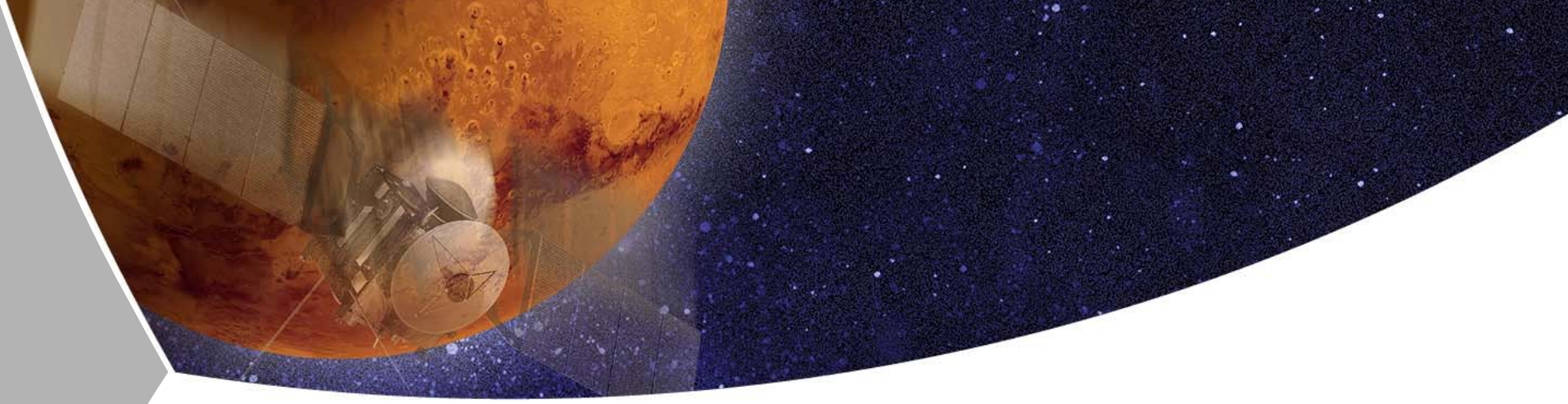


Design and Use of

Earth Observation Image Content Tools

Mihai Datcu[1, 2], Daniele Cerra[1], Houda Chaabouni-Chouayakh[1], Amaia de Miguel[1], Daniela Espinoza Molina[1], Gottfried Schwarz[1], Matteo Soccorsi[1]

[1] German Aerospace Center (DLR)

[2] Télécom ParisTech

How Can We Identify Images By Content

Satellite images

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

Applications

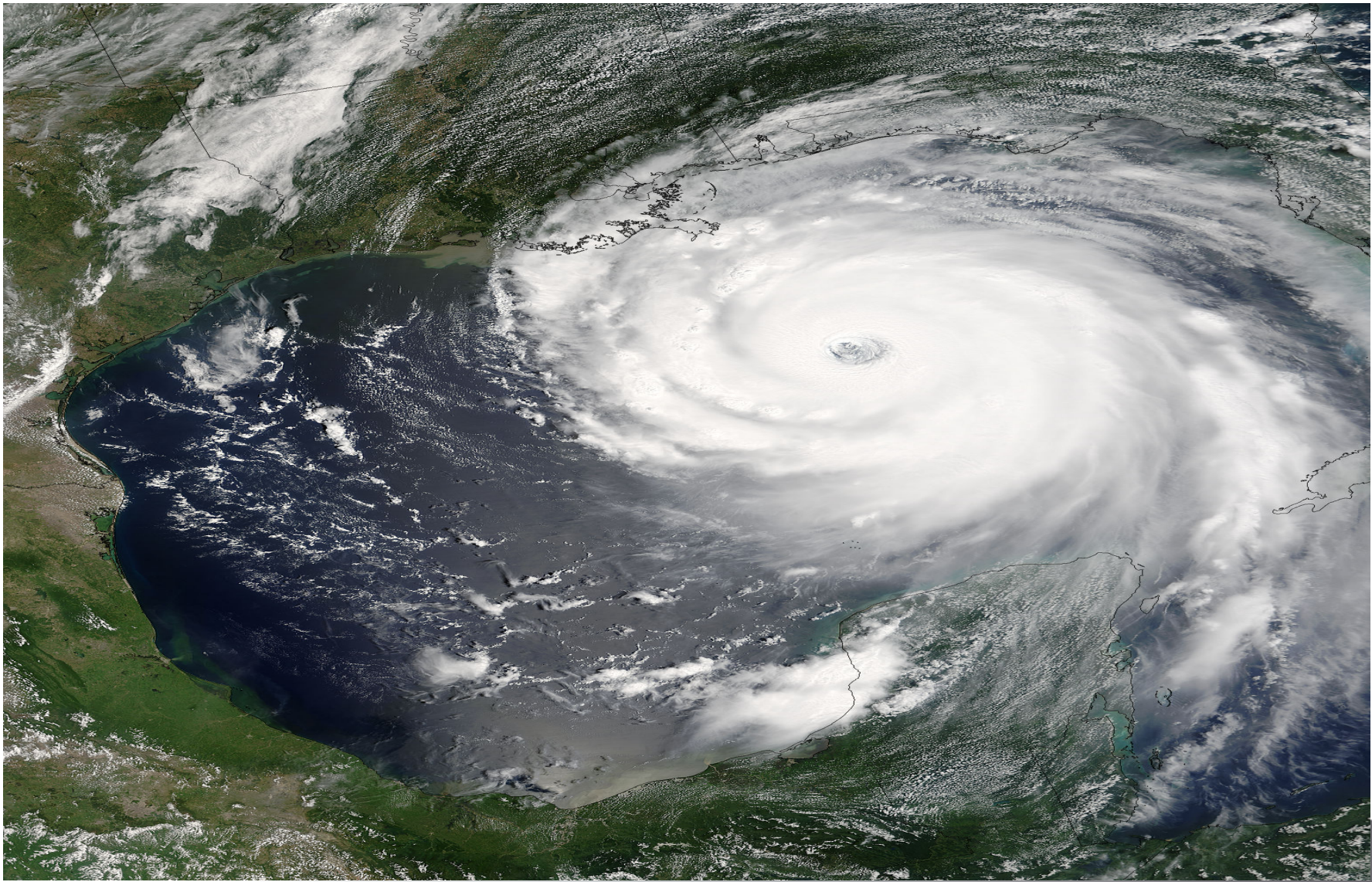
- commercial and institutions
- science and technology

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



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

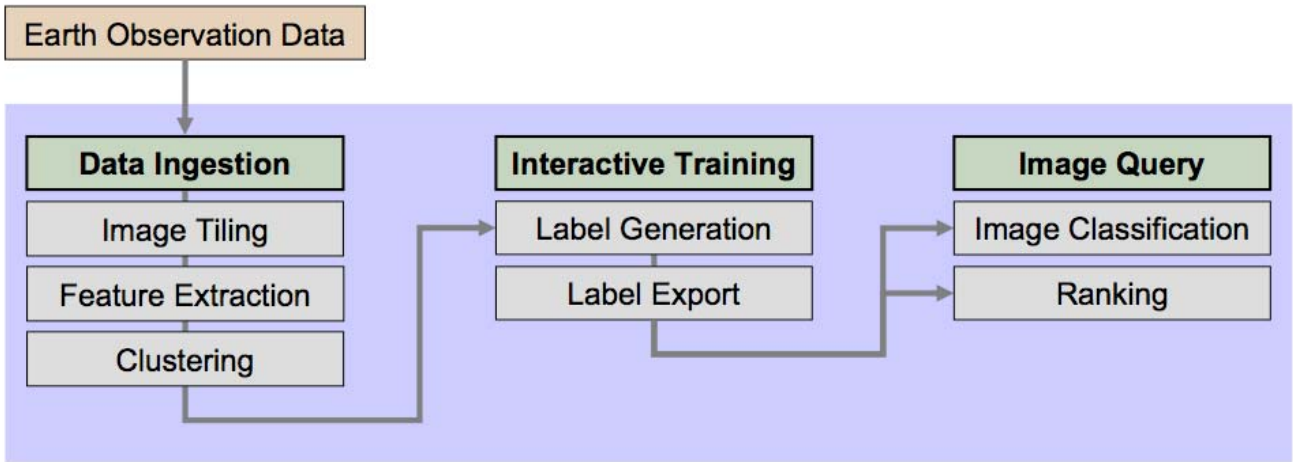
Step 1: Typical Interoperable Features

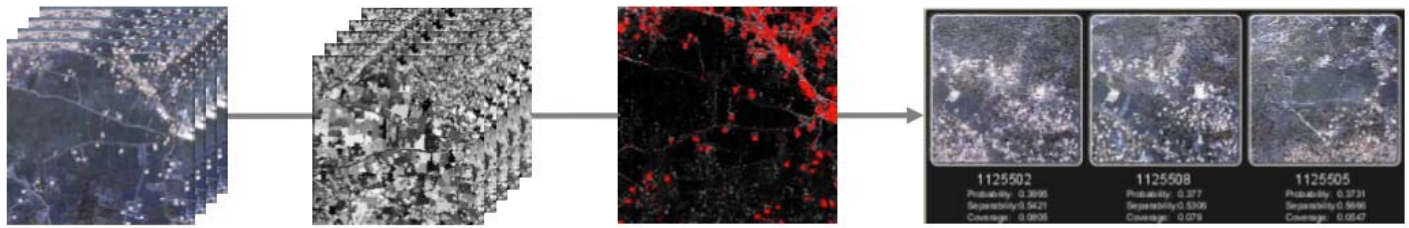
- Depending on image type (amplitude distributions, available models):
  - low or high resolution images
  - optical or SAR images

- High resolution SAR images [Popescu *et al*., 2009]:
  - generate and de-noise sub-windows

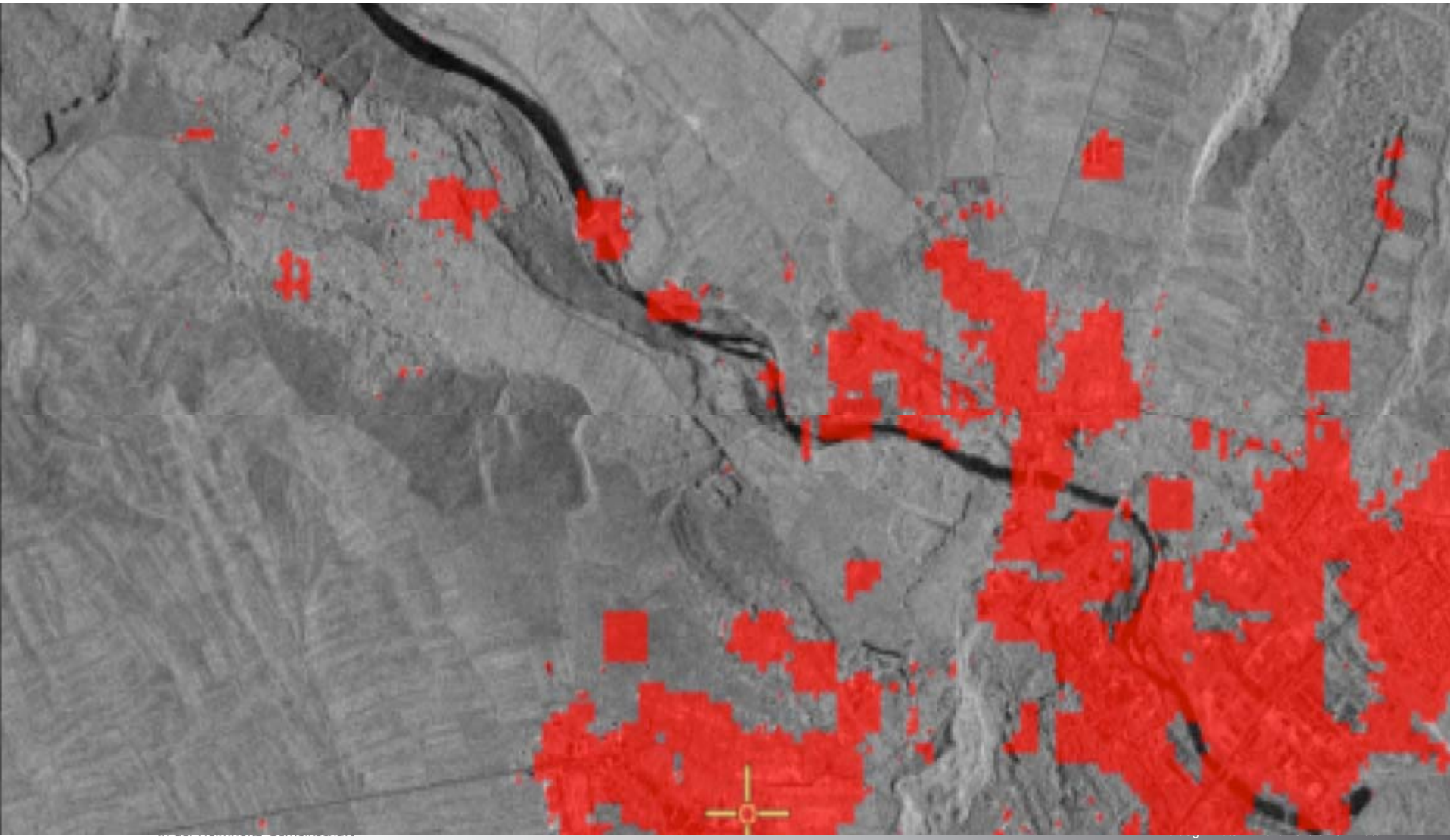
  Compute for each sub-window
  - mean value and variance
  - spectral centroid in along-track and across-track direction
  - spectral flux in along-track and across-track direction
  - entropy

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

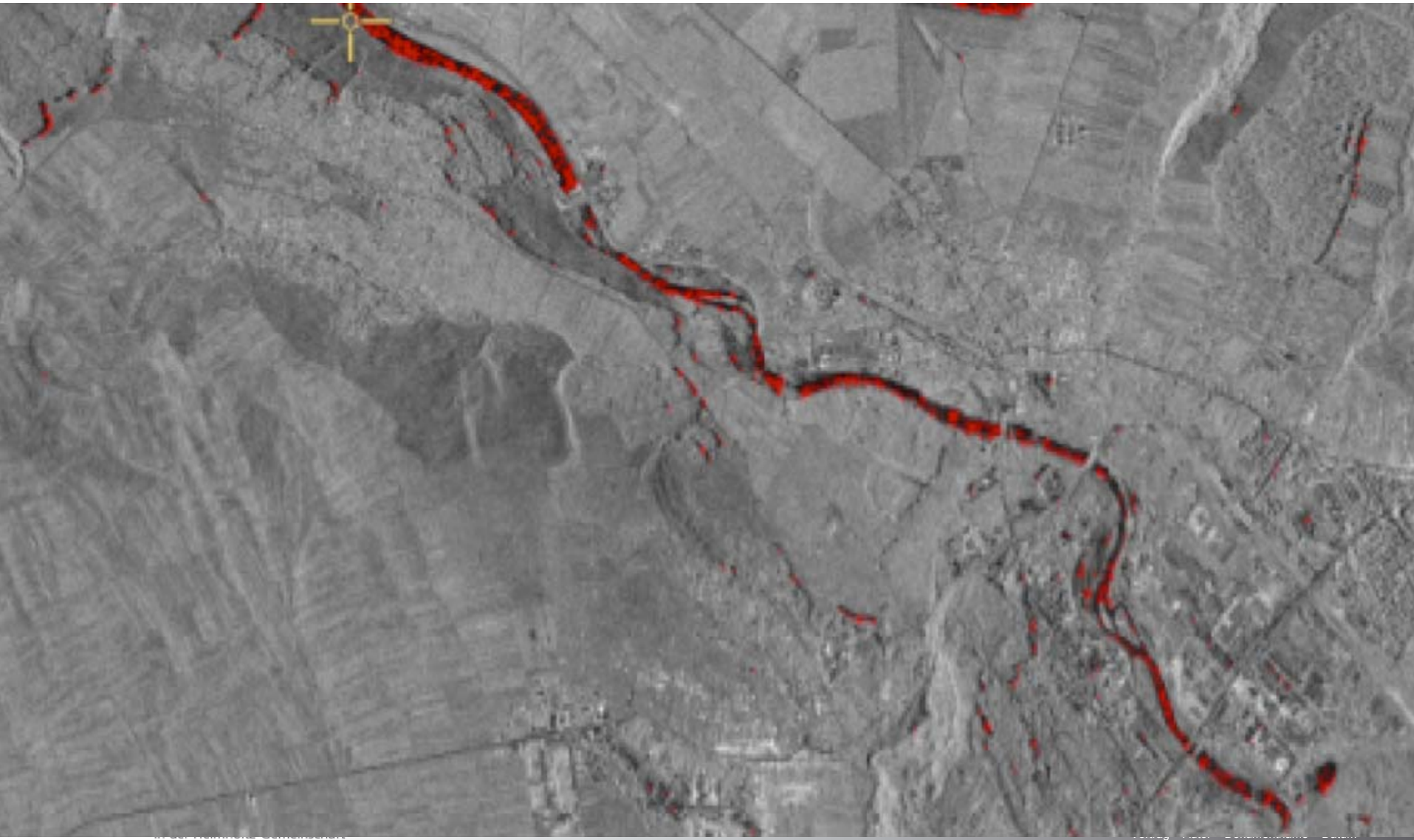




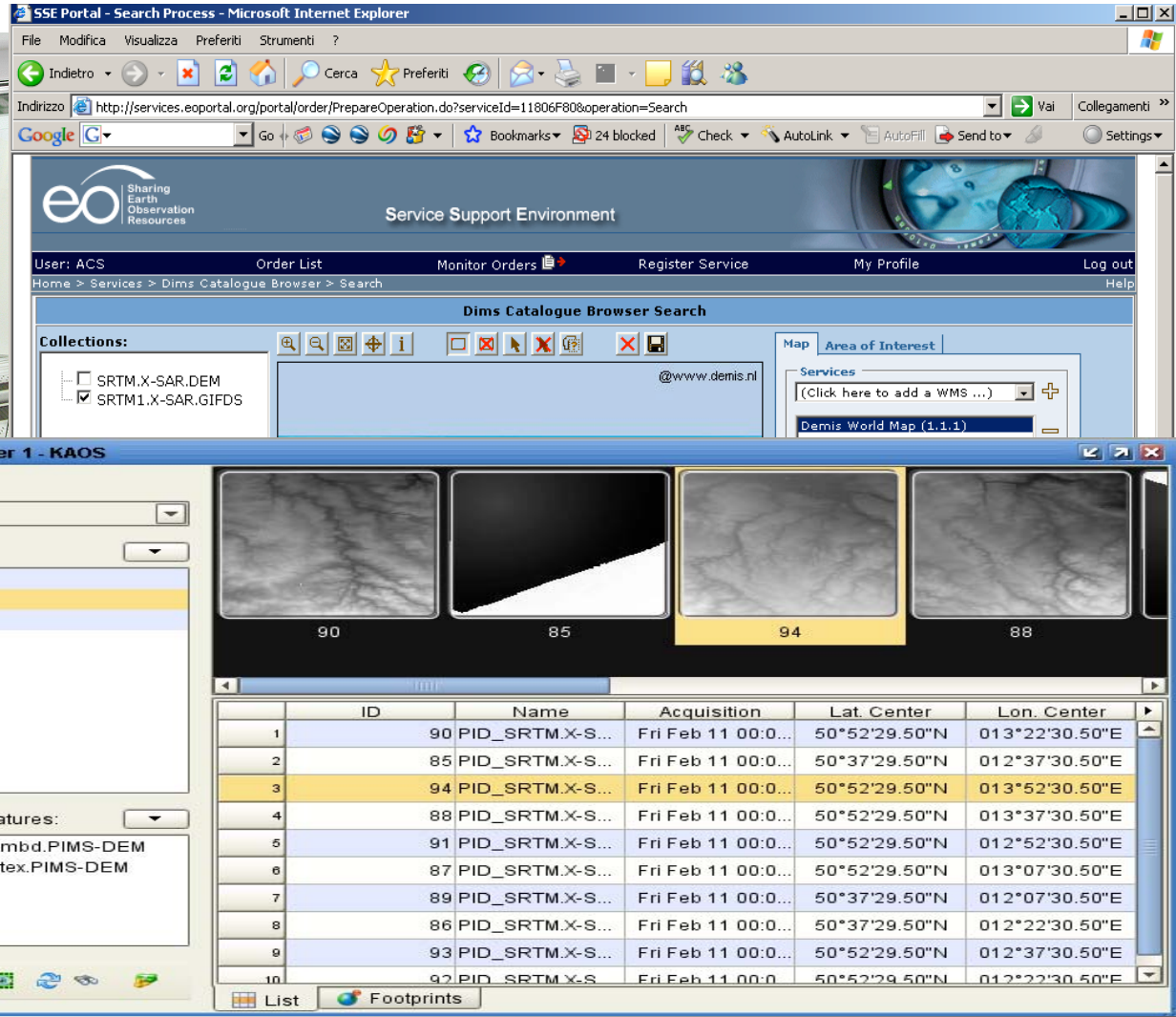
Example: Classification and Detection of Built-up Areas



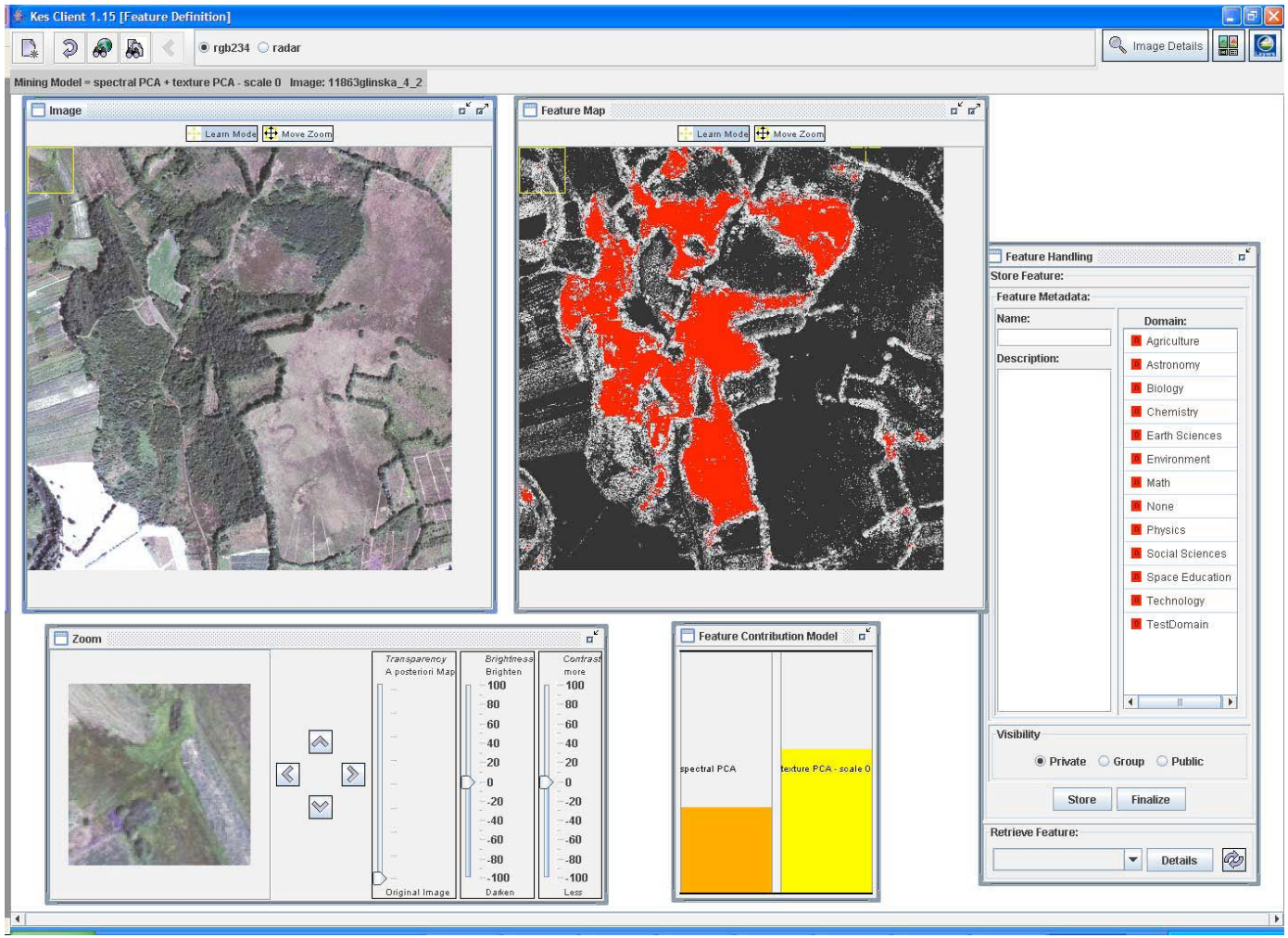
Example: Detection of Water Bodies



Step 3: Knowledge-based Image Information Mining KEO System, http://earth.esa.int/rtd/Projects/KEO/



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

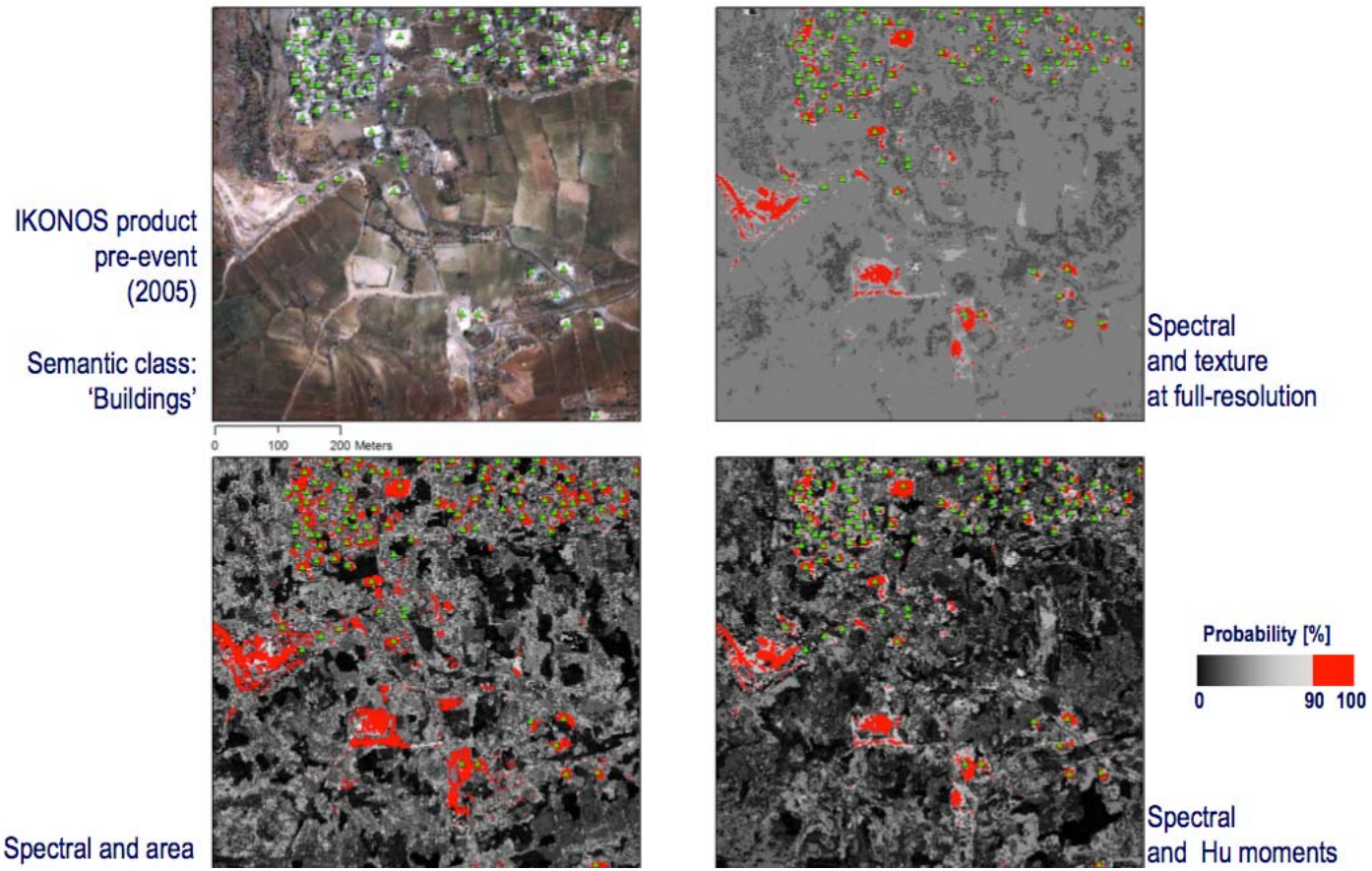
Villages

Savanna

Ships

Roundabouts

Use Case: Damage Assessment (Courtesy JRC/IPSC)



Conclusion and Outlook

What do we need for the Sentinel era?