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Multi-temporal Landsat for land unit mapping on project scale of the Sudd-floodplain, Southern Sudan

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ABSTRACT: The Sudd floodplain is extremely flat, covered mainly by grasslands, only locally interrupted by clusters of fields and seasonlly flooded by rain and/or river water. Since photo-interpretation is based on relief, vegetation structure and field pattern, such technique is not satisfying for the Sudd floodplain. Moreover, the most important environmental component - the flooding - can be assessed only on sequential series of photographs.

Studies of the Sudd-floodplain on regional scale have been carried out as environmental impact study for the Yonglei Canal project. However, such information proved of limited value on project scale. For the latter a combination of Landsat, aerial photography and field survey has been tried and proofed successful. The methodology, results and limitations are outlined for application in similar floodplain areas as there are the Llanos in Southern America, Zambesi floodplain, Kafue flats and the Okavango swamps in Africa.

Material

The available remote sensing material for the area was at the time of the survey (1983):
- Black and white panchromatic aerial photography scale 1:40 000 from december 1980.
- Computer Computable Tapes (CCT) of four sequential Landsat MSS Scene 186/055
  02/05/79
  11/10/79
  31/12/79
  18/01/80

Of these the first two and the last are used for multitemporal imagery. This sequential Landsat series is the first and the last set available for this area between 1972 and today with such short intervals.

95 relevés following standard ITC procedures (Gils et.al. 1984) were available as field reference materials.

Methods

Photo-interpretation followed the landscape-guided method (Gils et.al. 1984).

Pre-processing of Landsat CCT's started with radiometric corrections (sun angle, haze) and producing square pixels using standard IPL - ITC methods (Mulder 1982). The geographical correction could not be carried out by routine procedures due to lack of topographical orientation points in the survey area. Therefore the three Landsat images have been superimposed visually. The normalised vegetation index $\frac{IR-R}{IR+R}$ is calculated for each of the three sequential scenes.

Each of the three temperorally different vegetation indices has been coded by a colour. The vegetation index values have been scaled from zero to hundred. The highest to the lowest vegetation index in January has been assigned a corresponding hue in red. Similarly the vegetation indices in May are coded in green and those of the October image in blue. The three seasons superimposed produce a coloured map on approximate scale 1:250 000. For details and back ground see Mulder (1982).

The scene of October 1979 has been subjected - after standard correction (compare under sequential imagery) - to a supervised classification (SC) with the help of the field data. 141 Pixels were located on the scene were the land units were known. The Red (x-axis) and Infrared (y-axis) radiation intensities of the 141 samples were plotted in a feature space. The 141 were classified first into their land unit. A cluster analysis was performed and regions were delineated. Each delineated region in the feature space was colour coded. Thereafter all the pixels were given a colour according their place in the classified feature space.

The land units are named in the legend according to their vegetation, since this is their main characteristic to be observed both on the image and on the ground, due to the flatness of the area and scarcety of crops and artifacts.

Result and discussion

The supervised classification of the Landsat image resulted in 8 main legend units implying also 8 main vegetation legend units. The legend units are represented in the legend of figure 1. The land units might be compared with those obtained with other image processing techniques of Landsat data as there are the false colour composite used by the Mefit-Babtie (1983) survey and the multitemporal image of the present paper.

The standard Landsat image plus aerial photography interpretation by the Mefit-Babtie (1983) team resulted for the same area covered by the present paper in five vegetation legend units. There is more differentation in the Toich area with the supervised classification of the Landsat data as compared with the map based on standard Landsat products. However, the lower resolution of the standard might be an artifact, because the map from which this conclusion derives is on a scale 1:500 000 and the variety within the Toich could possibly not be mapped on this scale, but is cartographically representable on the 250 000 scale of the supervised classification.

The field sampling - on which the supervised classification was based - was designed in the hypothesis of an east-west catena of land (including vegetation) units. This catena is well expressed both in the image (fig.1 and fig.2) and the Mefit-Babtie map (1983). However, the images (fig.1 and fig.2) show a north-south catena in the toich form high (dry) to low (wet) sofar not noticed. This north-south catena within the Toich still has to be confirmed by field observations.

The multitemporal image (fig.2) has basically the same land unit pattern as compared with the supervised classification. The multitemporal image (fig.2) shows some additional differentiation within the toich. Within the high Toich two subunits show up. The high Toich closest to the settlements show a dense vegetation cover in late wet season only whereas the part further away has also some cover in mid wet season. Some parts of the Toich near the swamp and parts of the swamps (on the supervised image) appear to have their own seasonality and correspond with the marshy toich Typha-Leersia vegetation type of Yath (1984).

The supervised classification is practically a map, it needs only a legend to be so. The multitemporal image, however, shows not such clear boundaries and requires some interpretation if a map is required.

Evaluating we may say now that the multitemporal image is superior to both the supervised classification and the false colour composite. The multitemporal image might give a good land unit map on a scale 1:250 000. In this type of flat, fluctuating and flooding environment, it is also superior to black and white aerial photography. However, on project scale where a land unit map of 50 000 - 100 000 is required, only aerial photography combined with Landsat can give satisfactory results.

A main limitation to produce multitemporal imagery is the availability of scenes of suitable season within one year. In fact the used imagery set of three dates in the only suitable one between 1972 and today. For other parts of the Sudan and elsewhere no such series might be found.

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