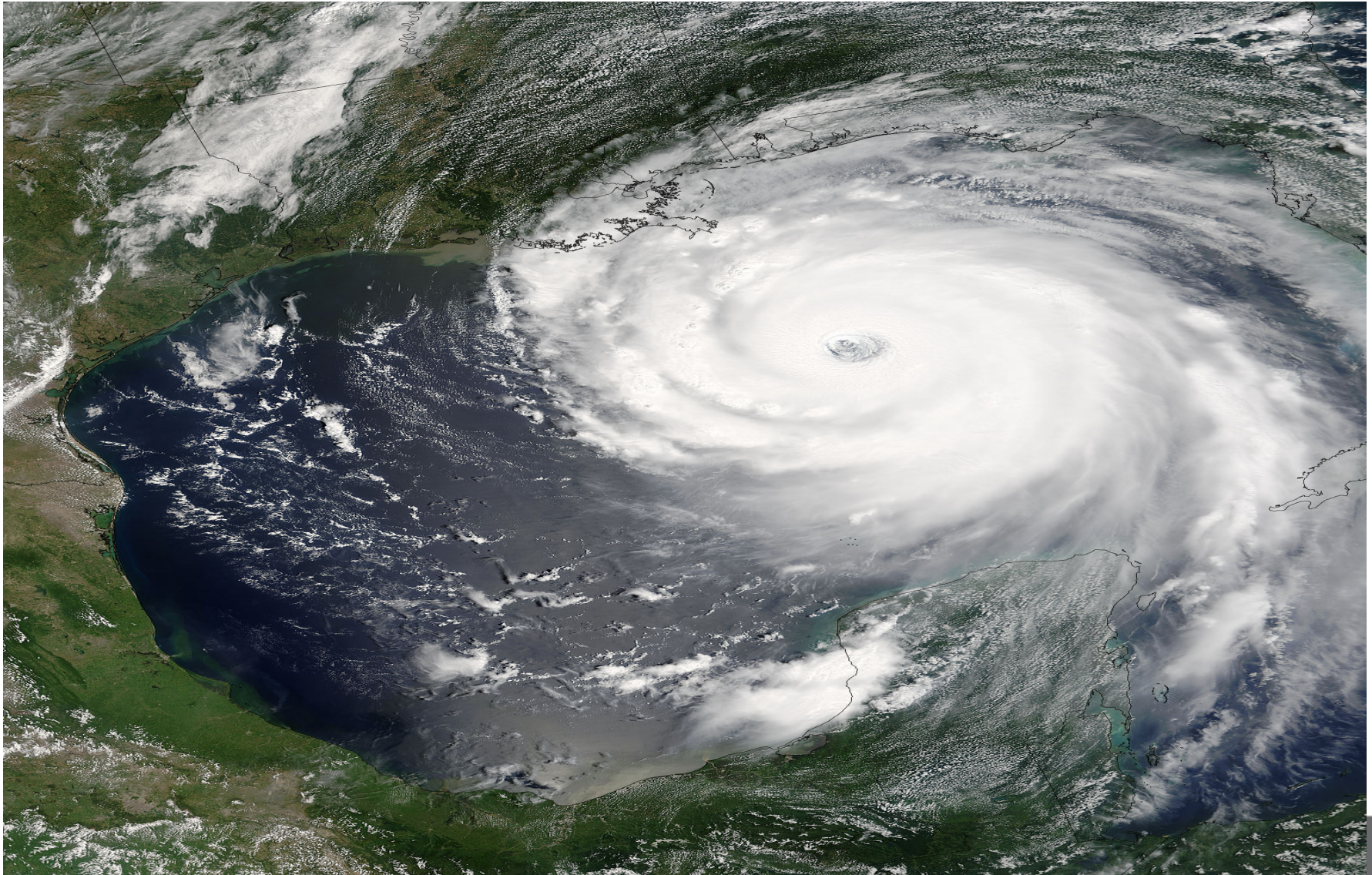
- commercial and institutions
- science and technology

## State of the art

- pixel data, metadata, toolboxes
- archives, catalogues, information systems, user interfaces
- services

# Hurricane Image

[http://visibleearth.nasa.gov/view\\_rec.php?id=7938](http://visibleearth.nasa.gov/view_rec.php?id=7938)



# Typhoon Image

<http://www.ga.gov.au/hazards/cyclone/>



**SAR Image of a Mountain** <http://www.infoterra.de/tsx/freedata/start.php>



# The Gap Between Applications and Available Data

## Typical image processing issues

- Identification of a cyclone compared to other features or cloud patterns (spectral bands, feature analysis)?
- Determination of its track, speed and landfall (time series of images, motion vectors)?
- What additional information do we need (geographical data, geophysical parameters)?
- Which precision and accuracy can we reach (test runs, use of reference data from image archives)?

## Typical geophysical issues

- How can we estimate the actual precipitation?
- How can we predict cyclones?
- Does climate change affect cyclones (occurrence, location, strength, size)?
- How accurate are these predictions (model verification)?

# How To Bring Applications Closer To The Data

## Goals

- Application-**in**dependent methods to identify and classify the content of images (above the pixel level)
- Support individual application-dependent user queries (e.g., train a “semantic” phenomenon, find typical images)

## Solution Strategy

- Append additional information to image products; keep all pixels intact
- Extract basic features from all images, generate feature maps
- Append feature maps to products
- Support user interaction (feature browser, etc.)
- Then: cluster features, classification, higher level relationships

# Step 1: Typical Interoperable Features

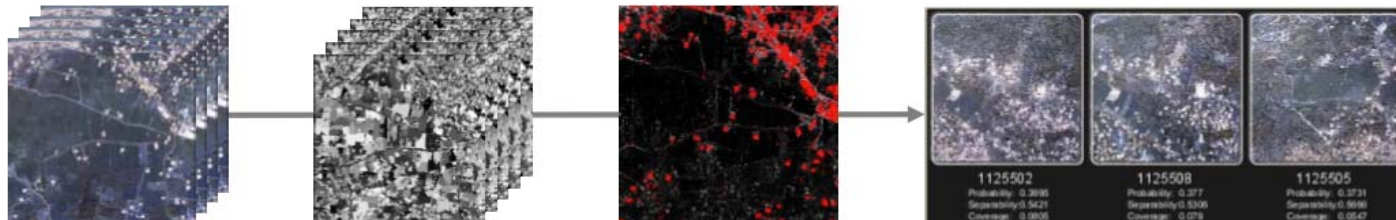
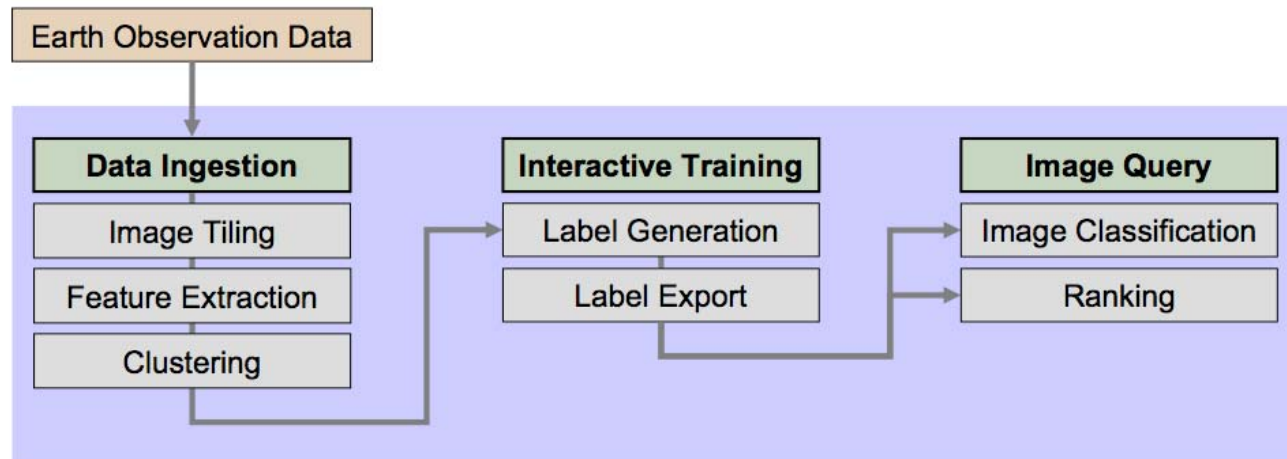
- Depending on image type (amplitude distributions, available models):
  - low or high resolution images
  - optical or SAR images
- High resolution SAR images [Popescu *et al.*, 2009]:
  - generate and de-noise sub-windows

Compute for each sub-window

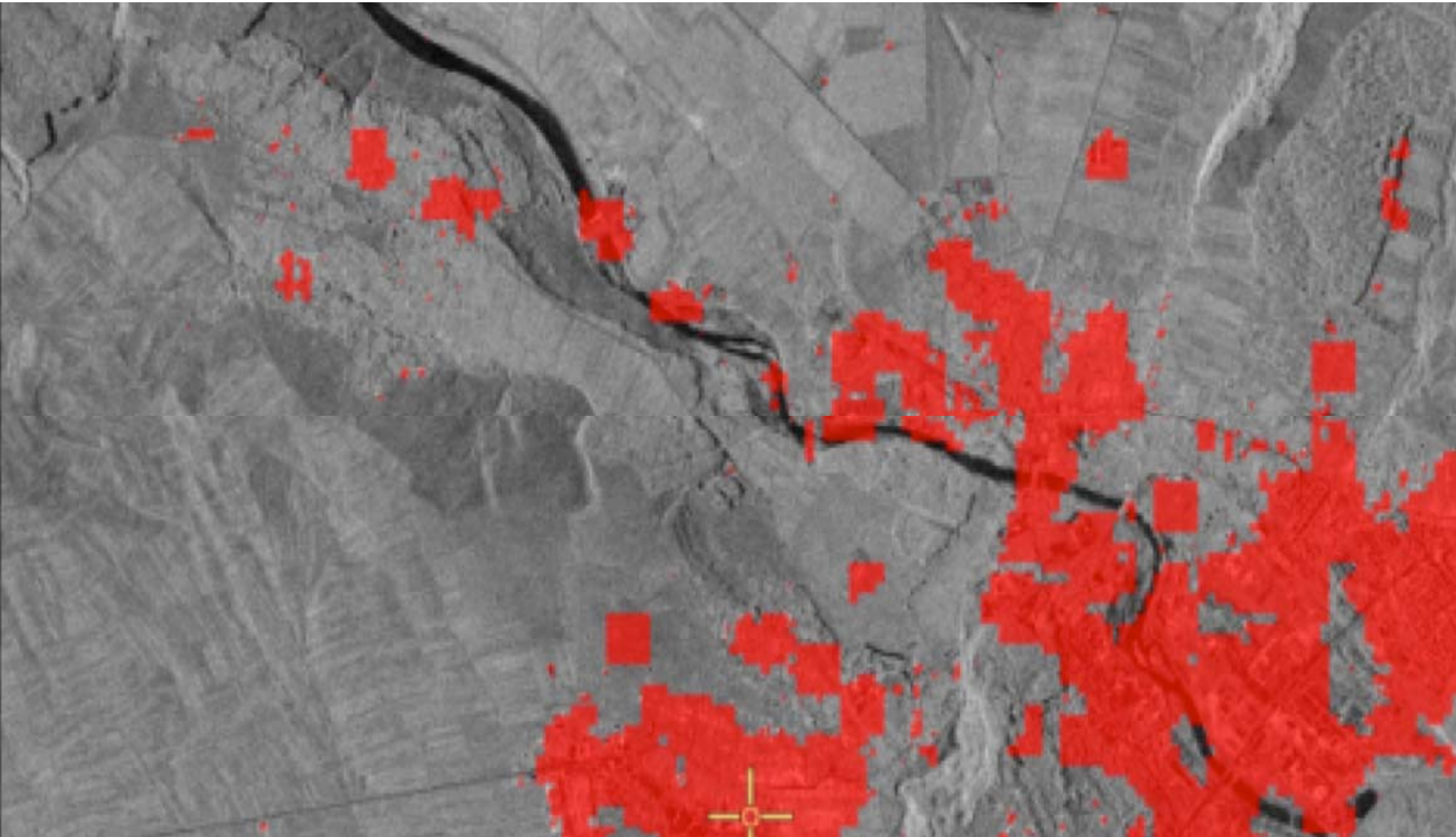
- mean value and variance
- spectral centroid in along-track and across-track direction
- spectral flux in along-track and across-track direction
- entropy



## Step 2: Knowledge-based Earth Observation and Image Mining (KIM System, Datcu *et al.*, 2003)



# Example: Classification and Detection of Built-up Areas



## Example: Detection of Water Bodies



# Step 3: Knowledge-based Image Information Mining

## KEO System, <http://earth.esa.int/rtd/Projects/KEO/>



SSE Portal - Search Process - Microsoft Internet Explorer

Indirizzo: <http://services.eoportal.org/portal/order/PrepareOperation.do?serviceId=11806F80&operation=Search>

eo Sharing Earth Observation Resources

Service Support Environment

User: ACS Order List Monitor Orders Register Service My Profile Log out

Home > Services > Dims Catalogue Browser > Search

Dims Catalogue Browser Search

Collections:

- SRTM.X-SAR.DEM
- SRTM1.X-SAR.GIFDS

Map Area of Interest

Services (Click here to add a WMS ...)

Demis World Map (1.1.1)



Image Browser 1 - KAOS

Projects: PIMS Test 01

Collection: dem-test

- PIMS-DEM
- PIMS-SRTM

Primitive Features:

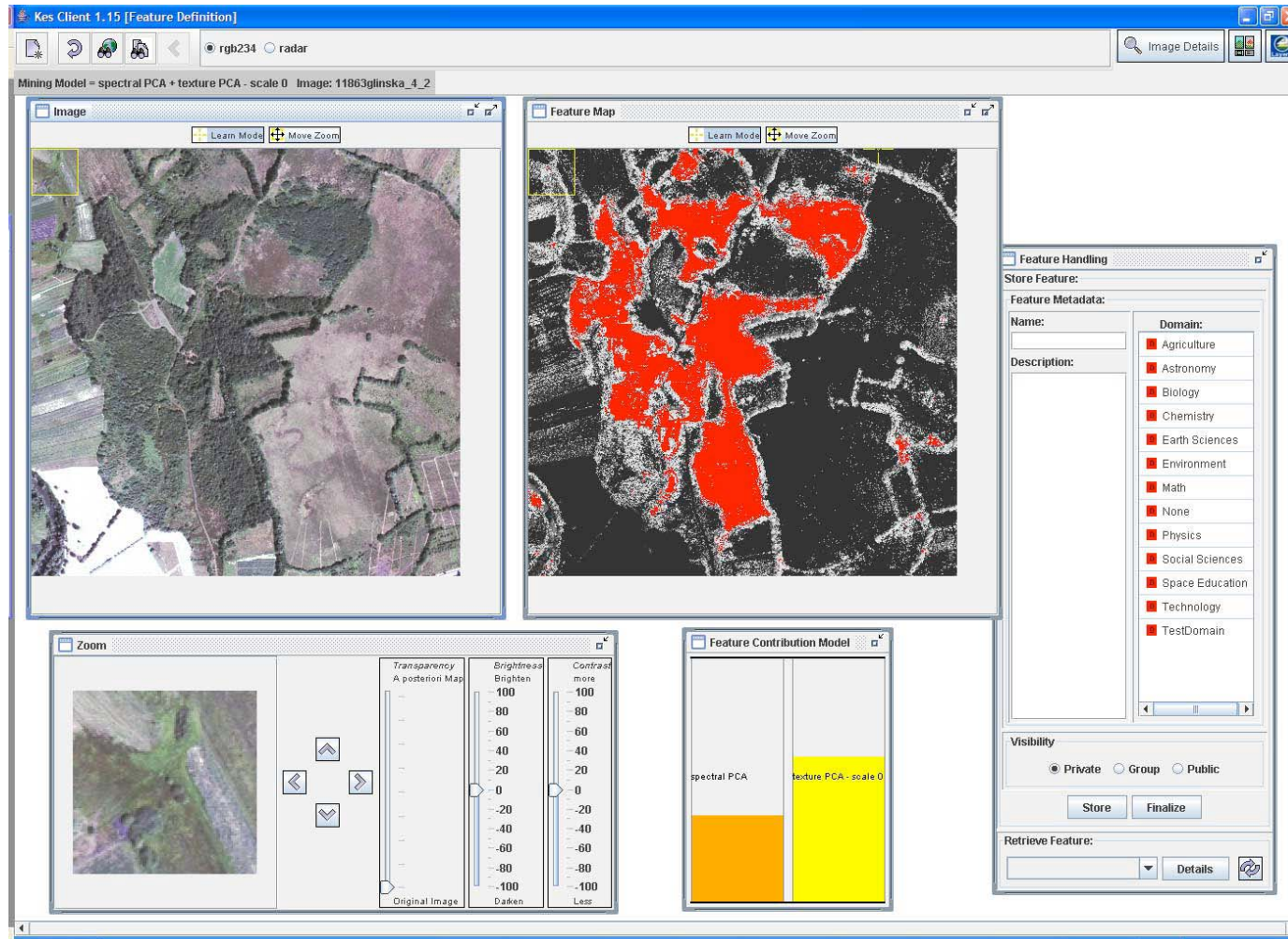
- PIMS-DEM embd.PIMS-DEM
- PIMS-DEM etex.PIMS-DEM

90 85 94 88

ID	Name	Acquisition	Lat. Center	Lon. Center
1	90 PID_SRTM.X-S...	Fri Feb 11 00:0...	50°52'29.50"N	013°22'30.50"E
2	85 PID_SRTM.X-S...	Fri Feb 11 00:0...	50°37'29.50"N	012°37'30.50"E
3	94 PID_SRTM.X-S...	Fri Feb 11 00:0...	50°52'29.50"N	013°52'30.50"E
4	88 PID_SRTM.X-S...	Fri Feb 11 00:0...	50°52'29.50"N	013°37'30.50"E
5	91 PID_SRTM.X-S...	Fri Feb 11 00:0...	50°52'29.50"N	012°52'30.50"E
6	87 PID_SRTM.X-S...	Fri Feb 11 00:0...	50°52'29.50"N	013°07'30.50"E
7	89 PID_SRTM.X-S...	Fri Feb 11 00:0...	50°37'29.50"N	012°07'30.50"E
8	86 PID_SRTM.X-S...	Fri Feb 11 00:0...	50°37'29.50"N	012°22'30.50"E
9	93 PID_SRTM.X-S...	Fri Feb 11 00:0...	50°52'29.50"N	012°37'30.50"E
10	92 PID_SRTM.X-S...	Fri Feb 11 00:0...	50°52'29.50"N	012°22'30.50"E

List Footprints

# KEO: Interactive, User Adapted, Image Content Access



# Step 4: Category-based Semantic Image Search Engine

## Goal

An interactive tool to help image analysts to explore image content, detect objects, patterns and structures in large image volumes.

## Concept (Costache *et al.*, 2008)

Support Vector Machines (SVMs) and Bayesian inference

## Applications

Object detection and context understanding

Recognition of smallest-scale objects

Identification of damaged infrastructure

Detection of changes, counting of people and objects

Mapping and humanitarian aid

Clouds  
Sea  
Desert  
Buildings  
Forest  
Fields  
Airports  
Villages  
Savanna  
Ships  
Roundabouts



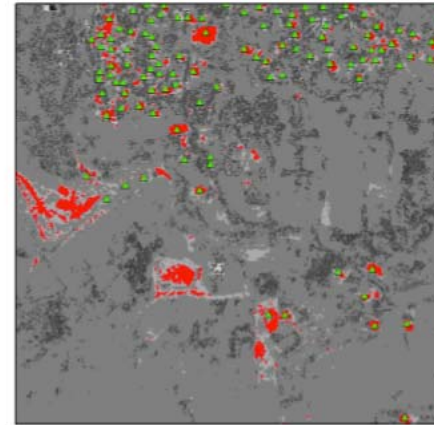
# Use Case: Damage Assessment (Courtesy JRC/IPSC)

IKONOS product  
pre-event  
(2005)

Semantic class:  
'Buildings'

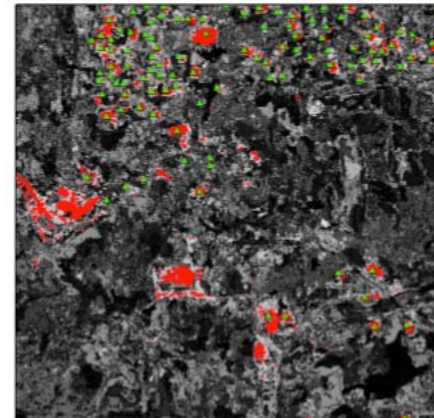
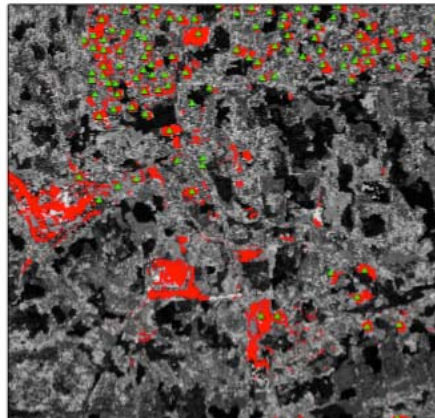


0 100 200 Meters



Spectral  
and texture  
at full-resolution

Spectral and area



Probability [%]



Spectral  
and Hu moments





# Conclusion and Outlook

**What do we need for the Sentinel era?**

