WOODED HEDGEROWS CHARACTERIZATION IN RURAL LANDSCAPE USING VERY HIGH SPATIAL RESOLUTION SATELLITE IMAGES

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1. INTRODUCTION

Wooded hedgerows in rural landscape have economical, social and ecological functions, which are widely recognized [1]. Indeed, the qualitative attributes assigned to these elements are more important than their presence or abundance and play a key role in 1- ecological functions (because of habitat or corridor capacity [2][3]); 2- economical functions (provide wood to farmers [4]). Significant qualitative attributes for hedgerows are morphology, composition and spatial arrangement of small elements [5]. In France, "Chambres d'agricultures"that are farmers' associations, integrate the continuity component to classify hedges into three classes as follows: continuous hedgerows, discontinuous hedgerows and very discontinuous hedgerows.

The research objective is to evaluate the very high spatial resolution satellite images capacity to detect the hedgerow network continuity. The characterization of one linear wooded element with remotely sensed data firstly depends on its composition and arrangement, and secondly on spatial and spectral sensors resolutions.

Remote sensing images with very high spatial resolutions are mostly used to detect and accurately identify the wooded elements presence such as hedgerows in the landscape [6] [7]. With very high spatial resolution imagery, object-based image analysis has been proved to be efficient to automatically detect [8] small elements in complex environments [9] [10].

In this study, an object-oriented approach using SPOT 5 and Kompsat very high spatial resolution satellite images was applied to identify and characterize wooded hedges continuity.

2. METHODOLOGY

2.1. Study site

This study was implemented in a Long Term Ecological Research site (LTER), namely the Pleine-Fougères Zone Atelier located in the Brittany region in the north-west of France. Since 1993, many environmental researches have been led in this typical western France bocage landscape. The

increased knowledge and precise monitoring of this area allow to establish tests accuracy and computational efficiency of the methodology.

2.2. Data

Two very high spatial resolution satellite images of different type were used for this study: a SPOT 5 and a Kompsat image (Table 1). Multispectral bands of both images were merged with the panchromatic band, using the Gram-Schmidt method. Two types of reference data were used, an orthophotoplan and reference maps of wooded hedgerows and field boundaries. All data were georeferenced based on Lambert2 conformal conic system using ArcGis 9.2 software.

Table 1 – Remote sensing data characteristics

Image	Date	Spatial resolution (m)	Spectral resolution (µm)
Kompsat Image	28/09/2008	4	0.45 – 0.52
			0.52 – 0.60
			0.63 – 0.69
			0.76 – 0.90
		1	0.50 – 0.90
SPOT 5 Image	24/09/2002	10	0.5 – 0.9
			0.61 – 0.68
			0.78 – 0.89
			1.58 – 1.75
		5	0.51 – 0.73
Orthophotoplan	Summer 2006	0.5	Panchromatic band

2.3. Extraction and characterization of small linear wooded elements

2.3.1. Multi-scale segmentation and multi-criterion classification

The extraction of small wooded elements was conducted with a two-step method. Firstly, images were segmented with a top-down technique [11] which includes both spatial and spectral criteria at different weights. Two segmentation scales were chosen (Figure 1): the "field level", which takes the reference field maps into account (segmentation being performed with a "chess board" technique); the "tree level", which discriminates small elements (segmentation being conducted using the "multi-resolution" segmentation algorithm).

Secondly, small wooded elements of a field boundary were classified from shape parameters (intersection and distance of a super-object at the "field level"), and from spectral parameters (green and red band minimum and maximum pixel value) (figure 1).

Segmentation and classification steps were conducted using the Definiens 5.0 software.

The final classifications were vectorized and validated using a "hedges map" produced from manual digitizing from the orthophotoplan.

2.3.2. Characterization of hedgerows

Characterization consists in dissociating hedgerows into three classes according to their continuity: continuous hedgerows, discontinuous hedgerows and very discontinuous hedgerows. The characterization was conducted as follows: the classification of small linear wooded elements classification was crossed with the field map (Figure 1) in order to define wooded and unwooded field boundaries. Then, GIS attributes were calculated for all hedgerows (number and area of small wooded elements). Segments of hedgerows, uncovered by wooded elements (gaps) were then defined. Number and gap distances were calculated for each hedgerow. The characterization of the hedgerow is a result of combination of trees and gaps as well as their proportion in the hedgerow.

The characterization of linear wooded elements was conducted with the ArcGis 9.2 GIS software.

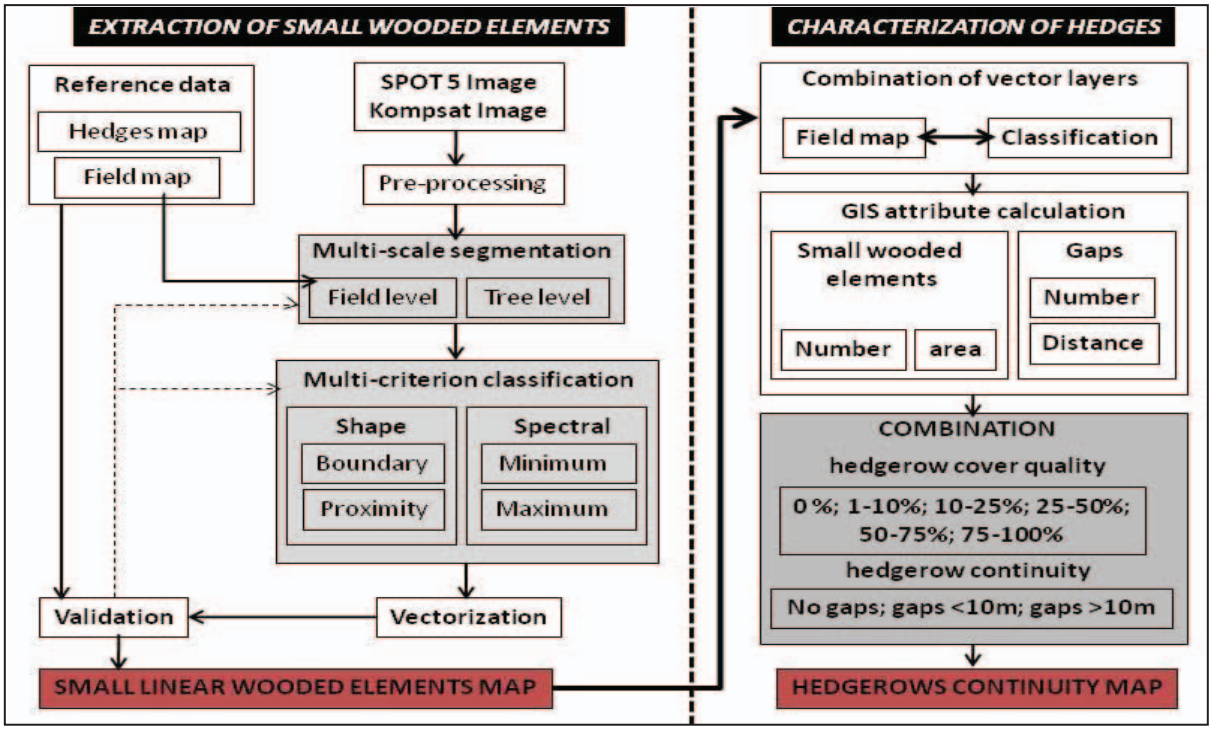

Figure 1 – Image processing procedure

3. RESULTS

The classification of small wooded elements extraction produces a 87% and 99% accurate detection for the SPOT 5 and Kompsat images respectively. The classification kappa index [12] was 0.79 and 0.82 respectively. Figure 2.a. displays a map of small linear wooded elements for the SPOT 5 image (Kompsat image figure 2.b.). Figure 2.c. displays a map of characterized hedgerows from Kompsat image. Characterization of the Kompsat image wooded hedgerows has been accurate, however the SPOT 5 image characterization is inaccurate.

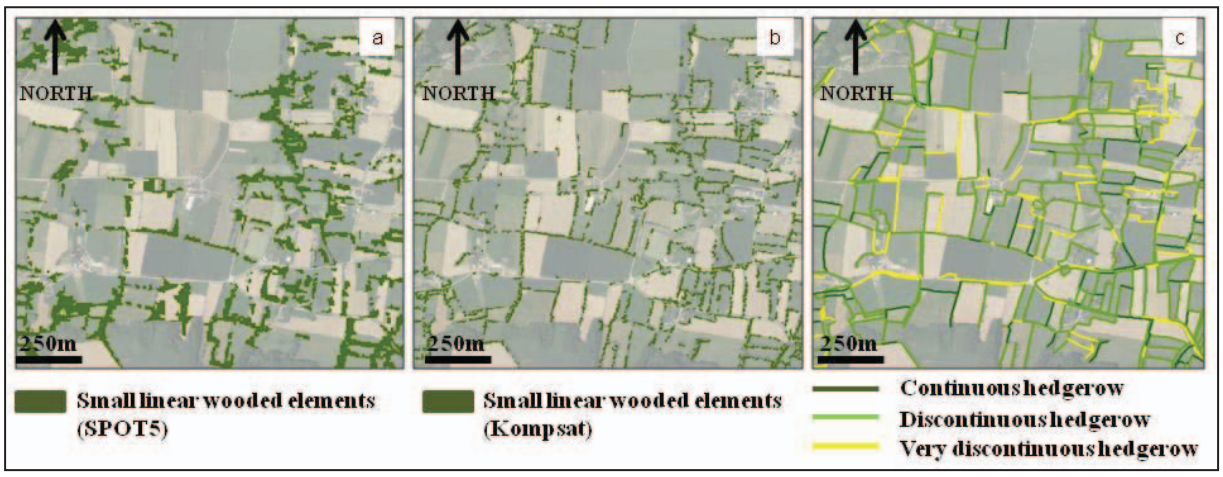

Figure 2 – (a) Mapping of small linear wooded elements from SPOT 5 - (b) Mapping of small linear wooded elements from Kompsat - (c) Mapping of characterized hedgerows from Kompsat.

4. CONCLUSION

It is concluded that object-oriented approach applied to satellite images with a very high spatial resolution about 1m is a computationally efficient, reliable and valid method for detecting small wooded elements and characterizing wooded hedgerows. Moreover, this method is generic and applicable to any bocage landscape. This method could be of great interest for the design of appropriate policies for landscape management, i.e. conservation of hedgerows in intensive agricultural regions.

5. REFERENCES

[1] J. Baudry et al., **"**Hedgerows: an international perspective on their origin, function and management", *Journal of Environmental Management,* Vol. 60, Issue 1, pp. 7-22, 2000.

[2] R.T.T. Forman, " Land mosaics: the ecology of landscapes and regions", Cambridge University Press, Cambridge, 632p., 1995.

[3] F. Burel, J. Baudry, "Landscape Ecology: Concepts, Methods and Applications", Science Publishers, Plymouth, 362p., 2003.

[4] A. Lotfi, « Durabilité écologique des paysages agricoles et production de bois, bocage et néobocage », thèse de doctorat de biologie de l'Université de Rennes1, sous la direction de F. Burel et D. Le Cœur, 203p., 2008.

[5] F. Burel et al., "Comparative biodiversity along a gradient of agricultural landscapes", *Acta Oecologica,* n°19, pp.47-60, 1998.

[6] D. Sheeren, "Discriminating small wooded elements in rural landscape from aerial photography: a hybrid pixel/object-based analysis approach", *International Journal of Remote Sensing,* 30(19), pp. 4979-4990., 2009.

[7] C. Vannier, L. Hubert-Moy, "Detection of wooded hedgerows in high resolution satellite images using an object-oriented method", *in* International Geoscience and Remote Sensing Symposium, IGARSS '08, 2008 IEEE International, Boston (USA), vol IV, pp. 731-734, 2008.

[8] S. Askoy et al., "Automatic Mapping of Linear Woody Vegetation Features in Agricultural Landscapes Using Very High-Resolution Imagery", accepted for publication in *IEEE Transactions on Geoscience and Remote Sensing*, 2009.

[9] U.C. Bentz et al., "Multi-resolution, object-oriented fuzzy analysis of remote sensing data for GIS-ready information", *ISPRS Journal of Photogrammetry and Remote Sensing*, 58, 239-258, 2004.

[10] C.Burnett, T. Blaschke, "A multi-scale segmentation/object relationship modelling methodology for landscape analysis", *Ecological modelling*, n°168, pp. 233-249, 2003.

[11] Baatz 2000 Definiens professional, Reference book Definiens 5.

[12] R. Congalton, "A Review of Assessing the Accuracy of Classi_cations of Remotely Sensed Data", *Remote Sensing of Environment*, 37, pp.35-46, 1991.