Contribution of Pléiades Imagery to the Integrated Management of Coastal Areas

— The case of the Thau Territory —

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Pléiades DAYS

Pléiades Users Thematic Commissioning

Thursday 3rd April 2014

Centre National d’Études Spatiales, Toulouse
THE THAU TERRITORY

* Spatial planning tools: (SMVM), SCOT, SAGE, Natura 2000
* National ICZM pilot area
* Engineering structure: SMBT (Syndicat Mixte du Bassin de Thau)
* Participatory approach

14 municipalities (communes)
2 clusters of municipalities
115,000 inhabitants
MAIN STAKES

Demographic pressure

Nature protection and urban sprawl

Multiple pressures on the Thau lagoon: eutrophication of water, sanitary risks, illegal building....

Maintaining traditional economic activities and broadening uses

Urban sprawl and vineyard removal

Seasonal population variations and public services (water, sanitation)

Pressure on real estate market and leaving of first-time buyers

Drinkable water resources

Abandoned industrial areas and pollutions

Coastal line erosion

...
**Sectoral Public Policies**
(Europe, State, Regions)

- Water
- Urban
- Agriculture
- Natural hazards
- Biodiversity
- ...

**Territorial Intelligence**

**Local Development**
Territorial Project
(Municipalities, Intercommunal authorities)

Territorial Intelligence as a broker between top-down sectoral public policies and bottom-up local territorial project
Connecting Territorial decision-making process with Information and Communication tools
CONTEXT

Objective of the project: land occupation mapping of the Thau Basin

- Artificialised area mapping
- Agricultural land and natural environment mapping

1944-2005 DB
2009 DB
2012 DB

2012 DB

A double approach for one final product
Acquisition of spatial data
(SMBT Urban expansion DB (2005), IGN Topo DB, Pléiades imagery...)

Setting up of a new nomenclature (IRSTEA-SMBT)

Adaptation of the existing 2005 land occupation map to the French land register

Photo-interpretation of artificialised areas for 2009

Photo-interpretation of artificialised areas for 2012
METHODOLOGY FOR AGRICULTURAL LAND AND NATURAL ENVIRONMENT MAPPING

**Softwares used**
- eCognition Developer 64 8.8
- ArcGis 10.2
- Excel

**Acquisition of spatial data**
(Pléiades imagery, IGN Topo DB, RPG, SMBT DB)

**Setting-up of nomenclature**
(IRSTEA-SMBT)

**Segmentation**

**Automatic classification**

**GIS processing**

**Classification assessment**

**Photo-interpretation of clouded areas**

**Photo-interpretation on automatic classification**

**Map of agricultural and natural areas**

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*With cluster facility*
Map of artificialised areas, 2012

GIS processing & combination

Map of agricultural and natural areas

Mask

Map of land occupation, Thau Basin
DATA USED

COMMON DATA

- 2013 SAGE-SCOT Limit
- Water network
  IGN Topo DB
- Road network
  IGN Topo DB
- Aerial orthophotos
  2012

DATA

Artificialised areas

- Urban expansion
  2005
  Cemagref/SMBT DB
  5 dates between 1944 and 2005
- ORTHO DB
  51 images, 50 cm resolution,
  May 2009
- Land register
  (2012 actualisation)

DATA

Agricultural land and natural environments

- NDVI
- RPG
  2010
ARTIFICIALISED AREAS
Setting up of a new nomenclature:
3 levels up to 2005
4 levels from 2009 onwards

<table>
<thead>
<tr>
<th>Classes niveau 1</th>
<th>Classes niveau 2</th>
<th>Classes niveau 3</th>
<th>Remarques</th>
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</thead>
<tbody>
<tr>
<td>1- Zone d’habitat</td>
<td>1.1- Habitat ancien</td>
<td>1.1.1- Cœur de village</td>
<td>Les constructions légères de type cabanes, abris, n’ont pas été recensées systématiquement. Elles sont ventilées dans les classes 1.3.4. ou 1.3.5. selon la taille du terrain.</td>
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<tr>
<td>1.1- Habitat ancien</td>
<td>1.1.2- Faubourg</td>
<td>1.1.3- Hameau</td>
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<td>1.1.4- Maison individuelle</td>
<td>1.1.5- Habitat collectif ancien</td>
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<td>1.1.6- Mas’/Domaine agricole</td>
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<td>1.2- Habitat collectif</td>
<td>1.2.1- Habitat grand collectif (R+2 et plus)</td>
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<td>1.2.2- Habitat petit collectif (R+1)</td>
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<td>1.3- Habitat individuel</td>
<td>1.3.1- Habitat pavillonnaire ordonné de maison mitoyenne</td>
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<td>1.3.2- Habitat pavillonnaire ordonné à forte densité (terrain moyen &lt;1000 m²)</td>
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<td>1.3.3- Habitat pavillonnaire ordonné à faible densité (terrain moyen &gt;1000 m²)</td>
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<td>1.3.4- Habitat individuel dispersé à forte densité (terrain moyen &gt;1000 m²)</td>
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<td>1.3.5- Habitat individuel dispersé à faible densité (terrain moyen &lt;1000 m²)</td>
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Artificialised areas

- Built-up areas
  - Continuous urban fabric
    - Village core
      - Suburb
        - Semi-detached houses
      - Dense residential area (plots < 500 m²)
  - Discontinuous urban fabric
    - Semi-detached houses
    - Dense residential area (plots > 500 m²)
  - Diffuse and isolated buildings
    - Isolated individual house (ancient or recent)
      - Hamlet
    - Mas’, agricultural estate
  - Cabin, hut, shelter
  - Unbuilt part
    - Unbuilt part
Adaptation to land register for a finer management of the urban fabric
PHOTO-INTERPRETATION METHOD USED FOR LAND OCCUPATION MAPPING FOR 2009 AND 2012
- Road network: creation of buffers - Various widths according to road nature (Topo DB)

- Extraction of streets with the help of urban area limits

- Combination of all layers (Classes of 2009 layer, then classes of 2009-2012 evolution layer) resulting in the creation of a mask for the obtention of agricultural land and natural environment areas
AGRICULTURAL LAND AND NATURAL ENVIRONMENTS
### NOMENCLATURE

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<th>Group</th>
<th>Subgroup</th>
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<td>212 Summer crops</td>
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<td>213 Vegetable gardening and greenhouses</td>
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<td>214 Uncultivated agricultural land with high vegetation</td>
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<td>216 Arboriculture</td>
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<td>233 Sclerophylous vegetation (garrigues-maquis)</td>
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<td>234 Open spaces without or with scarce vegetation</td>
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<td>235 Bare soils</td>
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<td>Forests and semi-natural environment</td>
<td>31 Forests and woods</td>
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<td>310 Forests and woods</td>
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<td>521 Lagoons</td>
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<td>523 Sea</td>
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Discrepancy between SMBT detailed nomenclature and the possibilities offered by automatic classification.
Creation of homogeneous patches:
SEGMENTATION

- Several tests
- Use of March and September images (RGB, NIR and panchromatic bands) and masks (roads and built-up areas)
- Problems encountered:
  - Clouds over the eastern zone
  - Inconsistency between land register and segmentation scale of agricultural and natural areas
Automatic determination of land occupation classes:
CLASSIFICATION

- Expert classification algorithms (decision tree)
- Algorithms for threshold definition
- Difficulty for determining thresholds for certain classes (ex: tree planted surfaces...) on the whole Thau territory
For the photo-interpretation of agricultural land and natural environments:

- Use of the **Urban area mask** and **road network buffer mask**
- Correction of topology (suppression of micro-polygons),
- Smoothing (lessening of object crenellation)

Photo-interpretation of clouded zones (segmentation basis as of September, with clouds over the eastern part)
Preparation of layers to be sampled: setting up of thresholds to distinguish 3 categories of objects (small, medium-sized, large)

- Large objects: surface > 0.8 ha
- Medium-sized objects: surface < 0.2 and > 0.8 ha
- Small objects: surface < 0.2 ha

\( nb: \text{suppression of objects under 0.05 ha} \)

Creation of confusion matrix with Excel software:
- One for segments (nature of the object)
- One for surfaces (surface of the object)

Calculation of accuracy coefficient (Radoux and al. method)

| Surface totale du bassin de Thau | 62138,50 |
| Surface totale de la zone échantillonnée | 978,09 |
| Y (s/S) | 0,02 |
| Tr[P(surf)] | 49,91 |
| Tr[P(seg)] | 70,38 |
| (1-Y) | 0,98 |

Coefficient de précision: 70,06

Accuracy coefficient: 70% of well classified objects, the remaining 30% are to be corrected by photo-interpretation.
The July 2012 image does not cover the whole territory.

- September 2012: clouds on the eastern part of the Thau Basin.
- Difficulty to discriminate certain classes during the automatic classification (ex: crops, bare soils, etc.)
- Classes detailed (for example in the Water class)
Map of agricultural lands and natural environments Thau Basin

Legend

- AREVOIR
- Forests and woods
- Verges
- Canals
- Winter crops
- Summer crops
- Water surfaces
- Uncultivated agricultural land
- Closed garrigue
- Open garrigue
- Lagoons
- Vegetable gardening
- Salt marshes
- Artificial water bodies
- Grasslands
- Bare soils
- Arboriculture
- Urban
- Vineyards
- Isolated wetlands
FURTHER DEVELOPMENT…

- Assembly of 2 parts: Urban areas/Agricultural land and natural environments
- Mapping global assessment
- In the future, possibility of mapping ecosystemic services on the basis of this land occupation map of the Thau Basin
ADVANTAGES AND LIMITATIONS OF THE Pléiades IMAGERY

ADVANTAGES:

- For automatic classification, the Pléiades imagery allowed to obtain a detailed nomenclature (3rd level of Corine Land Cover (CLC))
- Covers large surfaces with a fine spatial resolution
- In photo-interpretation, reflectance allowed to detect objects which were unperceived on aerial photographs with 50 cm resolution
- Pléiades imagery: allowed to achieve an object-oriented classification with 70% of well classified objects and a CLC 3rd level nomenclature

LIMITATIONS:

- Time resolution (3 dates) which did not permit to differentiate certain crops (confusion between vineyards and market gardening)
- Presence of clouds which obliged to photo-interpret
- During post-treatment of the object-oriented classification, the 20 cm spatial resolution of the orthophoto allowed to confirm the relevance of certain classes of land occupation in agricultural and natural spaces
- Very long processing times
Thank you for your attention

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Jean-Pierre Degas