

# Improving knowledge discovery from synthetic aperture radar images using the linked open data cloud and Sextant

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5-7 March 2014

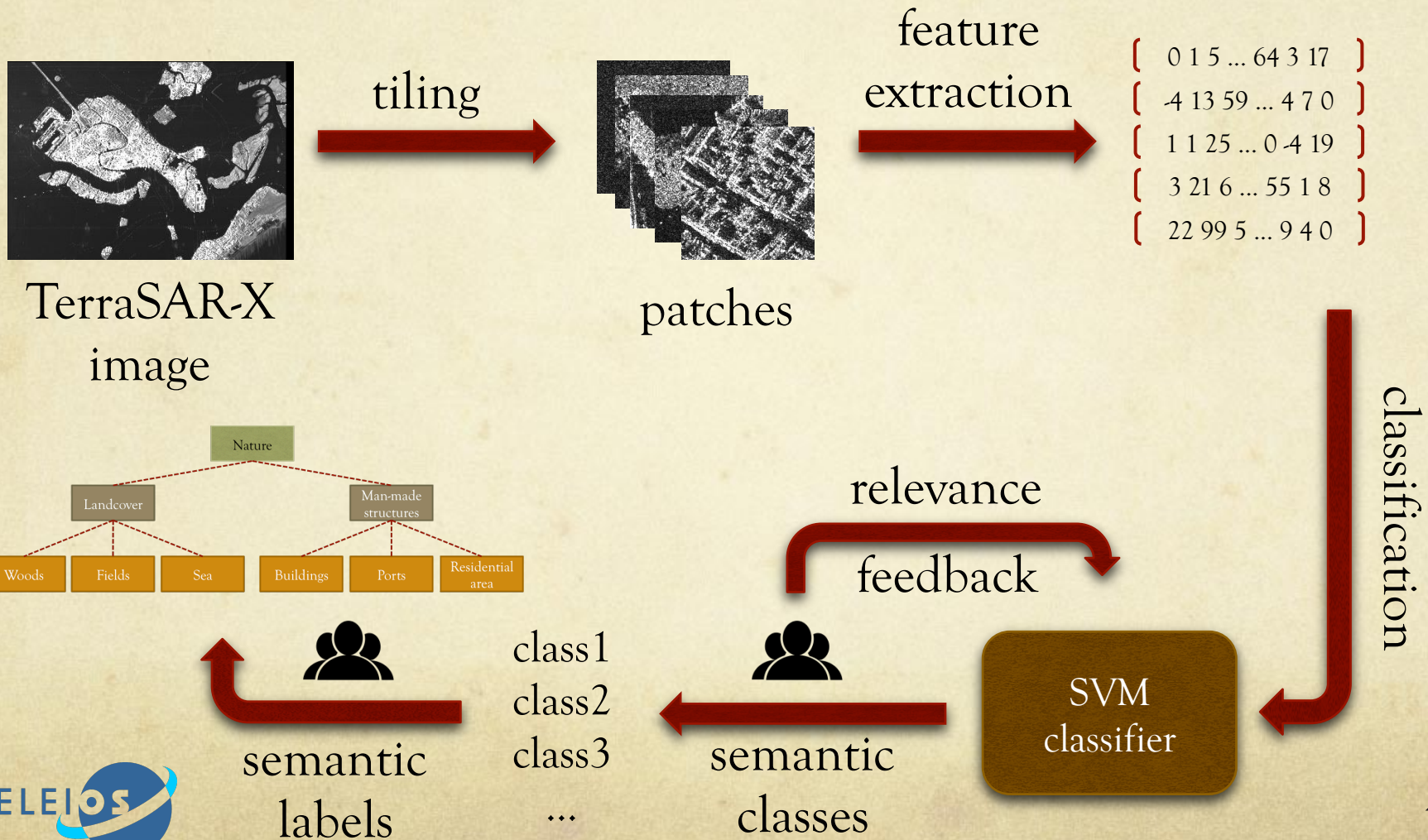
Universitatea Politehnica Bucuresti (UPB), Bucharest, Romania



# Outline

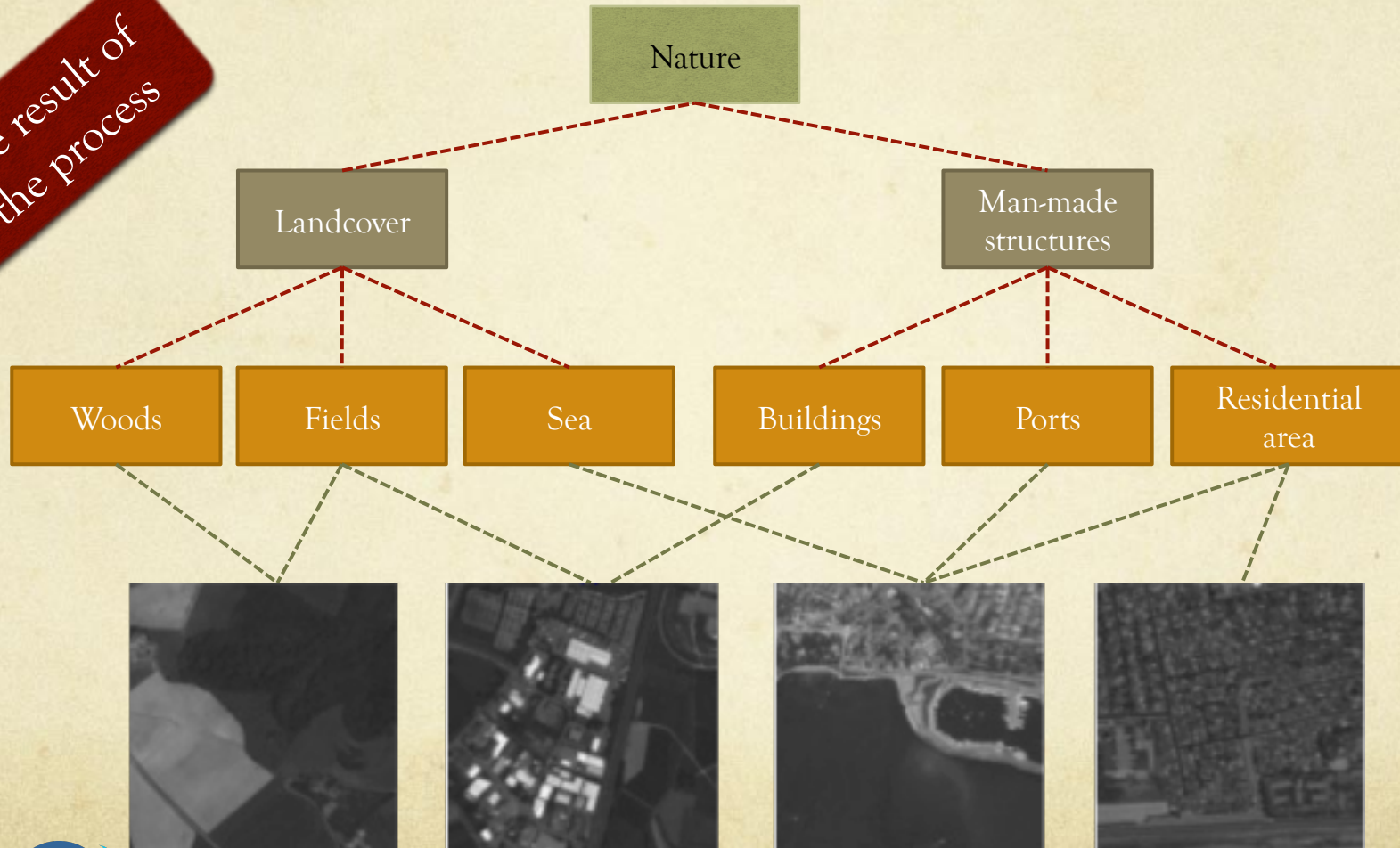
- Knowledge discovery from EO images in DLR
- The linked open data cloud
- The tool Sextant
- Improving knowledge discovery using Sextant
- Conclusions

# Knowledge discovery and semantic annotation in DLR



# Knowledge discovery and semantic annotation in DLR

The result of the process



# Knowledge discovery and semantic annotation in DLR

No. of scenes / No. of patches	No. of semantic categories	Methodology
109 scenes 110,000 patches	850 categories	<ul style="list-style-type: none"> <li>• Support Vector Machine</li> <li>• Relevance Feedback</li> </ul>

Woods

Fields

Sea

Buildings

Ports

Residential

Type of areas

Scene location

Urban and  
infrastructure areas

- Africa - 5 scenes
- Asia - 21 scenes
- Europe - 48 scenes
- Middle East - 8 scenes
- North America - 16 scenes
- South America - 11 scenes



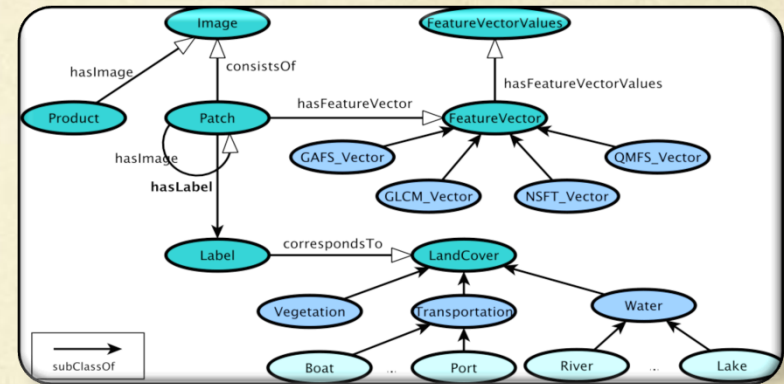
# Data modeling for knowledge discovery and semantic annotation



- Conceptual modeling of the knowledge discovery process and the semantic classes using an OWL ontology
- Use geospatial and temporal extensions of the SPARQL query language to query such data (e.g., GeoSPARQL and stSPARQL)

## BENEFITS

- High expressivity
- Declarative querying (e.g., “find all satellite images with patches containing water limited on the north by a port”)
- Combination with other data sources
  - ✓ high-quality GIS data
  - ✓ emerging/dynamic web resources and linked geospatial data



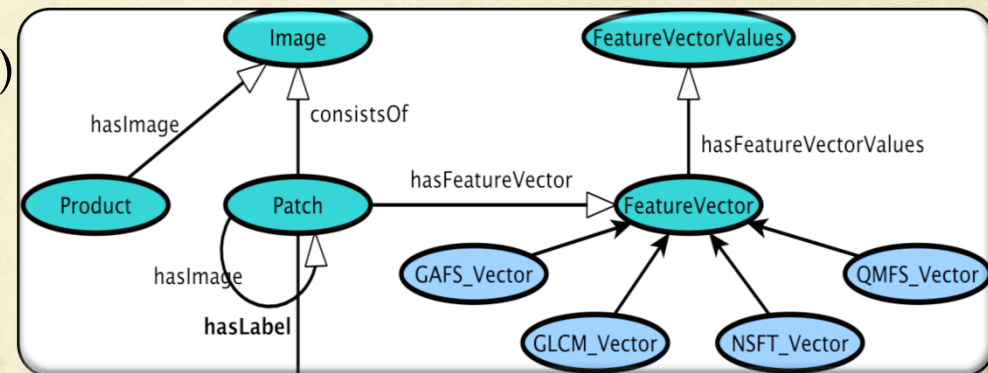
# Data modeling for knowledge discovery and semantic annotation



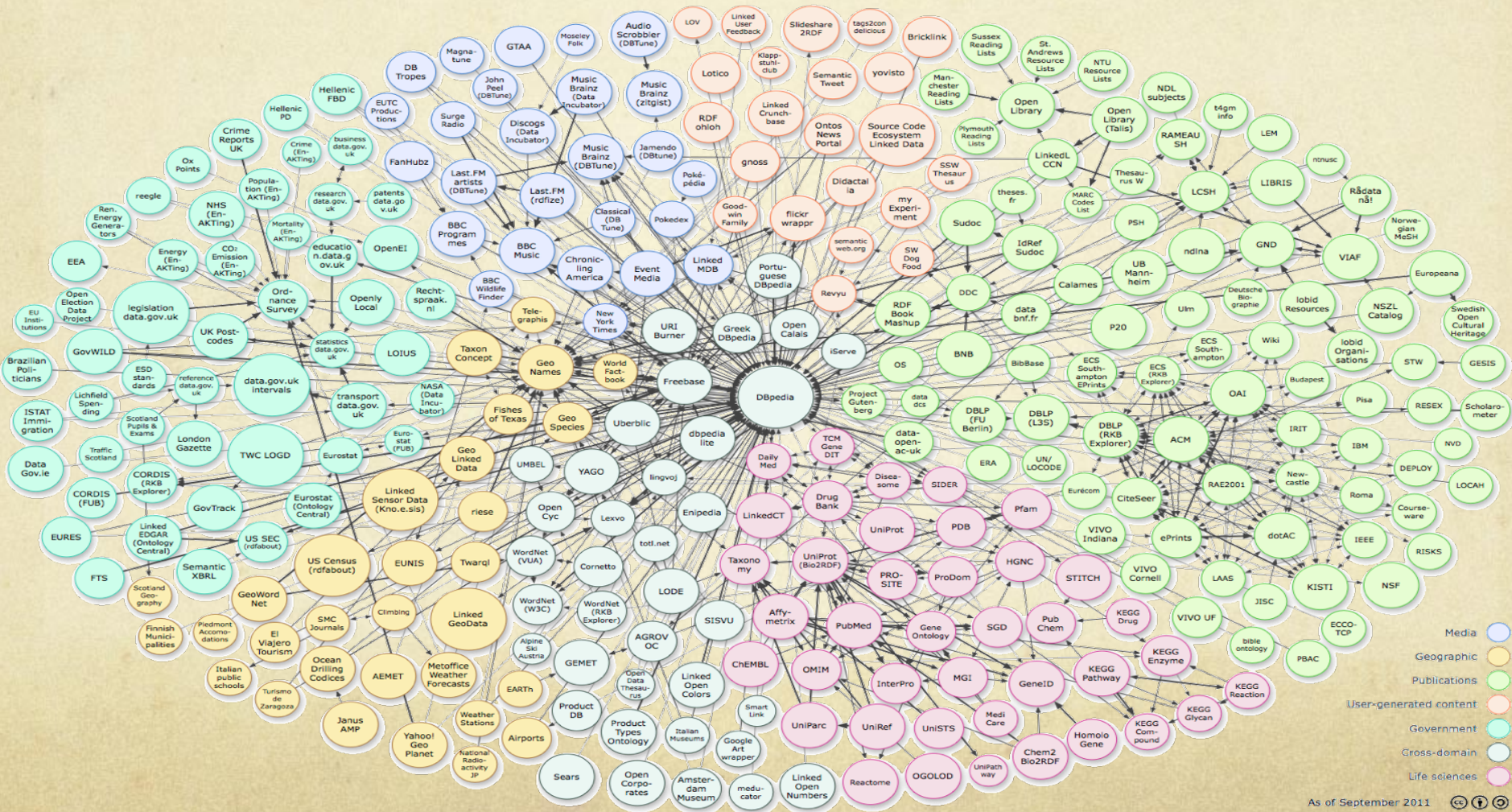
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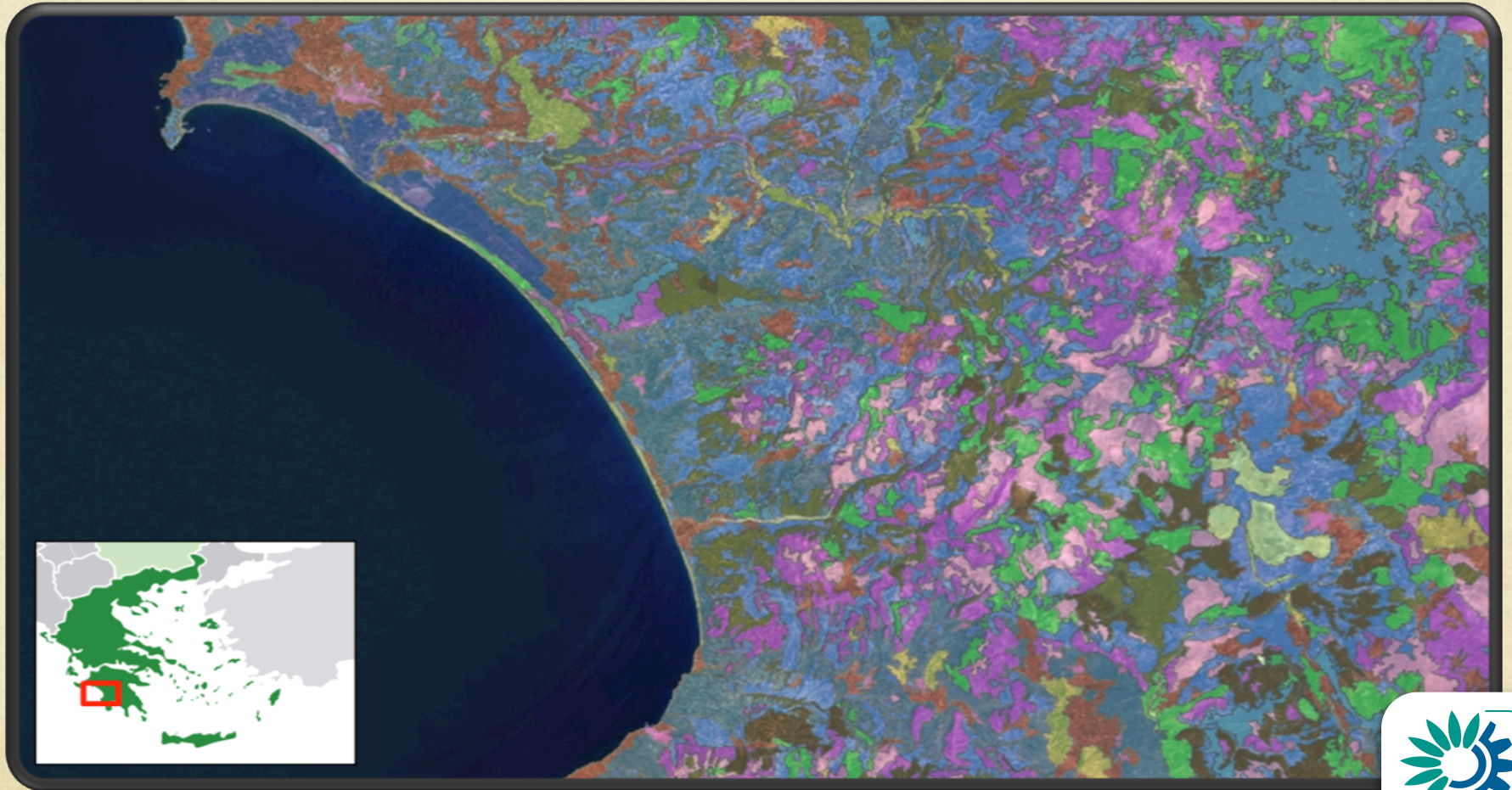



# The Linked Open Data cloud





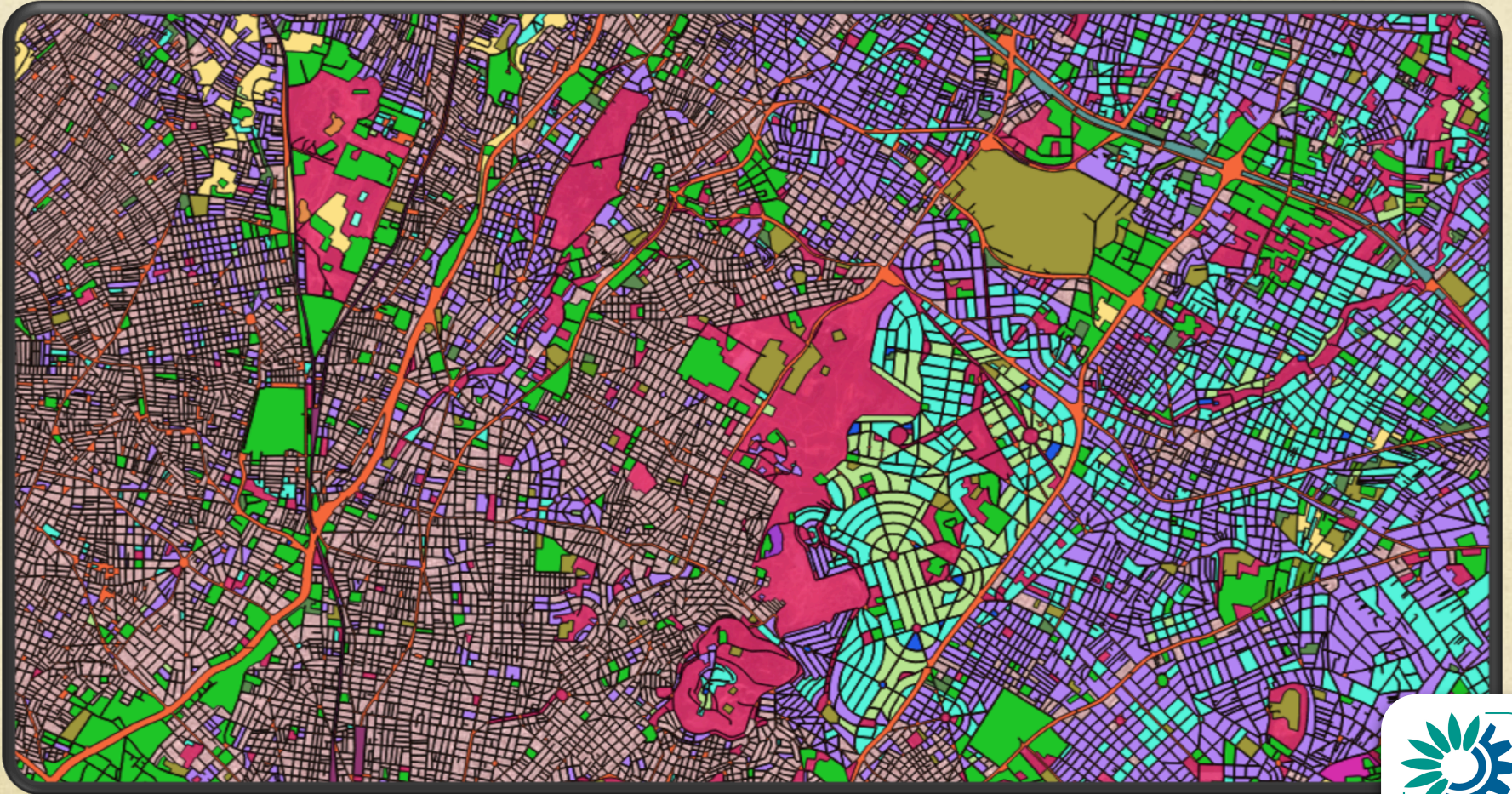
# CORINE Land Cover (CLC)



Available on  **datahub** as linked data



# Urban Atlas (UA)



Available on  **datahub** as linked data



# Open Street Map (OSM)

The image displays a screenshot of the OpenStreetMap (OSM) interface. The main map shows a street grid in Brussels, Belgium, with numerous red diamond markers indicating points of interest. A search bar at the top left contains the text "Search:". To the right of the search bar, it says "powered by Nominatim".

On the left side, there is a list of nearby points of interest, numbered 1 through 49. The list includes various locations such as "Embassy of the Czech Republic", "Metro", "Commission Européenne", "Thon Parnasse Hotel", "Au vieux Bruxelles", "ING Marnix", "ING Porte de Namur", "La Maison des Cyclistes", "Porte de Namur", "Mondo Hotel Léopold Br", "Restaurant Le Bretagne", "ISS", "Coaster", "CEFA", "Clinique des Chartreux", "In 't Spinnekopke", "Park", "Twist", "Bat. Administratif", "Metro", "Tunnel entre Gare Cent", "EHSAL hogeschool", "Gare du Congrès", "BELGACOM", "GALERIE RAVENSTEIN", "Sint Michiels kathedraal", "Nationale Bank van Belg", "Radisson Blu Royal Hotel", "The Office", "ING", "La Sirène", "Congrès - Congres", "Pizza Hut", "A la Mort Subite", "Ministère des Finances", "Metro Porte de Hal", "multiPharma", "Rue de L'Epee", "Rue des Renards, Bruss", "Louise", "RESTAURANT 'EL GRECO", "Restaurant 'La Boule R", "Ancienne Belgique", "Café O'Reilly's", "Interparking", "RESTAURANT 'MINOS'", "LA MAISON DU MIEL", "Subway", and "Pathé Palace".

On the right side, there is a legend titled "Facets" showing various categories and their counts: Node (400), ManMade (9), Amenity (2), Landuse (1), Tourism (31), Natural (35), Historic (3), Place (1), and Leisure (1).

At the bottom left, there is a scale bar showing 100m and 500m. At the bottom right, there is a logo for "AKSW" with a rainbow flag.

In the center, a detailed information panel is open for a specific location, "Chapelle - Kapellekerk". The panel displays the following information:

- Chapelle - Kapellekerk
- <http://linkedgedata.org/triplify/node489098929>
- rdf:type <http://linkedgedata.org/ontology/Node>
- rdf:type <http://linkedgedata.org/ontology/Amenity>
- rdf:type <http://linkedgedata.org/ontology/BusStation>
- rdfs:label@nl Kapellekerk
- rdfs:label@fr Chapelle
- igdo:directType <http://linkedgedata.org/ontology/BusStation>
- geo:geometry POINT(4.34936 50.8417)
- geo:lat 50.8417023
- geo:long 4.349356
- igdo:contributor <http://linkedgedata.org/triplify/user246>

# Sextant



A web-based tool for

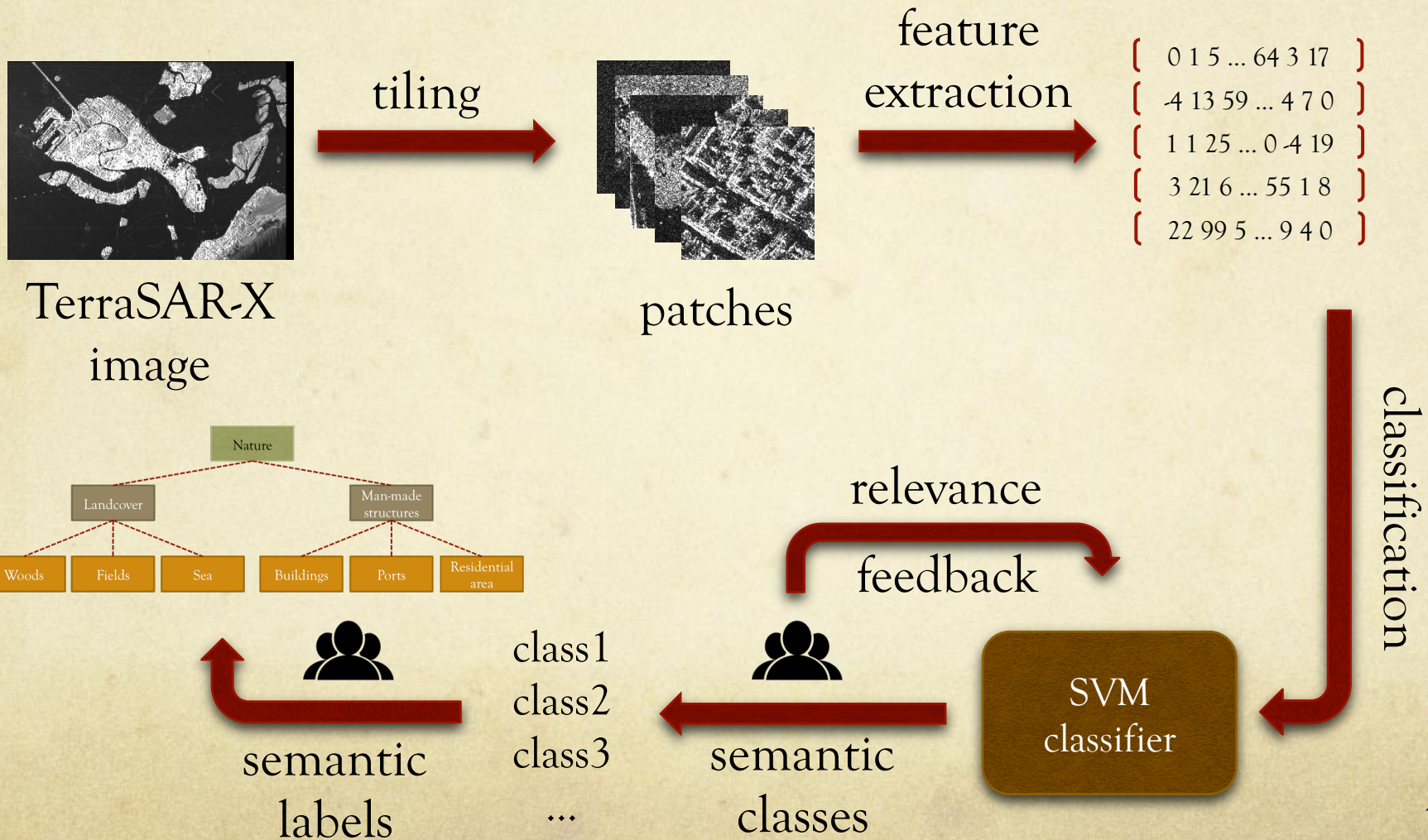
- **browsing and exploring** linked geospatial data
- **creating thematic maps** produced by querying the **spatial and temporal** dimensions of **linked data** and other geospatial data sources in **OGC standard file formats** (e.g., KML)
- **sharing and collaborative editing** of thematic maps

Find more at:

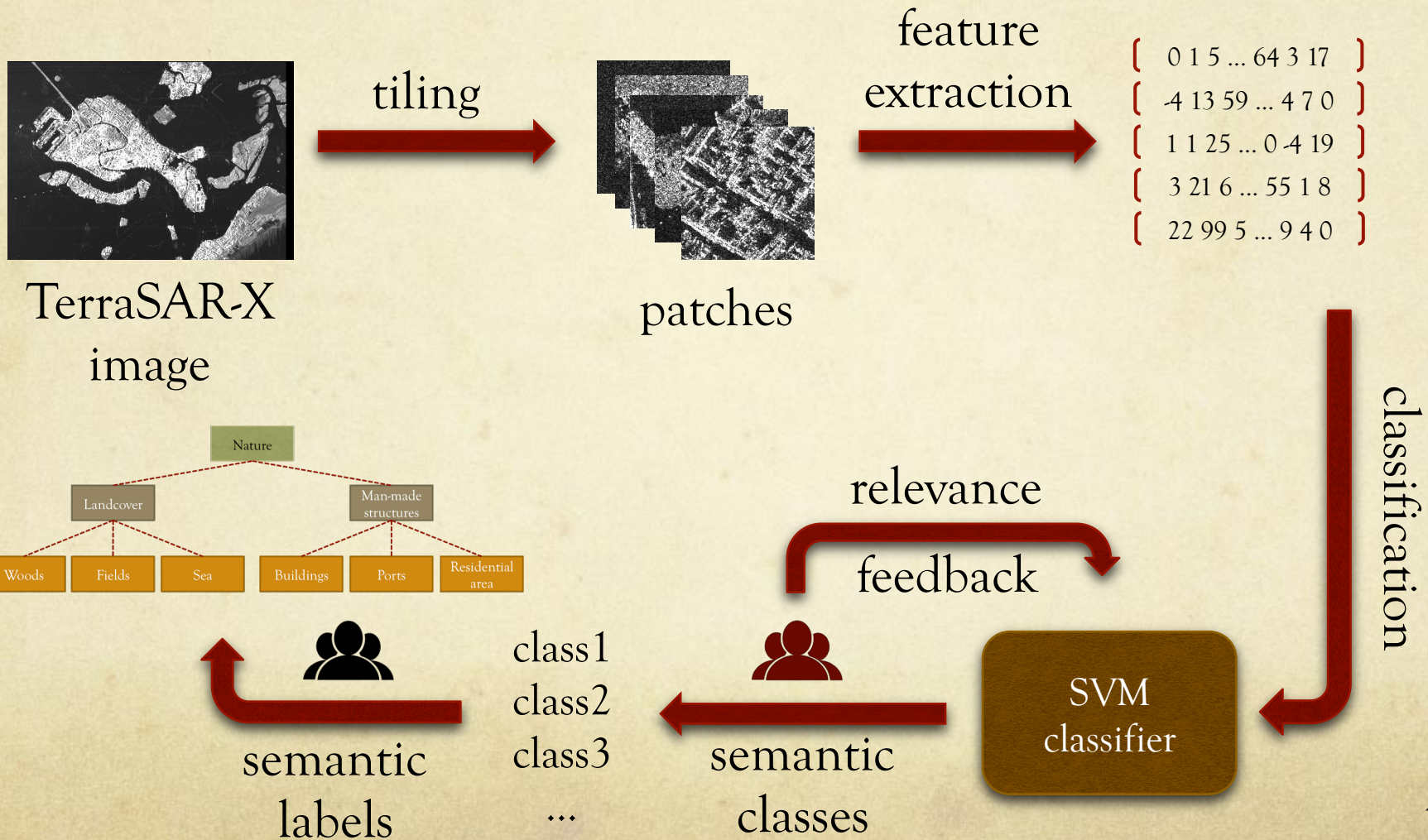
<http://sextant.di.uoa.gr/>

Interoperable with well-known GIS tools  
(e.g., ArcGIS, QGIS, Google Earth)

# Improving the knowledge discovery process of DLR using Sextant

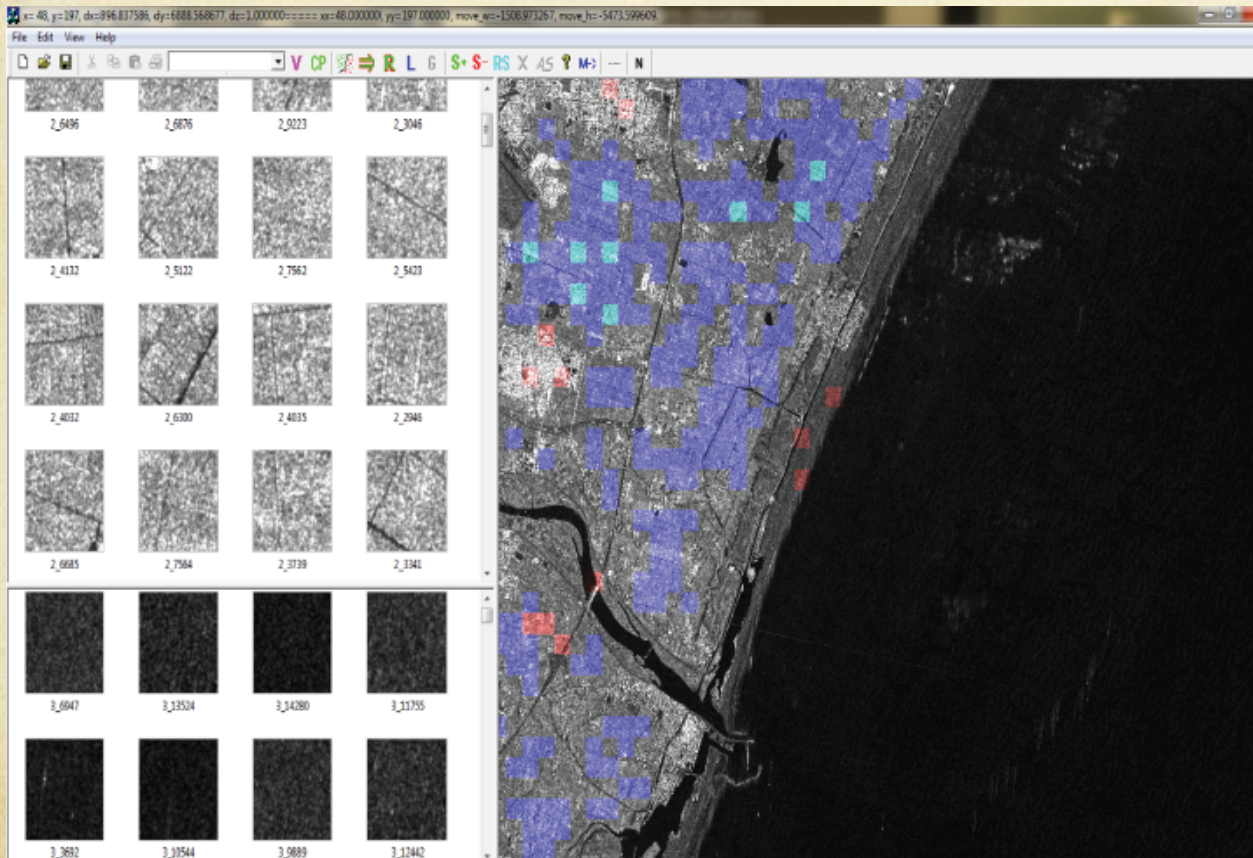


# Improving the knowledge discovery process of DLR using Sextant



# SVM-RF: a semi-automatic process

Iterative annotation of TerraSAR-X image patches using the SVM classifier with a relevance feedback module (RF)



Green patches:  
positive examples

Red patches:  
negative examples

Blue patches:  
classified

# SVM-RF: a semi-automatic process

## Current status of SVM-RF



- Cannot discern the content of a patch
- Difficult to work on radar images only
- Man in the loop

## Improvements using Sextant

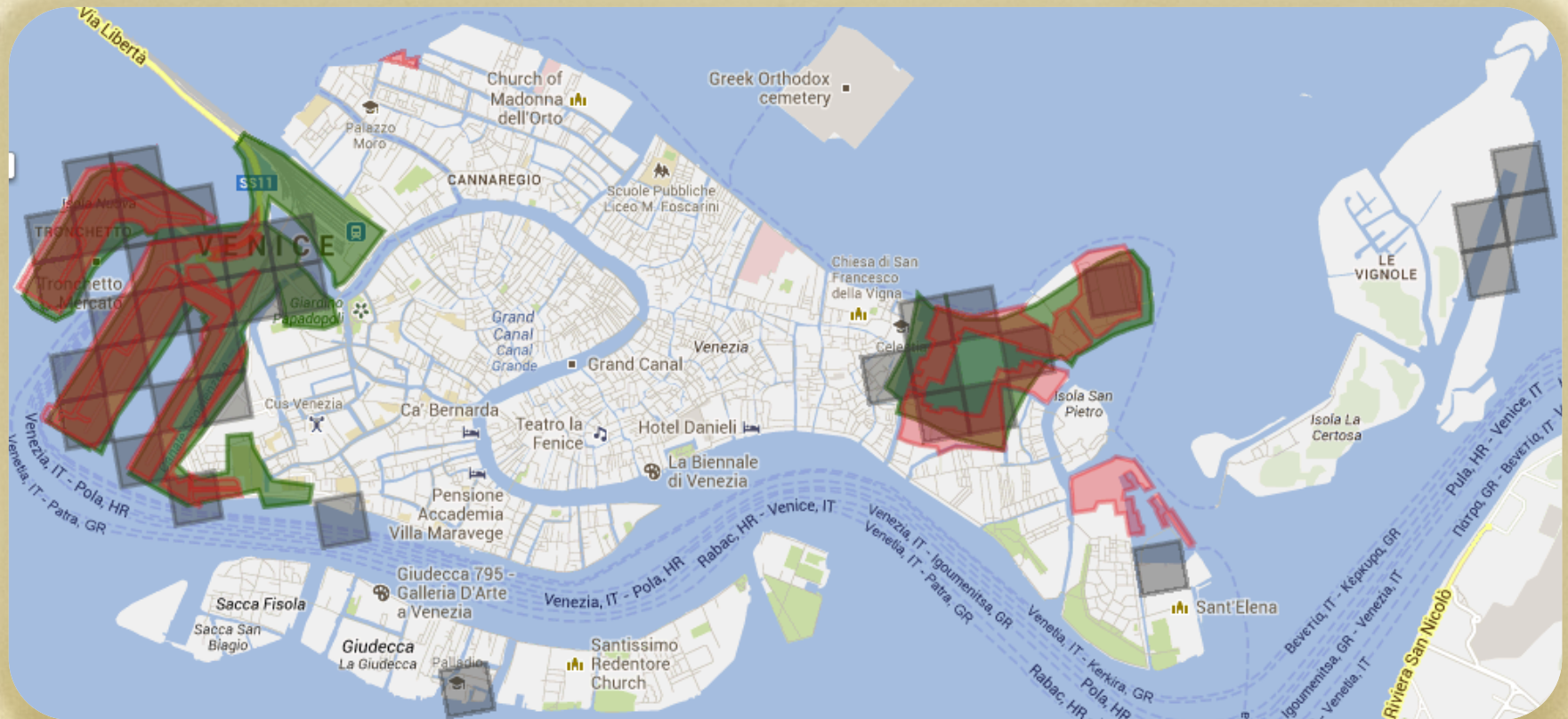


- Bring in auxiliary geospatial data sources
- Bring in background maps (and any other WMS layer)
- Automate using logical if-then rules



# Improving the knowledge discovery process of DLR using Sextant

Validation of patch annotations corresponding to port areas



CLC

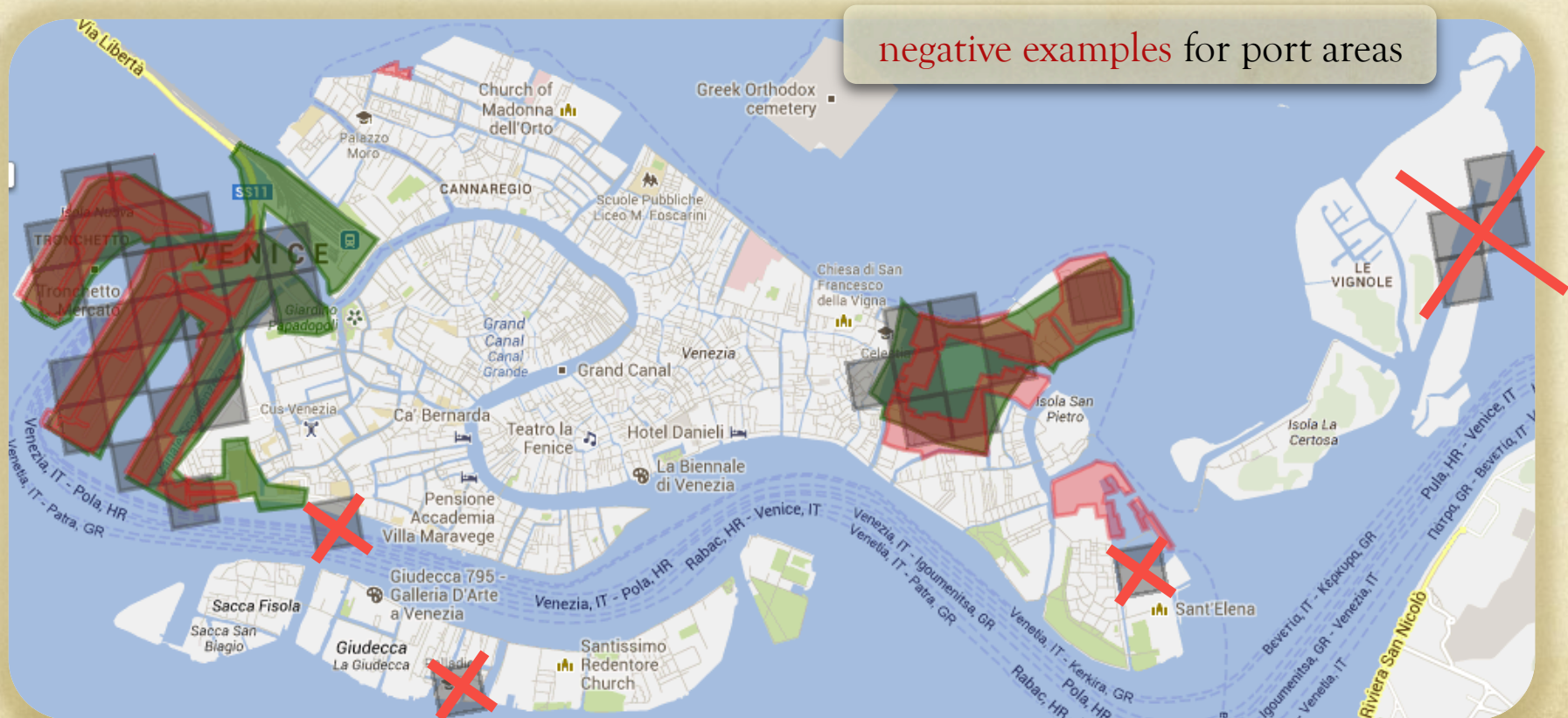
DLR

UA

<http://bit.ly/sextant-venice-ports>

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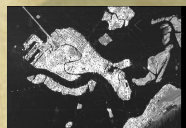
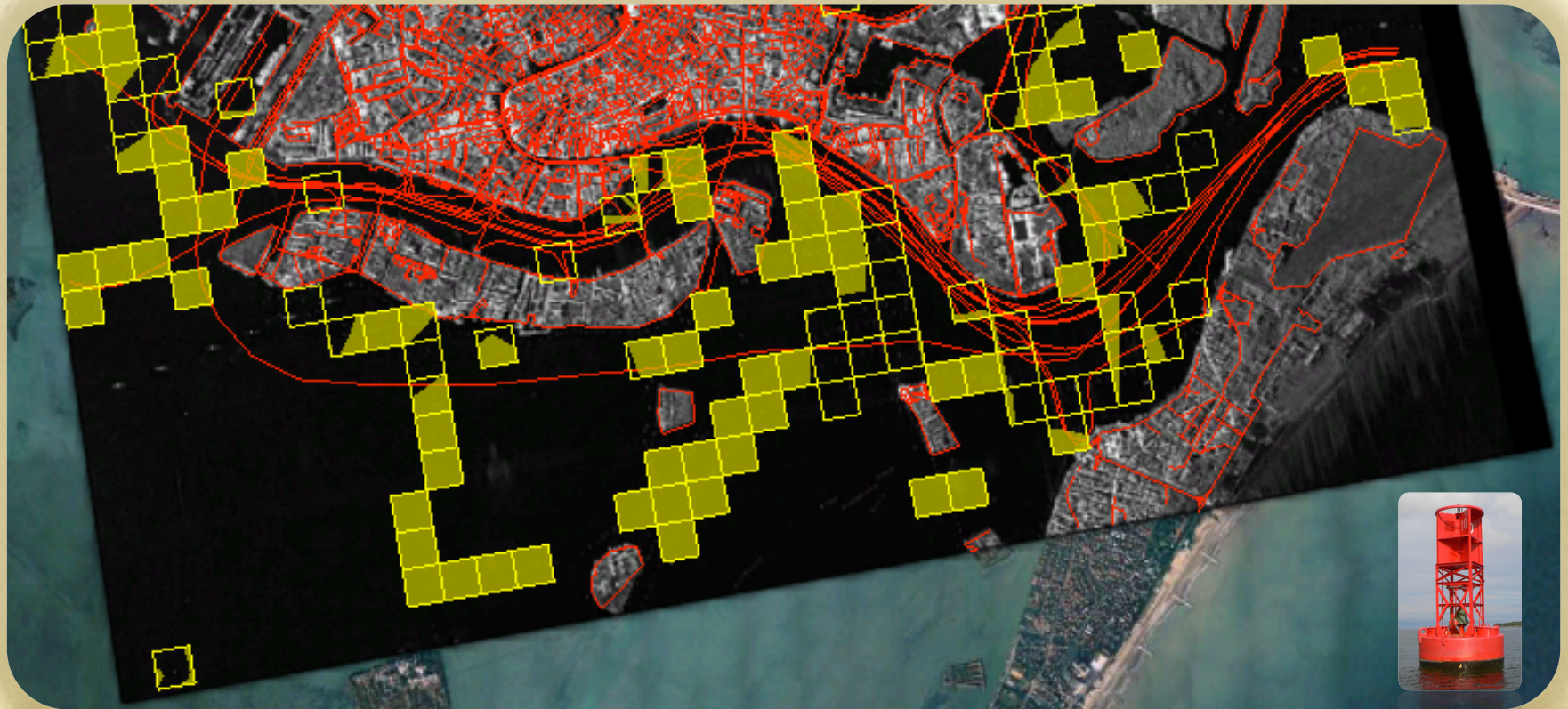
DLR

UA

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# Improving the knowledge discovery process of DLR using Sextant

Validation of patch annotations corresponding to buoys



TerraSAR-X  
image

— road network  
(OSM)

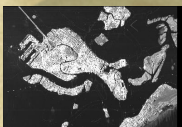
buoys  
(DLR)

# Improving the knowledge discovery process of DLR using Sextant

Validation of patch annotations corresponding to buoys

logical if-then rules

```
1 if patch.annotation = "buoy" AND
   patch.inside(sea) AND
2  FORALL other_patch.annotation = "water_way"
3  AND ( NOT patch.near(other_patch) OR
         patch.intersects(other_patch) )
4 then
5   patch.remove_annotation()
6 fi
```



TerraSAR-X  
image

— road network  
(OSM)

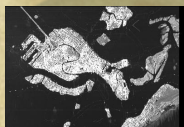
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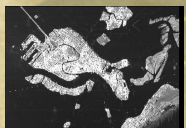
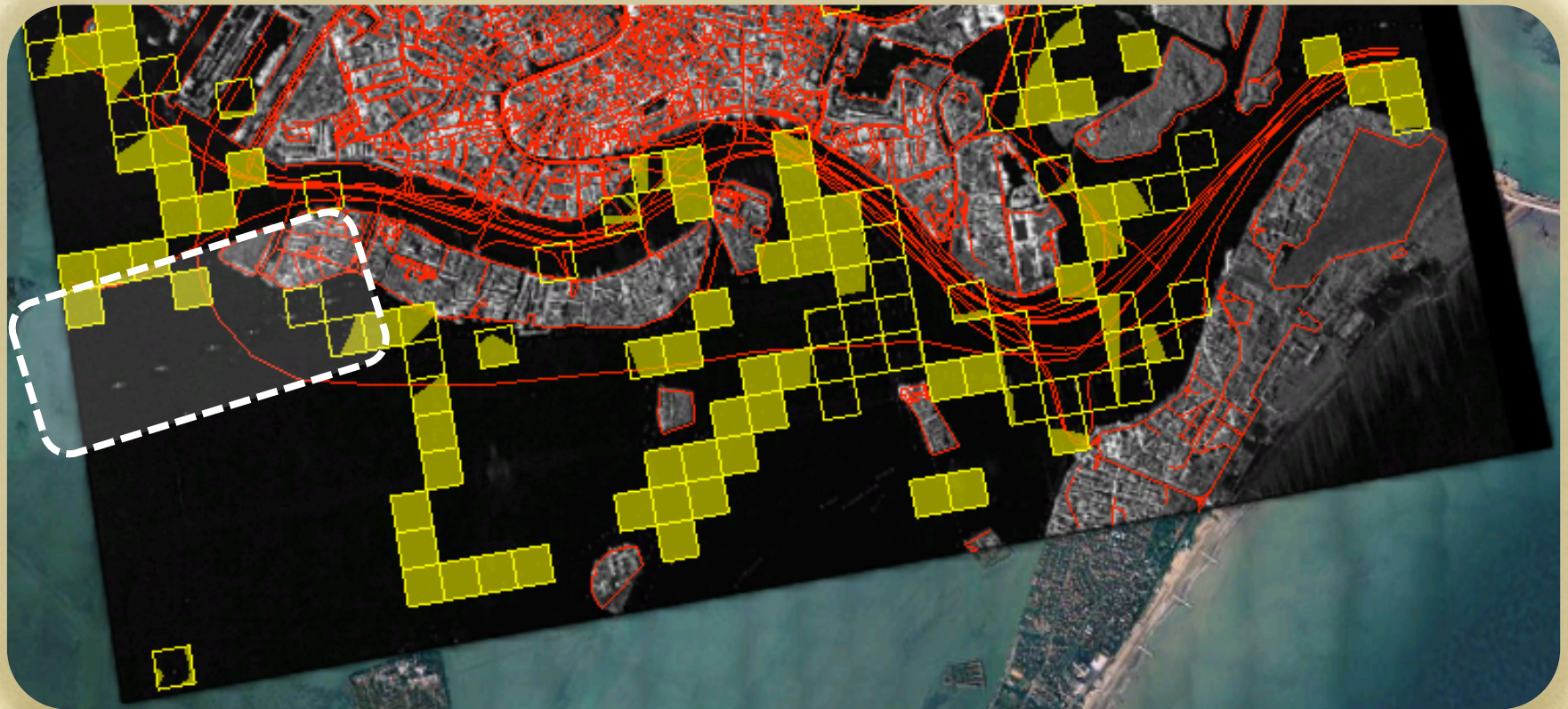
TerraSAR-X  
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buoys  
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Validation of patch annotations corresponding to buoys



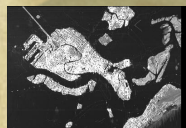
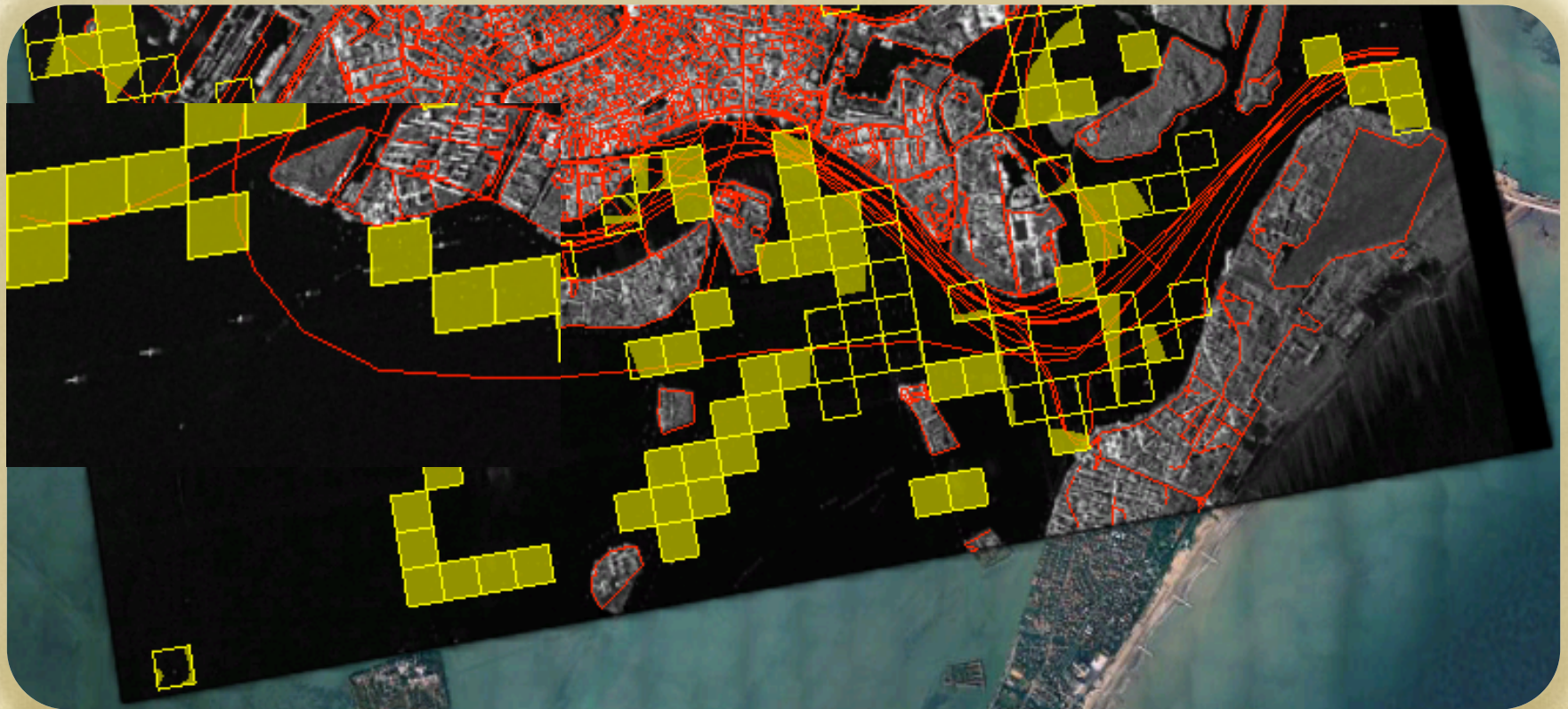
TerraSAR-X  
image

— road network  
(OSM)

buoys  
(DLR)

# Improving the knowledge discovery process of DLR using Sextant

Validation of patch annotations corresponding to buoys



TerraSAR-X  
image

— road network  
(OSM)

buoys  
(DLR)

# Other applications of Sextant

## Rapid mapping

**Sextant**

Endpoints

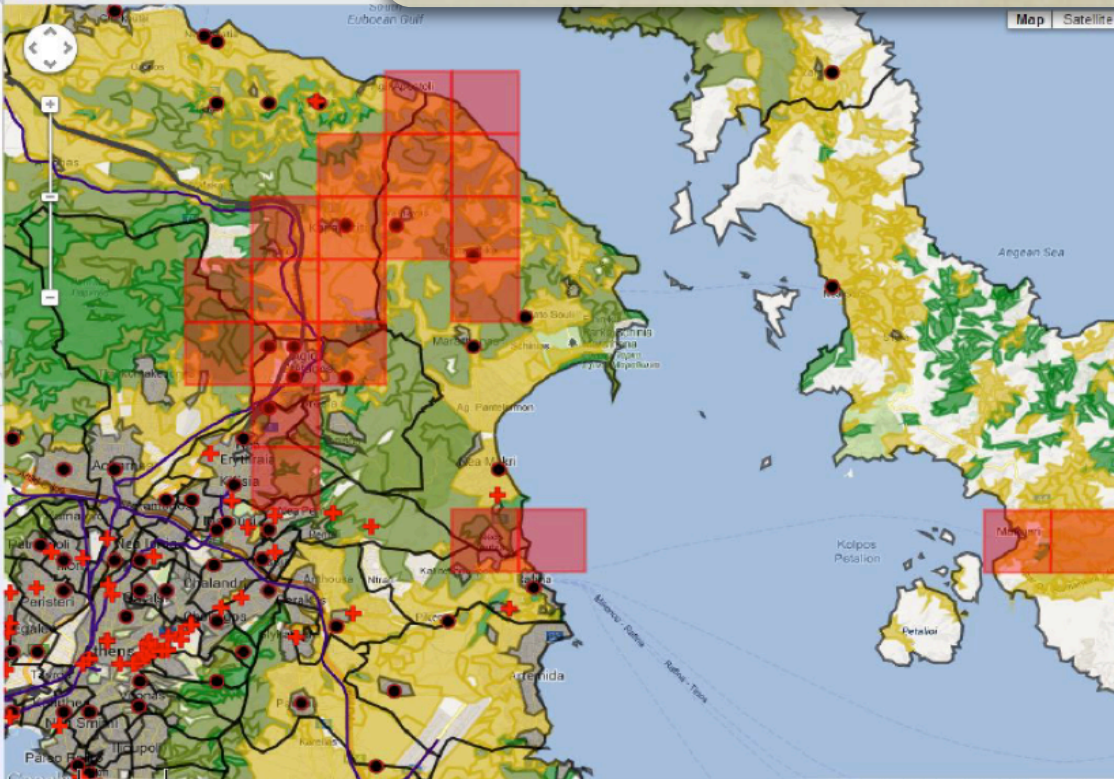
Layers

- Hotspots
- Hospitals
- Geonames
- Rail Network
- Road E75
- Municipalities
- Urban Fabric
- Agricultural Areas
- Forest
- Shrubland

Query

Explore

Map KML Layers



The screenshot displays the Sextant software interface. On the left, there is a sidebar with a 'Layers' section containing a grid of icons and checkboxes for various data layers such as Hotspots, Hospitals, Geonames, Rail Network, Road E75, Municipalities, Urban Fabric, Agricultural Areas, Forest, and Shrubland. Below this is a 'Query' and 'Explore' section. The main area is a map of Attica, Greece, showing a topographic base map with several red and orange overlays. A large red grid is overlaid on the central part of the map, and several red crosses are scattered across the area, representing hotspots or endpoints. The map includes labels for cities like Athens, Eleusis, and Piraeus, and geographical features like the Aegean Sea and the Gulf of Corinth. At the bottom right of the map, there is a small text box that reads 'Map data ©2013 Google - Terms of Use - Report a map error'.



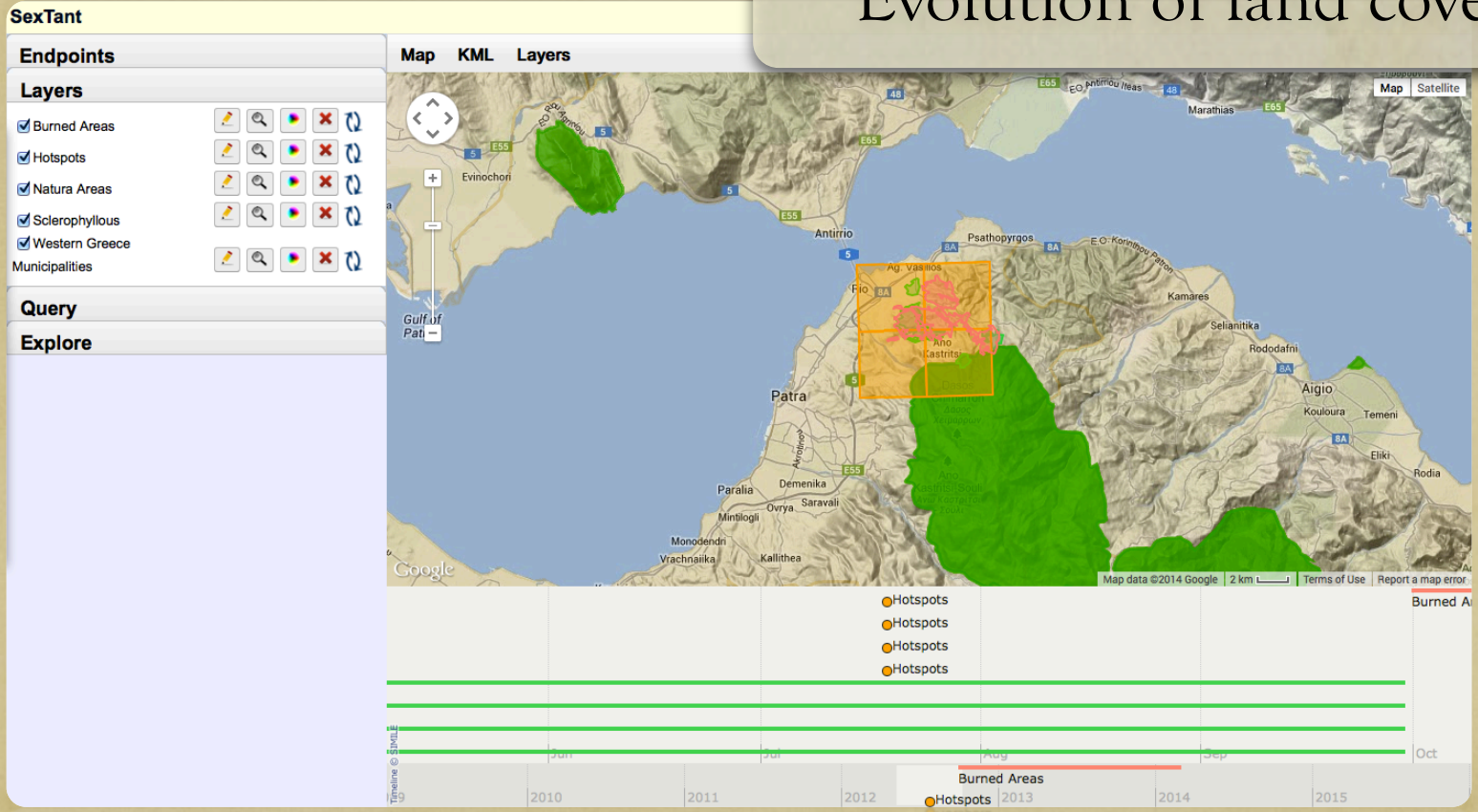
<http://bit.ly/sextant-rapid-mapping-attica>





# Other applications of Sextant

Evolution of land cover

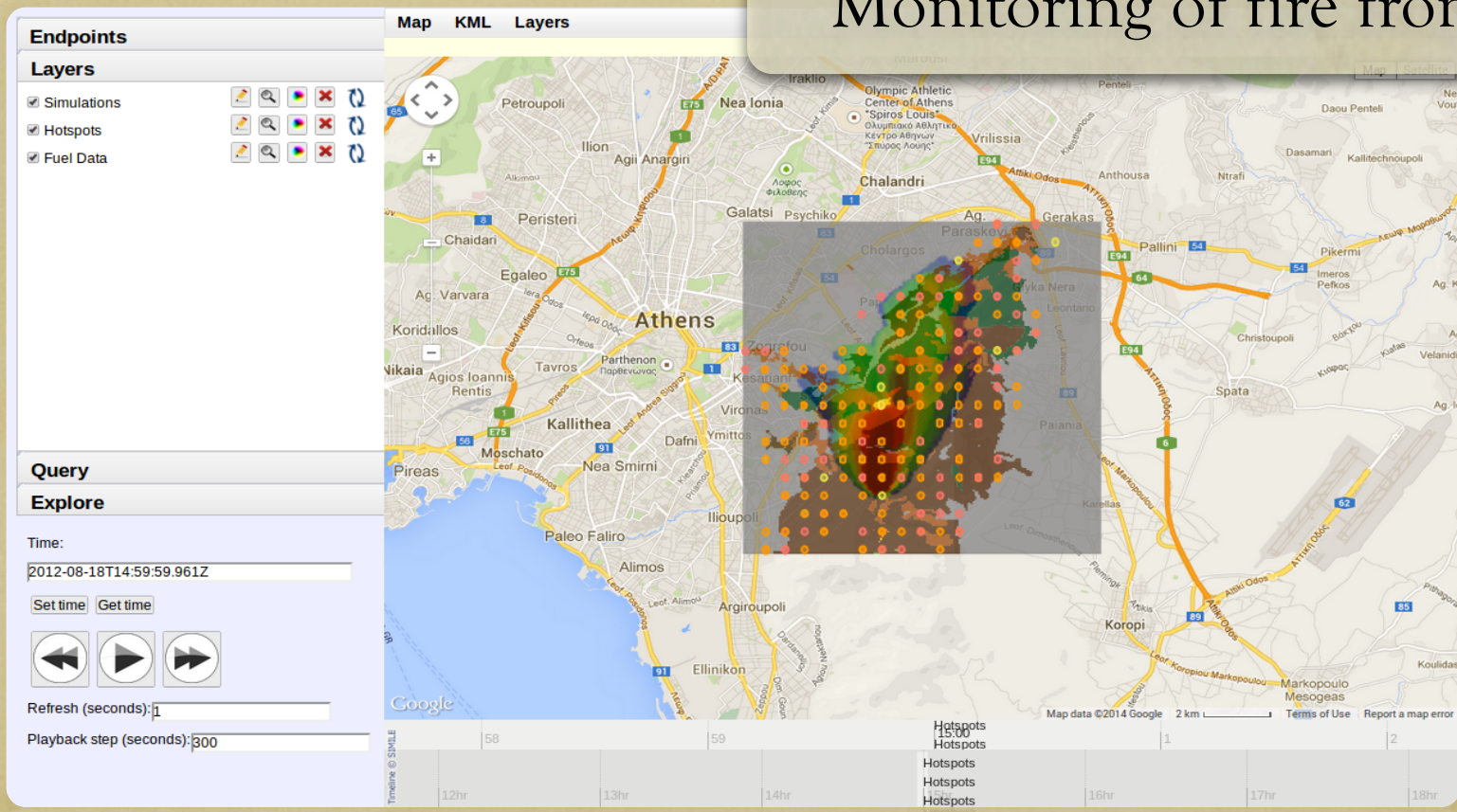


<http://bit.ly/sextant-land-cover-evolution>



# Other applications of Sextant

## Monitoring of fire fronts



<http://bit.ly/sextant-fire-front-monitor>

**SWeFS**

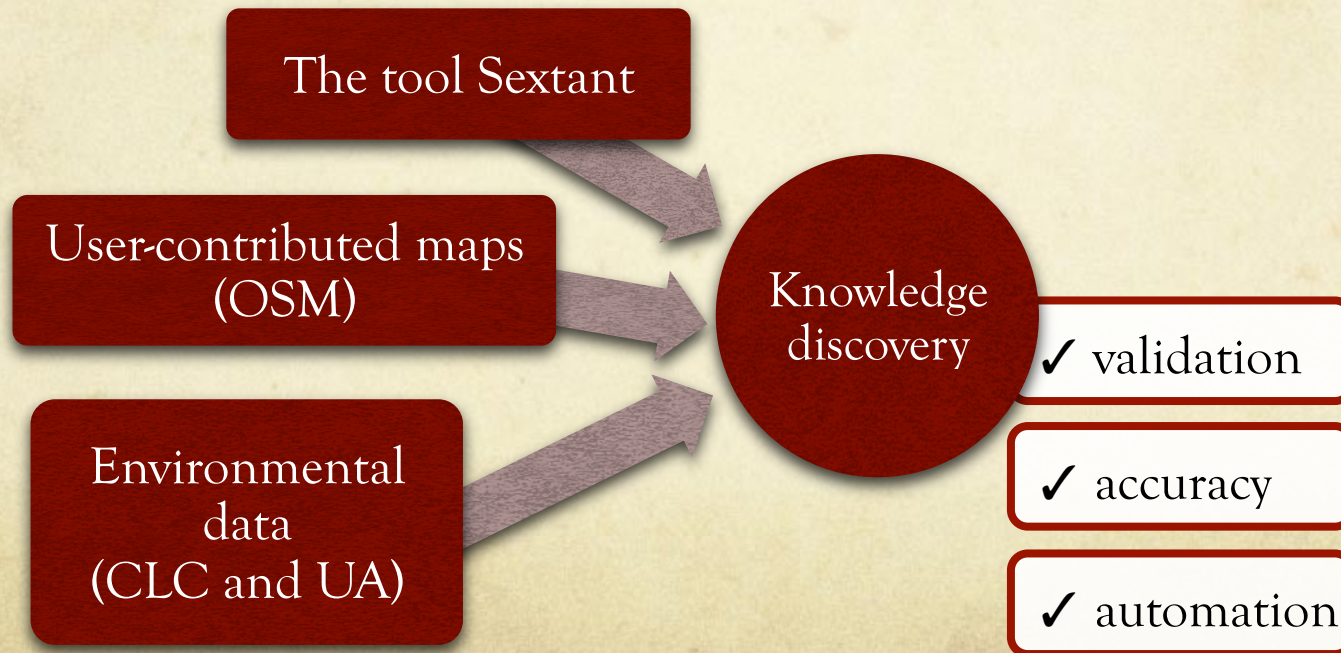
# Sextant is being extended

- ✓ Map registry
- ✓ Legend information
- ✓ Production of statistical maps
- ✓ Development of appropriate interfaces for mobile platforms
- ✓ Query builder integration
- ✓ Support of more file formats: ESRI shapefiles, JPEG JFIF, FITS, etc.

*Tell us about your needs!*

# Conclusions

- Knowledge discovery and semantic annotation of TerraSAR-X images in DLR
- Linked open data and semantic web technologies can prove useful to (and enhance) EO products



Thank you

