Remote sensing assessment of irrigated areas extension in the Kou watershed

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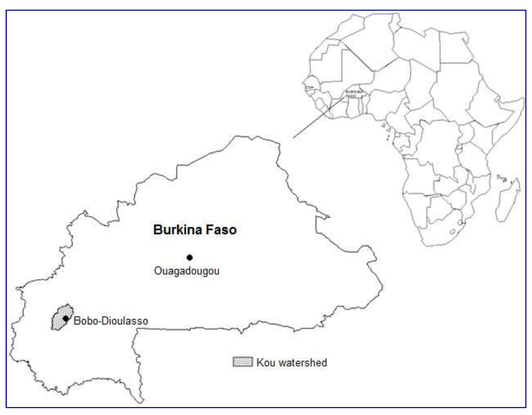

Fig. 1. General localization

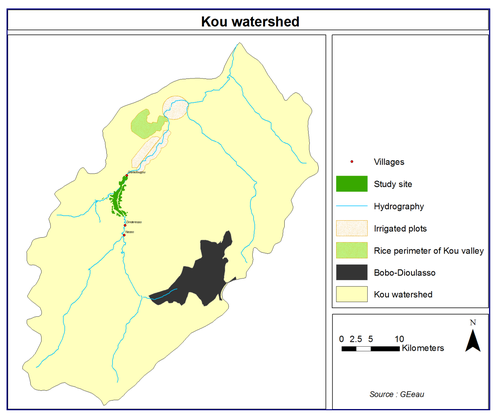

Fig. 2. The Kou watershed

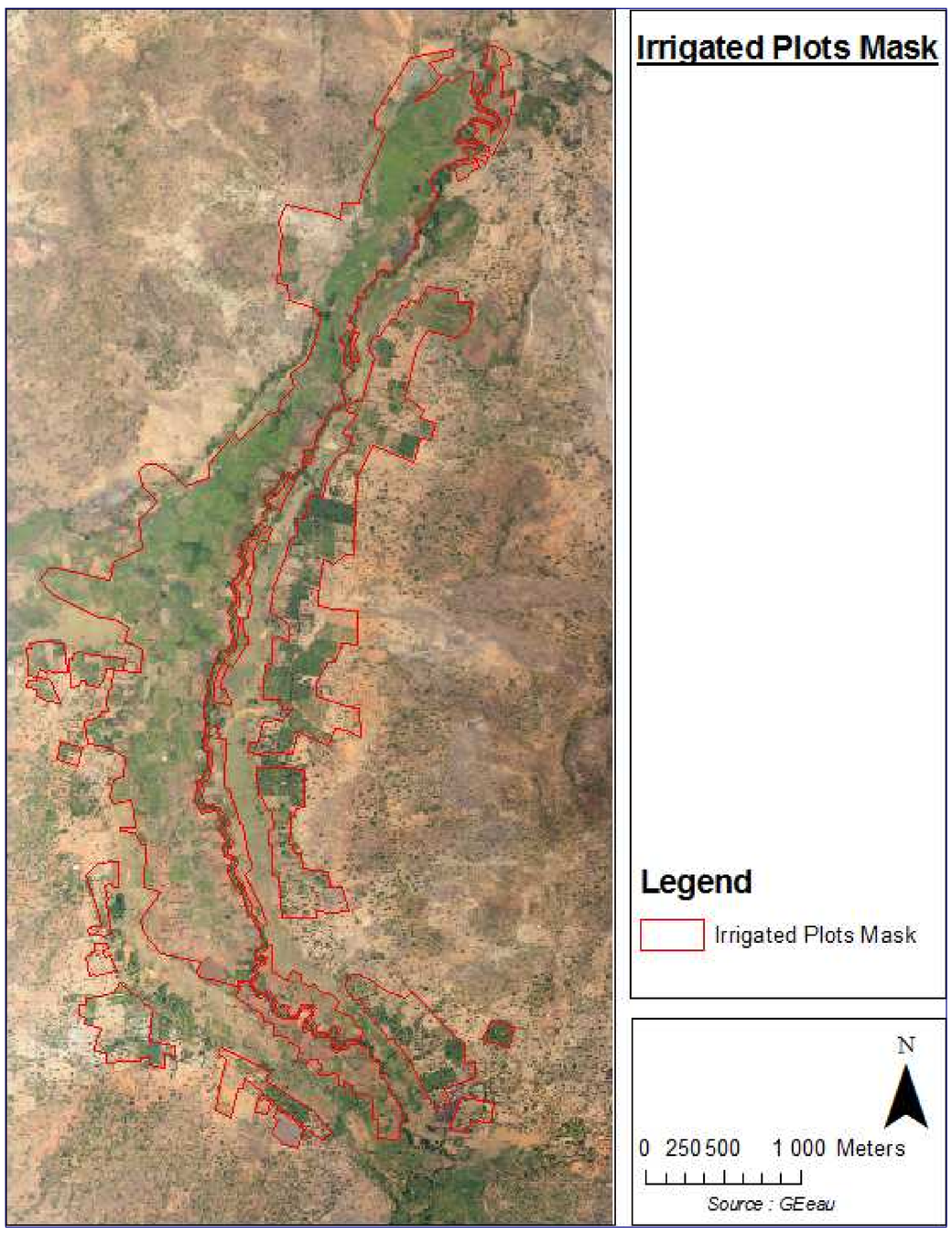

Fig. 3. Irrigated Plots Mask

Context & Objectives

The Kou watershed is characterized by important water resources used for drinking water supply of Bobo-Dioulasso city and surrounding localities, for agriculture needs through very important irrigated areas, for industry, and for aquatic fauna and flora preservation. Since some decades, one observes more and more increased pressure on Kou water resources. Regarding the big water needs for irrigated agriculture, a comparative visual observation of satellite imagery of the irrigated surfaces during the years 1980 and during years 2000 shows an evident increase.
This fact would have a priori a significant impact on the state of the Kou watershed's water resources.
The global objective of this study is then to search a correlation between irrigated surfaces and water resources, in order to establish a potential of irrigation for the available water resources in order to estimate maximal irrigable surfaces. In this scope, an hydrometric network was already installed in our region of interest, and historical data exist. These hydrometric data will be coupled with irrigated surfaces estimation.
The specific objective of this study is the evaluation of the Kou watershed irrigated areas, with the help of remote sensing.

Methodology & Materials

The methodology chosen is based on images supervised classification in order to extract irrigated zones surface.
Because of the images various origins, we first conducted an images pretreatment that essentially consisted in image reflectance calibration. This operation appears to be indispensable when working with images coming from different sensors.
Next classification methods were applied : a maximum likelihood classification, followed by a decision tree classification were applied to images for which vegetation index (NDVI) was priorly calculated. The later classification method has been introduced in order to permit a better discrimination between natural vegetation and crops which often react in similar spectral ranges. This method is based on threshold detection of vegetation classes. In order to generate the detection thresholds of crop classes, a statistical analysis of Regions of Interest (ROI's) pixels distribution was carried out.
We had for this study a set of images and various data: Landsat-4 TM, Landsat-5 TM, Landsat-7 ETM+, SPOT 5, aerial views, agro meteorological data, cartographic data (GIS), data investigation reports, etc.
The statistical analyses were carried out with Statsoft Statistica; the image processing, with ITT ENVI; and the spatial information management, with ESRI ArcGIS.

Results

The classification methods used allowed to estimate irrigated surfaces, without having, however, any detailed information. In fact, with 30 m spatial resolution images (Landsat) covering a survey zone with "reduced" to "mean" agricultural lands size, it is often difficult to discern natural vegetation pixels from crop pixels. So, we had to consider mixed classes of pixels that strongly skewed our final results.
The overall accuracy of our classifications is between 70% and 90%, with Kappa coefficients between 0.4 and 0.85 what is called as "tolerable" and "good".
However, our remote sensing evaluations are of the same precision level as obtained by the means of hydro agricultural inventories led on the same zone. The committed mistakes remain in an interval of +/-20%.

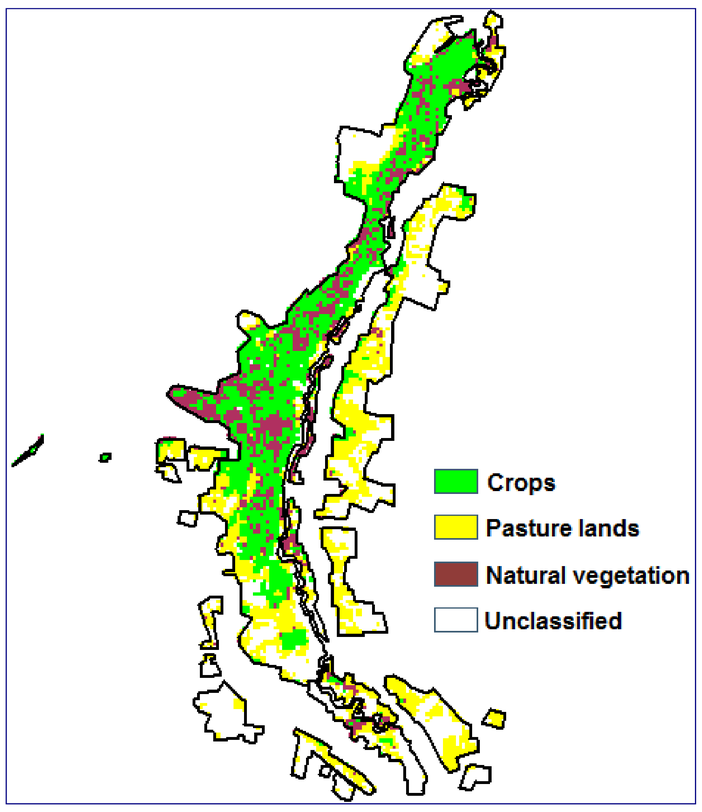

Fig. 4. May 5, 1988 Landsat-5 TM image classification

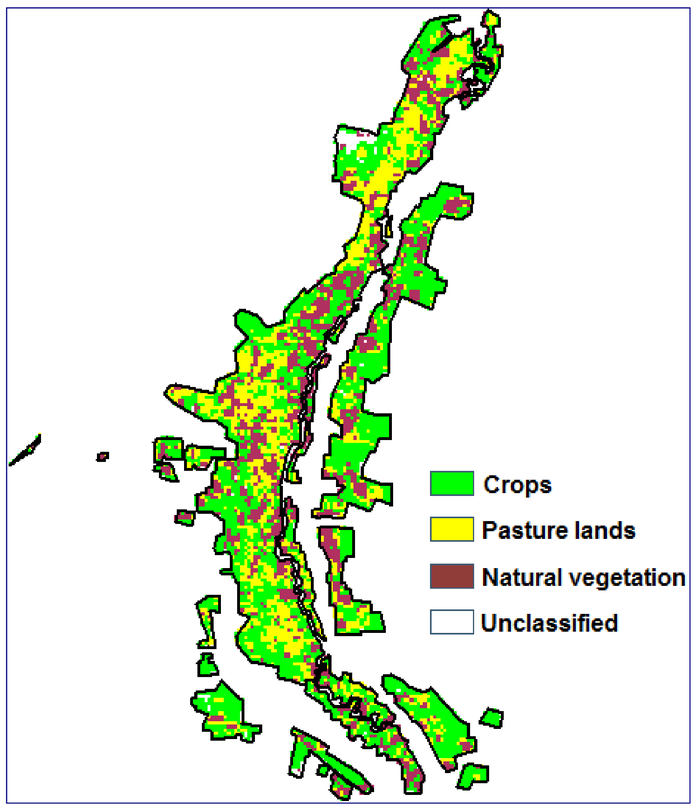

Fig. 5. Jan. 10, 2007 Landsat-5 TM image classification

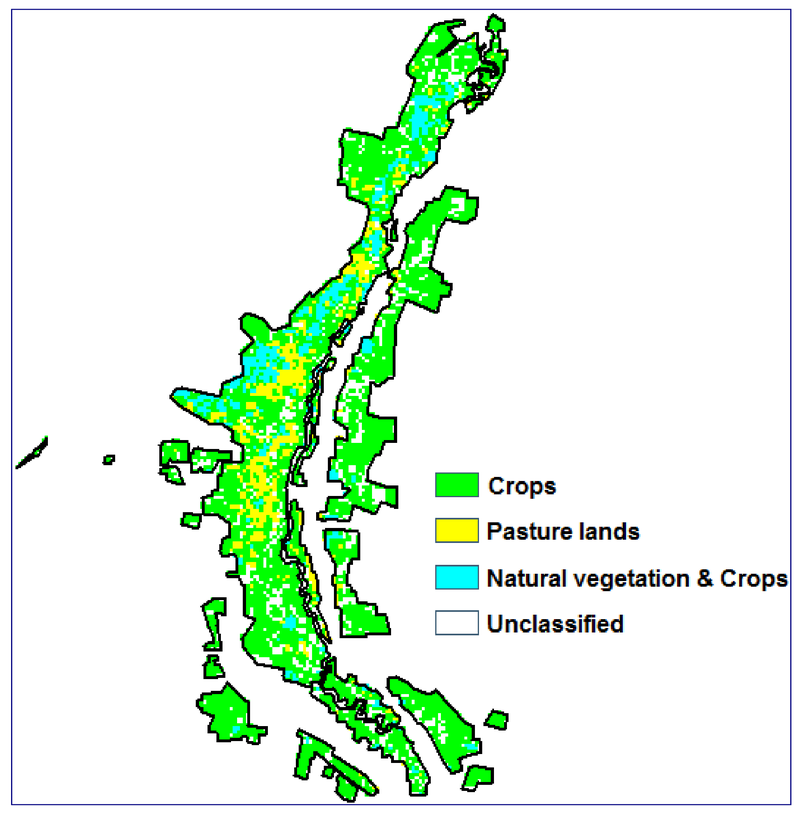

Fig. 6. May 18, 2007 Landsat-5 TM image classification

Perspectives

This study could be improved by the means of: satellite images with high-resolution on which the small-scale irrigated plots are more visible, which would allow a better recognition of the "pure" pixels of vegetation or crops; application of "unmixing" techniques in case of using medium spatial resolution products, which could make it possible to go further in the re-classification of "mixed" classes (crops and natural vegetation, combined).
Finally, the combination of irrigated areas estimation over the 3 preceding decades with available hydrometric data should permit, in case of a good correlation, to establish the Kou's potential of irrigation in our region of interest, this in order to limit expansion of irrigated areas.