Hedge detection (Green Belt Networks, “Grenelle 2 of environment”)

Analysis and comparison from different source (optical, radar), HRS and VHRS images

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Abstract

The challenge of recreating a green belt (hedge, forest, green corridors ... and a blue belt (waterways, bodies of water ...) is to restore biodiversity that the ecological continuity required. A coherent ecological network allows species to move, interact, and continue to support human being.

The main objective of this project is to explore the potential of image processing methods to map hedges, corridors, woodlands of the green belt. A methodology is proposed and applied to several sensors: high resolution (HRS & VHRS) optical and radar satellite, respectively FORMOSAT-2 (8m) SPOT 5 (2.5m) and TerraSar-X (3m).

Method:

- Supervised classification
- Unsupervised classification

Application to 2007 Formosat-2 images resolution: 8 m

4500 by 4000 pixels

8 dates: 13/02, 04/04, 30/05, 30/06, 07/07, 04/08, 15/09, 13/10

Unsupervised classification:

- Identification of 9 green belt classes (low and high hedge), some of them are mixed with woodland, brush or scrub.
- Hedge are clearly visible and well designed.
- Hedgerows and roads are separated.
- Grass strips are visible but are in the same class as meadows and grassland.
- Hardwood and conifer are well classified (99%).

Supervised classification

- The rate of success for hedge (90% corrected classed) is high, but hedges are very extended and over represented.

The unsupervised classification is closer to reality, despite, either a deficit or a surplus (hedge in forest edges or in some wasteland).

In summary:

study area: 59,788 ha (9.342 million pixels) hedge: 3,800-9,600 ha (6.5-15%) (...

Application to 2010 Spot-5 images resolution: 2.5 m

5000 by 6000 pixels, 3 dates: 27/06, 20/09, 16/01/2011

Method:

- Automatic segmentation.
- Unsupervised classification of the 3-date and textural images (heterogeneity) → good linear detection
- Unsupervised classes interpretation (could be automatic with spectral/temporal thematic class database).
- Supervised classification (if ground truths are available).
- The rate of success for hedge (95% corrected classed) is high, but hedges are very extended and over represented but less than with Formosat-2 (8m)
- Fusion of interpreted unsupervised and supervised classification CNS gives to CS 6 kinds of hardwood, which remove hedge mixed in these classes.
- Hedge are detected, well designed, but present a light deficit

In summary:

study area: 18,750 ha (30 million pixels) hedge: 1400-2800 ha (7.5-15%) (...

Application to 2008 TerraSar-X images resolution: 3 m

dates: 28/09, 09/10, 20/10, 31/10, 11/11.

- Automatic segmentation.
- Unsupervised classification.
- Classes interpretation from the unsupervised classification result.
- Unsupervised classification of textural images obtained from variation coefficient calculated on image points neighborhood.
- Automatic calculation of an index of heterogeneity from the previous classification.
- Automatic calculation of image derived from the index of heterogeneity.
- Fusion of this image with first interpreted unsupervised classification.
- 75% of pixel corrected classed for Hedge

In summary:

study area: 9,650 ha hedge: 965-1450 ha (10-15%)

Conclusion

- Sensitive to the residual error of multi date image rectification.
- Supervised classification difficulty of taking hedge samples (linear multiform, residual error of multi date image rectification) and mixels problems → Over representation of Hedge class in supervised classification process.
- Unsupervised classification: multiple Hedge classes (with other woodland classes) →Correct representation of Hedge class, hedge deficit (or surplus if method is less strict)

Methods are validated on these three datasets and conclusions are:

- Importance of multitemporal (a minimum of 3 dates is preferred).
- June and autumnal dates are better to distinguish Hedge class.
- Importance of Red and/or MIR bands.
- Fusion between supervised and unsupervised classification gives a balance between excess and deficit of class Hedge (commission and omission errors are reduced).
- The Hedge is detected for a resolution between 2.5 and 8 meters.