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E11- AGRICULTURAL STATISTICS AND SPACE
IMAGES IN MADAGASCAR
ESTIMATION OF SECOND RICE SEASON
ACREAGE IN A SUB-PREFECTURE

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ABSTRACT

Like many developing countries, Madagascar hardly manages to get a precise and quantized notion about its economical realities. Space images are then of great interest, particularly for acreages estimation of crops in agricultural statistics.

But their use in an operational way can't be done without some problems, mainly those about costs. In fact, if agricultural statistics are done every year, it is impossible for a developping country to buy all the images covering an area (money), to exploit all of them (need of great computers...), and to have results in due time.

So must be found a way of reducing these three kinds of costs. It means that the appropriate method must be able to supply results on some area, even if it is not covered by all the images used.

Our approach tends to this, and comprises the following steps :

- selection of a representative image:all the phenomena existing in the area studied (it can be for instance a province) must be on the image

- selection of a date, where most of the crops of a year are present

- stratification of the studied area

- construction of parameters for patterns (crops) recognition (actually we work on rice)

- estimation of crops acreage in some area

Selection of a representative image

The purpose is that all the phenomena, related to agriculture, existing in the studied area, must be present on the image. The area is composed of 17 types agro-ecologic. So the image (or images) to be used must have all (or at least most) of these 17 types.

Each image is characterized by all the types agro-ecologic present on it, and then the one having all (or the most) of the types agro-ecologic is selected. If an image is not sufficient, a set can be selected.

Selection of a date

The purpose is to find intervals of time, in which the selected image can supply a maximym of results about crops. So the searched intervals must be in such a way that :

- the image has most of the crops, cultivated during an agricultural year
- these crops are in different states, for maximum discrimination.

So each month of the year is decribed by all the crops of the region, and their states in them. A matrix in presence/absence (0/1) is obtained : if in a montha crop is present (absent) in a particular state, then it is coded 1 (0).

Using a hierarchical clustering method on this matrix, we obtain classes of monthes.

Each class is characterized by crops and states of crops. So it is easy to select, under the conditions of our approach, a class having the more crops and the more states of crops, in which an image will be look for (see table 1).

Stratification

Remembering that we must reduce the costs of exploitation and time, before classification and stratification, a reduction of the number of the pixels and the variables must be done.

Reducing the number of pixels is carried out in two steps. First by reducing the image itself, and second by sampling pixels in a systematic way.

Considering the image, it can be noticed that there are redundancies on it, in terms of agro-ecological types. So it can be reduced in such a way that will stay, only the strict minimum required for classification. To do this the area of the image has been divided in 108 quadrats, characterized by extension of the agro-ecological types. On the basis of this variable, 28 quadrats have been sampled, to construct the reduced image.

After, at each time, classification needs to be done, pixels are sampled systematically.

For classification and stratification, the number of variables has been reduced by using a canonical discriminant analysis approach.

First the pixels has been classified in two, by a non hierarchical clustering method, related to nearest centroid classification. These two classes being the most different in the data, a projection of the value of all the pixels of the image, on a factorial axis given by a canonical discriminant analysis on them, will organize the values between these two extremes. These two extremes being, in an hand the most absorbing, and in other hand the most reflecting. So by doing classification, and stratification on this factorial discriminant axis, we get classes organized from absorption to reflection, the classes being related to states actually existing on the ground, (flooded area will be in absorbing class, and green vegetation (chloropyll) will be in reflecting class). On this unique variable, discrimination between strata is simply done by founding their limits.

Construction of parameters for rice recognition

Using two dates, rice recognition is not very difficult. In effect, on the first date of april, the paddy fields are flooded. So by classification, they will in the same class as water. Selecting a second date where they are green (chlorophyll) it is then easy to separate them from the water.

It is what we' ve done.

After classification on the first date, a mask is realized to isolate what is damp on the second date. Next classification is done only on these areas on the second date, to separate rice from water. Nearest centroids methods have been used for the classifications.

Estimation of rice acreage in a sub-prefecture

With the parameters of rice extraction, it is easy to count in the strata 2 and 3 (concerned with rice) the number of pixels classified in rice.

Then if R is this number, and N the total number of pixels in the two strata the proportion of rice per pixel is $r = \frac{R}{N}$

So if for some sub-prefecture we have the number P of pixels for the two strata, we can have the number of pixels in rice by the formula : $P * r$.

Determination of P

On the 28 quadrats making up the reduced image, we have for each of them, the extension of each type agro-ecologic, and the extension of each stratum.So relations (multiple linear regressions) can be constructed between extension of type agro-ecologic and stratum.

So as extension of types agro-ecologic does exist, knowing them, permit us to calculate the extension of each stratum.

The relations are such of :

$$P = \sum_{m=1}^{L} U_m * B_m + B_0$$

where P : extension of the stratum
U_m : extension of the type agro-ecologic m
B_m and B_0 : estimated coefficients

Conclusion

The result obtained on the Marovoay sub-prefecture, overestimation of 4%, is such that we think, that by the increase of resolution (SPOT, Thematic Mapper) the capabilities offered by remote sensing can be exploited , in an operational way, for agricultural statistics in the developping countries.

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