ForeCAST :

Use of VHR satellite data for forest cartography

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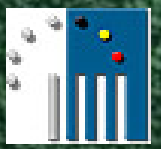
I-MAGE CONSULT

UCL- Dpt Sciences du Milieu et de l 'Aménagement du Territoire



Funded by BFP

Description of partnership

I-MAGE Consult

Private partner

Experienced in teledetection, mapping of natural resources and management of environmental information

UCL- Dpt of Environmental Sciences and Land Use Planning

Scientific partner

Geomatics unit

Forestry unit

Objectives of the project

- To transfer results obtained in the field of scientific research to the private sector for forestry applications and regarding VHR satellite images processing techniques
- To make operational and validate those techniques and the know-how acquired in the research field
- To design a production workflow for the creation of forest maps meeting a number of needs of the forest managers and administrations

Objectives of the company

- Stay qualified with new technologies
  - VHR images
  - New segmentation and classification methods
- Expand and enhance his cartographic services related to forestry
  - New cartographic products
  - New clients and contacts

Satellite choice and test sites

- Choice of images : SPOT 5 and IKONOS-2
  - IKONOS-2 → VHR images, 1:10.000 scale products
  - SPOT5 → cheaper alternative
- Choice of three test sites
  - In Belgium, France, Morocco
  - To develop a robust protocol that can be applied in various conditions

Cartographic products identified

- Based on interviews of end-users
- Needs and requirement of end-users (scale from 1:10.000 to 1:20.000)
  - Poster (non orthorectified image)
  - Spatiomap (orthorectified image)

  } Licensing restrictions
  - Stands limits (delineation of forest stands and clearcuts)
  - Stands map (description of existing parcels)
  - Forest reference-map (when no information is available)

Method

From image to product

- Feasabilty assessment
  - Does the image provider allow it?
  - Is it worth it ?
  - Is it technically possible ?
- Methodological choices from raw images
  - What is necessary ?
  - What can be automated ?
  - How to do it ?

Planimetric accuracy assessment

- Complementary to confusion matrix
- Concentrates on limits
- Hint on cartographic quality
  - Coherent with standard norm
  - Not scene dependent
- Correction of systematic errors

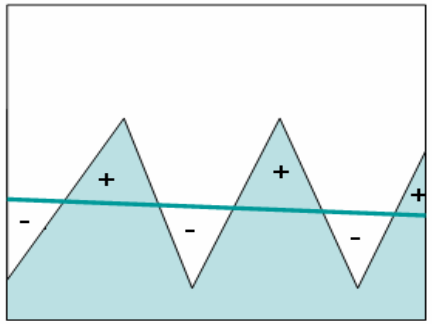
3 sources of planimetric errors

- Orthorectification
  - Depends on quality of GCP and DEM
  - Evaluated with RMS from check points
- Residual parallax
  - Function of tree height
  - Modelisation of accuracy and precision
- Confusion between classes
  - Function of similarity between classes
  - Estimation of accuracy and precision

Estimates of accuracy and precision

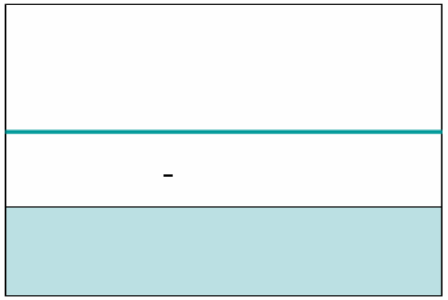
- Accuracy : absence of bias
  - Estimated by the normalised sum of signed area of conflict
- Precision : smallest range of errors
  - Estimated by the normalised sum of conflicting areas minus the bias

Good accuracy, bad precision



: Reference

Bad accuracy, good precision



Object-oriented forest description

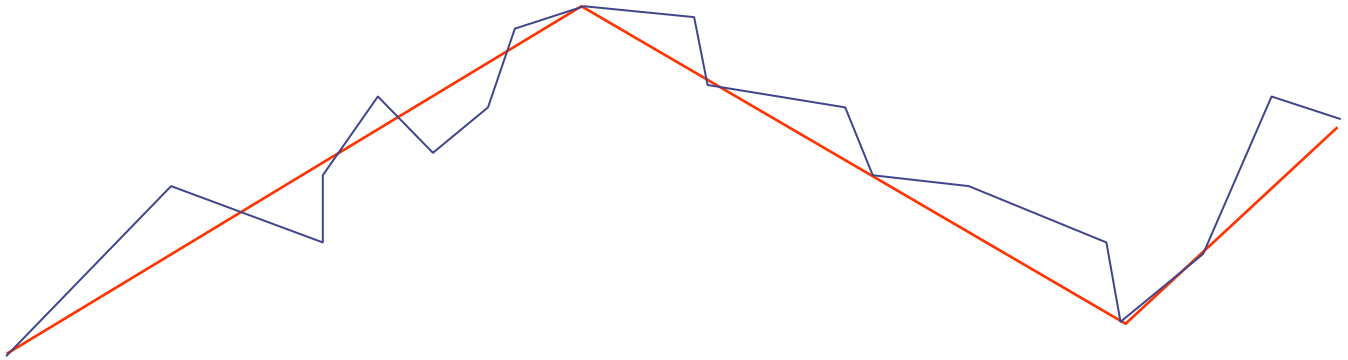
- Segmentation using e-Cognition
  - Multi-scale
  - Tuning between shape and color
- Different scale factor used for contextual analysis
- Enhanced object description
  - Radiometry
  - Texture
  - Shape

Image fusion skipped

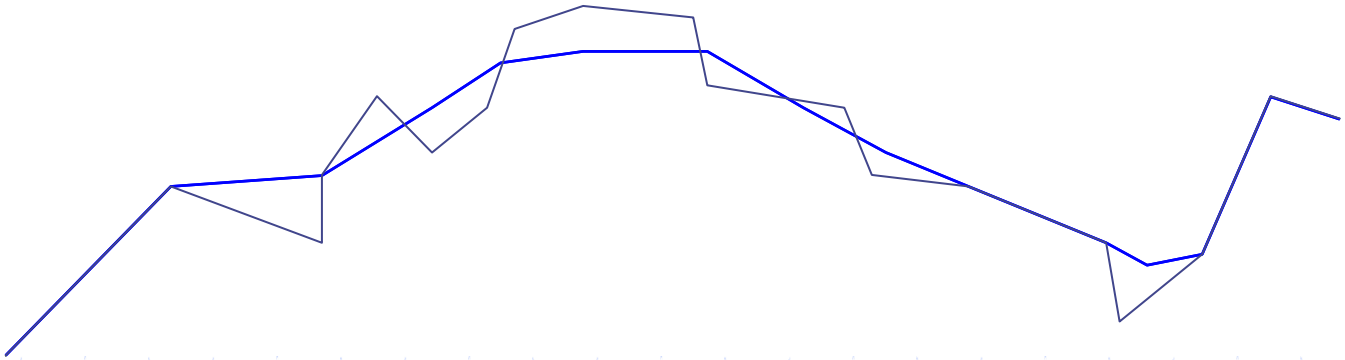
- Object based approach
  - Segmentation uses all layers
    - Small structures from panchromatic
    - Large structures from multispectral
  - Values summarized per object
    - Texture from panchromatic
    - Spectral information from multispectral

Simplification of the limits

- Comparison of 2 algorithms
  - Douglas-Poiker's point removal



  - Middle line



Results and discussion

SRTM good enough for IKONOS

- Good results with RPC files
  - Needs less GCP's
- NGI DEM interpolated from contour lines
  - 0.8 m RMS Z
- Similar results for NGI and smoothed SRTM
  - NGI DEM : 1.24 RMS X and 1.37 RMS Y
  - Smoothed SRTM : 1.24 RMS X and 0.98 RMS Y
  - Non smoothed SRTM : 1.20 RMS X and 2.49 RMS Y
- Good GCP's difficult to obtain in forested areas

Forest stand maps

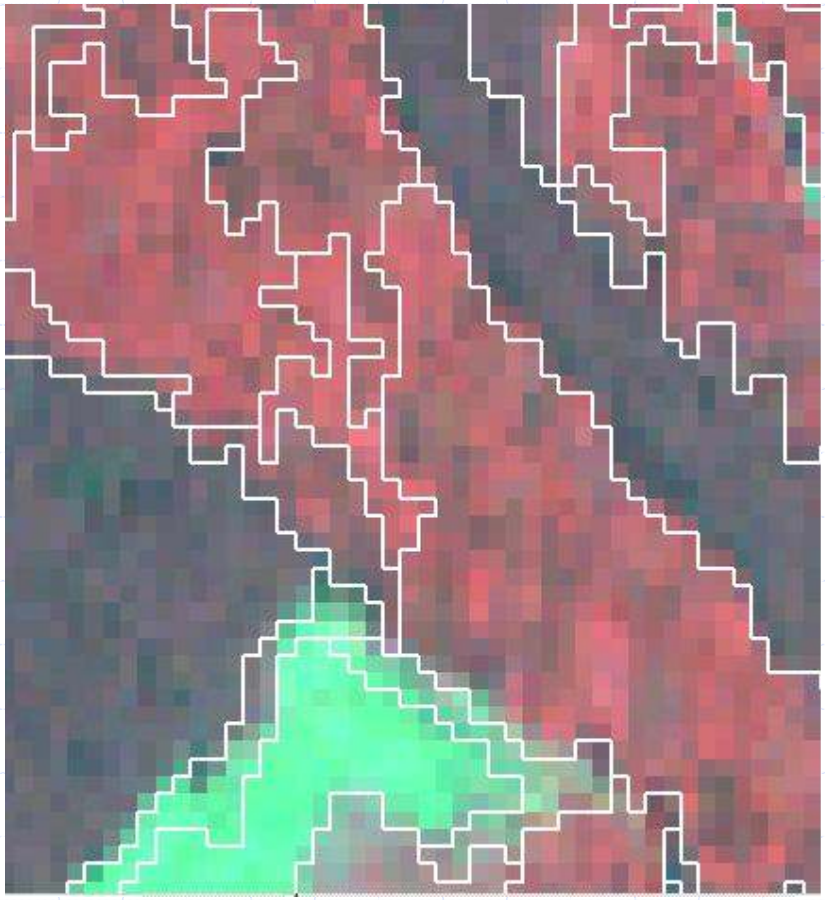
- Segmentation only is not sufficient
  - Small inclusions are also important

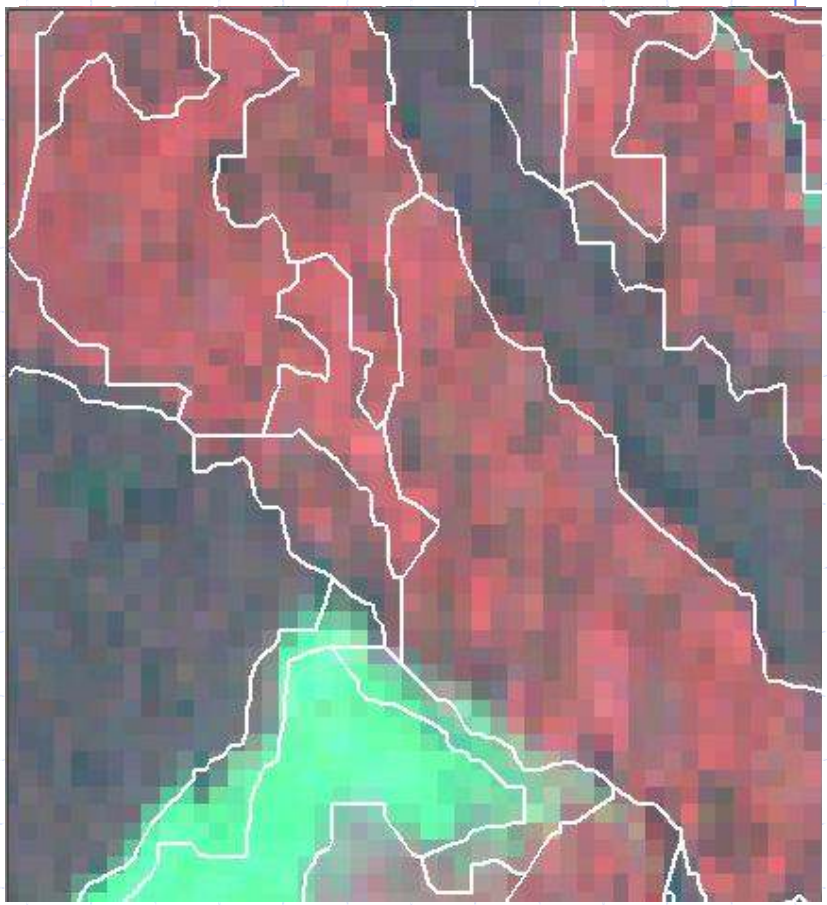
  → High scale factors not appropriate
  - Heterogenous area grouped as smaller regions

  → Large forest stands remain divided
- 2 solutions
  - Manual grouping
  - Classification-aided segmentation

Simplification improves visualisation

- Enhanced products for GIS or maps





Impact of simplification

- Limited effect on the bias
- Douglas-Poiker
  - Performs better on straight lines
  - Can create artifacts
- Middle-line algorithm
  - Reduction of the range of variation (up to 20 %)
  - Performs better on curved boundaries

IKONOS 1 m close to SPOT 5 m

- Summary of coniferous/residuous interfaces
- IKONOS panfused, 1M
  - Parallax errors std: 7.8 m
  - Segmentation errors std : 3.6 m
- IKONOS multispectral, 4M
  - Parallax errors std : 7.8 m
  - Segmentation errors std : 4.9 m
- SPOT 5 panfused, 5M
  - Parallax errors std : 6.5 m
  - Segmentation errors std : 6.8

Conclusions

Technological transfer in 3 steps

- Product description
  - What do end users really need ?
- Methodological development
  - What can we do ?
  - Is it worth doing it ?
- Knowledge transfer
  - How to and why doing it ?

Providing 1/20000 forest maps

- Orthorectification using SRTM
- No image fusion necessary
- Grouping of segments needed
  - Manual or classification based
- Close edge precision for SPOT 5 and IKONOS…
  - Parallax is main cause of errors
  - Confusions due to shade
- …but
  - Smaller MMU with IKONOS
  - Better description with IKONOS

More to come…

- Classifications to be validated
  - 15 classes in forests
  - Distinctions between groups of species
  - Age (height) classes
  - Stand homogeneity (closed or open cover)
- Correction of parallax
  - Using height from ancillary data or from image
  - Using stereo pair

Thank you for your attention