AN OBIA FOR FINE-SCALE LAND COVER SPATIAL ANALYSIS OVER BROAD TERRITORIES: DEMONSTRATION THROUGH RIPARIAN CORRIDOR AND ARTIFICIAL SPRAWL STUDIES IN FRANCE

Thierry TORMOS[1], Stéphane DUPUY[2], Kris VAN-LOOY[1], Eric BARBE[3] & Pascal KOSUTH[3]

KEY WORDS: Top-down classification tree construction, Rules-based classification, Large mapping, Classification automation, Riparian Corridor, Artificial sprawl, Broad scale spatial analysis

1- Introduction

The spatial analysis is a key feature to the ability of human not only know and understand the structures, dynamics and changes in the environment, societies and territories but also to be exchanged between stakeholders in society (citizens, government , socio-economic) to define coordinated management strategies and implement them. OBIA have revolutionized the processing of H&VHRS remote sensing data by providing effective computer-assisted classification techniques whose results come close to the quality of manual photo-interpretation, while being much faster and cheaper and much more reproducible. As a result, we proposed in this paper an operational OBIA procedure designing for the extraction of spatial information from H&VHSR remotely-sensed data over broad territories.

2- OBIA procedure

Example of top-down tree classification construction

OBIA approach: The construction of the tree can be categorized as top-down (i.e., low to high level) image interpretation (see opposite). For each decision in the classification, rules are developed using fuzzy or crisp membership function based on one or several relevant spectral, spatial and contextual features selected by either expert knowledge or trial and error runs or sole visual judgment. Tree classification is implemented over the hierarchical image object network specific for each study.

Classification automation : The study zone is first divided into homogeneous mapping regions according to the image acquisition date. Then, a master ruleset is designed according to the OBIA approach on a pilot zone. Finally, the master ruleset is implemented for each mapping region in adjusting classification rules and eventually added some classes to the classification tree for taking into account regions specificities.

3- Demonstration through riparian corridor and artificial sprawl studies in France

Languedoc-Roussillon region

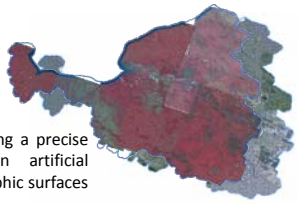
CS1- Riparian corridor management

Maintaining and restoring good riparian buffer area conditions could constitute a major action to improve the freshwaters' ecological status required by the European Water Framework Directive (WFD) by 2015. As a result, the first case study (CS1) is dedicated to the fine classification of Riparian Area Land Cover (RALC) in order to build spatial indicators will help in better understanding and predicting mechanisms influencing river ecological status at riparian scale.

Datasets

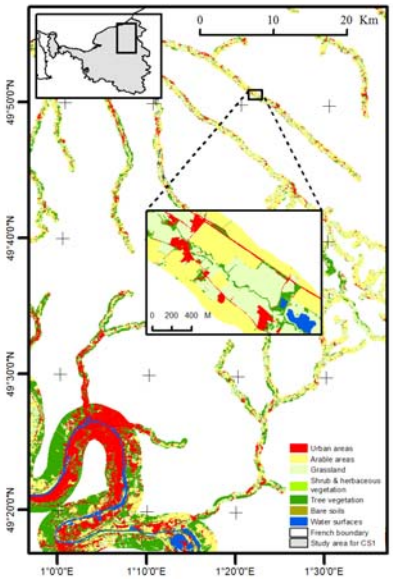
Two types of High and Very High Spatial Resolution (H&VHSR) multispectral remotely sensed data: orthophotos (0.5 m) and SPOT 5 XS satellite images (10 m).

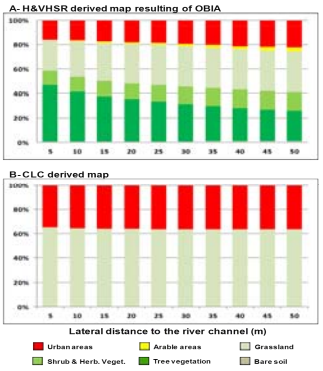
In addition existing spatial thematic data giving a precise (metric precision) spatial information on artificial continuous areas (city centre), roads, hydrographic surfaces (lakes and reservoirs) … were acquired.



SPOT 5 XS (10m) and orthophotos (0.5m) mosaics over the Normandie basin

Results





On the left: Extract of riparian area land cover map in obtained over the Normandie basin (5600 km² riparian area) from our OBIA procedure. A high accuracy was obtained (85 % total accuracy) with a relatively operational time-efficiency (16 hours / 1000 km² for threshold adjustment & processing time using 4 CPU on server).

Above:Riparian spatial indicators: Area percentages of a given land cover type according to the lateral distance to the river channel upstream of a stream ecological station (3km upstream). In A, built from H&VHSR-derived map resulting of OBIA; in B built from CORINE Land Cover (CLC) database. Such results highlight the huge interest of OBIA for producing H&VHSR-derived map in order to better characterize riparian conditions over broad territories.

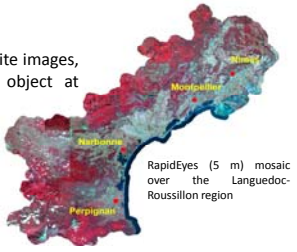
CS2- Artificial sprawl management

In France, in the peri-urban context, artificial sprawl (i.e., sprawl of urban and other artificial land development such as roads, quarries, landfills...) dynamics are particularly strong with huge population growth as well as a land crisis. The conversion of land with agricultural potential is all the more worrying as it is usually irreversible. As a result, the second case study (CS2) is dedicated to the fine extraction of artificial objects at a given time for better localizing artificial sprawl and quantifying loss of land at both local and regional scales.

Datasets

RapidEye images (5 m), HSR multi-spectral satellite images, were collected in order to extract artificial object at summer 2009.

Given the difficulties involved in extracting roads from remotely sensed images, we collected this information from available French topographic data.



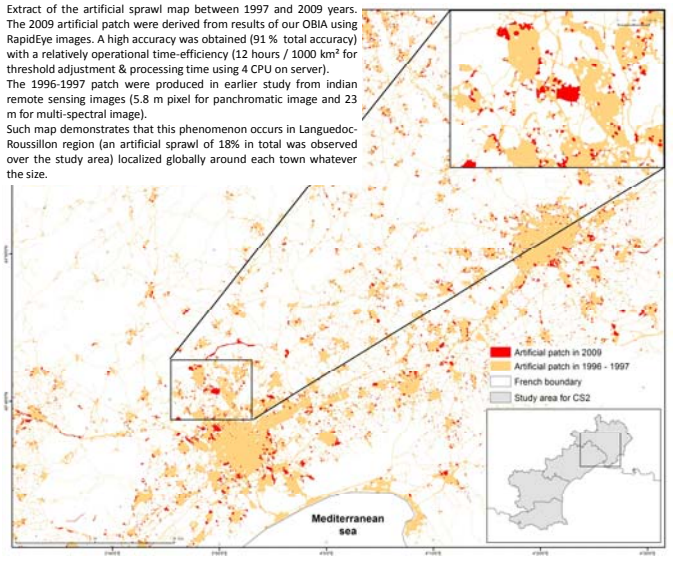
RapidEyes (5 m) mosaic over the Languedoc-Roussillon region

Results

Extract of the artificial sprawl map between 1997 and 2009 years. The 2009 artificial patch were derived from results of our OBIA using RapidEye images. A high accuracy was obtained (91 % total accuracy) with a relatively operational time-efficiency (12 hours / 1000 km² for threshold adjustment & processing time using 4 CPU on server).

The 1996-1997 patch were produced in earlier study from indian remote sensing images (5.8 m pixel for panchromatic image and 23 m for multi-spectral image).

Such map demonstrates that this phenomenon occurs in Languedoc-Roussillon region (an artificial sprawl of 18% in total was observed over the study area) localized globally around each town whatever the size.



4- Conclusion

To conclude, through these two case studies, concerning riparian corridor and artificial sprawl management from local to national scale, this paper demonstrates the drastic need of fine-scale information for supporting action strategies and the high interest of our OBIA approach for producing this information. Our approach, based on a top-down approach for the construction of the classification tree and the use of 'knowledge-based rules' classification technique appears operational given the high accuracy results and relatively short processing time obtained in the two case studies. OBIA, following our approach, will be probably at very short run a broadly applicable method for producing reliable spatial information dedicated to carry out broad scale spatial analysis supporting public policies

References

Dupuy, S., *et al.*, 2012. An Object-Based Image Analysis Method for Monitoring Land Conversion by Artificial Sprawl Use of RapidEye and IRS Data. *Remote Sensing*, 4(2), pp. 404-423

Tormos, T., et al., 2012. Object-based image analysis for operational fine-scale regional mapping of land cover within river corridors from multispectral imagery and thematic data. International Journal of Remote Sensing, 33(14), pp. 4603-4633.

1 : IRSTEA, UR MALY, Pole ONEMA/IRSTEA freshwater hydroecology, Lyon, F-69336, France
2 : CIRAD, UMR TETIS, Montpellier, F-34398 , France
3 : IRSTEA, UMR TETIS, Montpellier, F-34398 France

thierry.tormos@onema.fr