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1. Introduction

For Tucumán province in Argentina, citrus crops have great economic and social importance. Tucumán is the biggest producer of lemon in the world, with around 40,000 ha of citrus farms.

In addition, Tucumán province supplies potatoes for more than 50 percent of national consumption. Due to the importance of these crops for the province, it was fundamental to have precise information of the planted area, in little time and with low cost. Remote sensing (RS) technology allowed to obtain information about agricultural data. Due to multispectral characteristic of the technology, there were less human errors and costs as well.

Estación Experimental Agroindustrial "Obispo Colombres"(EEAOC) is an autarchic institution of the Tucumán province government. It was set up to provide solutions to the different problems existing in both agricultural and livestock provincial activities and their associated industries by means of research and technology development.

Since 1997, Tucumán Province has been using digital information from Landsat TM and ETM+ satellite imagery and generating a very important database for the regional economy.

During this period, problems arose with citrus crops' classification, fundamentally associated with the spatial resolution of Landsat images. To solve these problems, auxiliary information was used using air pictures and CBERS IIb HRC images (Brazilian satellite).

Spatial resolution is very important in image interpretation because it intervenes at the detailed level. It is directly related with the work scale and the reliability obtained in the interpretation. In terms of spectral resolution, a sensor will be as much suitable as the number of bands.Radiometric resolution indicates the sensor capacity to detect variations in the energy received. It is identified with the value range that the sensor codes. The bigger the radiometric resolution, the better will be the image interpretation.

The launch of WorldView-2 satellite provided a new perspective to estimate crops planted areas. WorldView-2, with 8-band multispectral commercial imagery, provided more spatial, spectral and radiometric resolution in comparison to other satellites. This satellite is equipped with the Red Edge and Yellow bands that are specifically designed to detect key vegetative phenomena. The Red Edge band marks the transition between where plant pigments absorb visible light and reflect infrared light. Its position varies and shifts according to changes in plants' health, age and growth rate. Similarly, the Yellow band can detect changes in the amount of chlorophyll in leaves.

2. Objetive

The main objective of this project was to evaluate the WorldView-2 data capabilities to identify citrus (Citrus sp) and potato (Solanum tuberosum) crops in Tucumán province, taking advantage of high spatial resolution and the wide spectral range of WorldView-2 data.

3. Hypothesis

The high spectral and spatial resolution of RED, RED EDGE, NIR1 y NIR2 bands of WorldView-2, would allow the identification of Citrus (Citrus sp) and Potato (Solanum tuberosum) crops.

4. Materials and Methods

4.1 Study area and received images

In August 2010, the proposal for 8-Band Challenge was sent, requesting images of the study area, located in the West of the Chicligasta department of the Tucumán province, Argentina. (Figure 1).

Figure 1: Study area

The central point had the following coordinates: Lat.S -27º 20´ 14.92´´ / Lon.W -65º 43´ 03.82´´. The date of the received images was April 28, when potato crops were not sowed. For this reason, other images, acquired on October 18, were provided which proved useful for the study.

4.2. Growth cicle of the study crops

4.2.1. Citrus crop

The topography of the citrus area determined plantations systematised in curved of level mainly, separated at a distance from 7 to 10 m, with a distance among plants of 2.5 to 6 m. Between the third and fourth quarter of the year, the plants became more uniform, with height ranging from 2.20m to 3.00m and the average diameter between 1.5 m and 2 m.

Starting from the fourth quarter of the year, the morphology aspect of plants determined the agronomic handling. Pruning, fertilization; the irrigation, density of plants per hectare and the weeds control influenced the spectral reply.

Figure 2 shows the crop morphological aspects in their different growth stages: A: small citrus (1.5m x 0.80m), B: medium citrus (2.5m x 2.00m), C and D: fence citrus (3.5m x 3.5m)

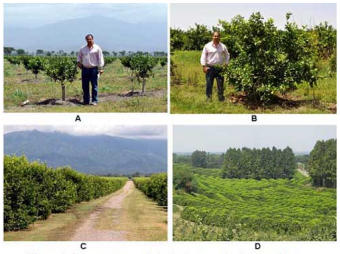


Figure 2 Citrus crop morphological aspects in the growth stages

4.2.2. Potato crop

Potato crops are sowed during May to July and harvested during September to October. Potato sowing distance is 0.80 m among rows. In Tucumán province, farming area of potato crop is on ridge due to the use of irrigation system.

Potato crop stages are schematised in the Figure 3: A: sowed tuber seed, B: vegetative growth, C: Begin of the tubers production, and D: Tubers growth

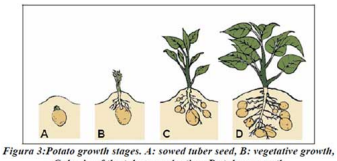


Figura 3:Potato growth stages. A: sowed tuber seed, B: vegetative growth, C: begin of the tubers production, D: tubers growth

Figure 4 shows the tubers growth stage on the field.

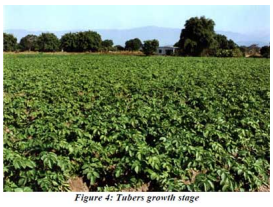


Figure 4: Tubers growth stage

4.3. Images processing

4.3.1. Images reprojecting. All the received images were reprojected to the República Argentina official system: POSGAR, to facilitate their comparison with other local geographical data.

4.3.2. Images selection. Image 10OCT18144957-M3DS_R1C2-052427178010_01_P001 were selected for citrus crops and 10OCT18144957-M3DS_R3C3-052427178010_01_P001 for potato crops. In the case of potato crops the R3C3 image was selected due to the predominance of crop fields in a tubers growth stage, because they were sowed in late date for the Tucumán province crop sowing schedule.

Regarding citrus crops the R1C2 image had the advantage of presenting plantations of different sizes, ages and crop handlings.

4.3.3. Inspection on the land of the conditions crops. To carry out the selection of the training fields interviews to farmers and visits to selected farms were made.

4.3.4. Image statistician description. Central trend measurements and dispersion were calculated, to know the general trend of the reflectance detected in each band and the pixels homogeneity level.

4.3.5 Construction of the spectral profiles. For each coverings present in the images the spectral profiles were elaborated in order to evaluate the spectral separation of the defaulted thematic classes. In the Figure 5 the spectral profiles are observed:

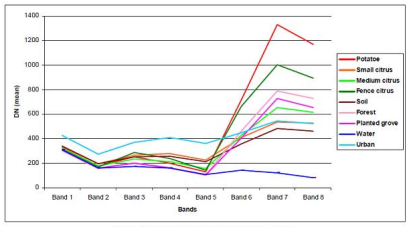


Figure 5: Spectral profile of the images classes .

4.3.6. Images generation with the selected bands. Based on the spectral profile analysis the bands RED (5), RED EDGE (6) and NIR1 (7) were selected due to these bands presented the biggest separation among the ND (Digital Number) of each class. Although the NIR2 (8) band presents values that allow differentiate the classes, these differences they are more accentuated in the band 7.

4.3.7. Images mask. On the natural forest and urban areas were put on a mask to avoid the "noise" that produce in the classification the spectral signatures heterogeneity. Existing thematic maps were used to make the mask.

4.3.8. Spectral signatures extraction. The extraction spectral signatures was carried out on the training field, several fields of same category were selected in order to reflect the variability in each one of the classes.

4.3.9. Supervised multiespectral classification. Selected the signatures groups the supervised multiespectral classification was carried out, checking interactively the ownership to each assigned class. The redundant signatures and those that caused conflicts with other classes were discarded. The selected rules of decision were:

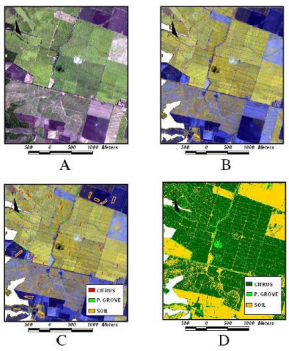
- Non-parametric rule: Parallelepiped
- Overlap rule: Classify by order
- Unclassified rule: Parametric rule
- Parametric rule: Maximum Likelihood

4.3.10. Classification evaluation: The classification evaluation was carried out using Accuracy Assessment module of ERDAS. 100 points were generated aleatorily on the origin image and was proven the agreement between the truth-land and the resulting map. The work reliability, such general as for category, was obtained by means of the elaboration of confusion matrix and evaluation parameters by class and general.

5. Results

5.1. Citrus crop

Classification stages of the citrus crops are shown in the Figure 6: 6A make reference to the reprojection stage and the images selection, images are shown in composition RGB: 4-3-2; in 6B the masked image is shown, in composition RGB: 7-6-5 that correspond to the bands select for the analysis; in 6C the localisation of the spectral signatures appears; in 6D the images classification is presented.



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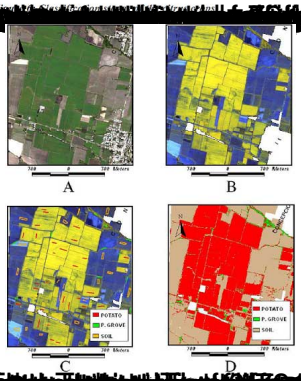

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