Preliminary Results of Processing Terrain and Remote Sensing Data of the Zablou Area (Burkina Faso)

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Abstract

Interpretation products of aerial photographs and satellite imagery were used in IDRISI together with information on terrain data in a dBase file to evaluate information obtained during a first field reconnaissance. GIS enabled to study a complex soil attribute and multispectral satellite data in relation to physiographic soil boundaries. Consequent aerial photo-interpretation and digitizing on screen produces imagery with indication of areas to be checked in a final fieldwork.

Résumé

Les résultats de l'interprétation des photos aériennes et des images satellitaires ont été utilisés dans IDRISI conjointement avec un fichier dBase contenant les données du terrain pour évaluer l'information obtenue lors de la première reconnaissance du terrain. Le SIG permet d'étudier l'ensemble des caractéristiques du sol ainsi que les données multispectrales du satellite en relation avec les limites physiographiques du sol. Par la suite, l'interprétation des photos aériennes et la digitalisation des images sur écran, reproduit des nouvelles images avec l'indication des régions qui doivent être examinées durant la recherche finale sur le terrain.

1. Introduction

The Zablou area is located north-west of Kaya along the road from Kaya to Lac Dem (Fig. 1). The area served as a test area for application of techniques to produce maps from results of airphoto-interpretation, satellite data and terrain data.

Three programs were used (CASTERAD, 1992) :
- GEO-PAKKET to digitize maps of airphoto-interpretation,
- ERDAS 7.4 to process satellite data,
- IDRISI 4.01 to combine data of remote sensing, airphoto-interpretation and terrain.

At the start of the research, the following data were available:
- remote sensing imagery,
- a first interpretation of landscape, physiography and soils,
- a terrain database as result of a first fieldwork.

The research aims to answer the question: "Do GIS and remote sensing techniques help in evaluating interpretations on physiography and soils after a first field reconnaissance ?"

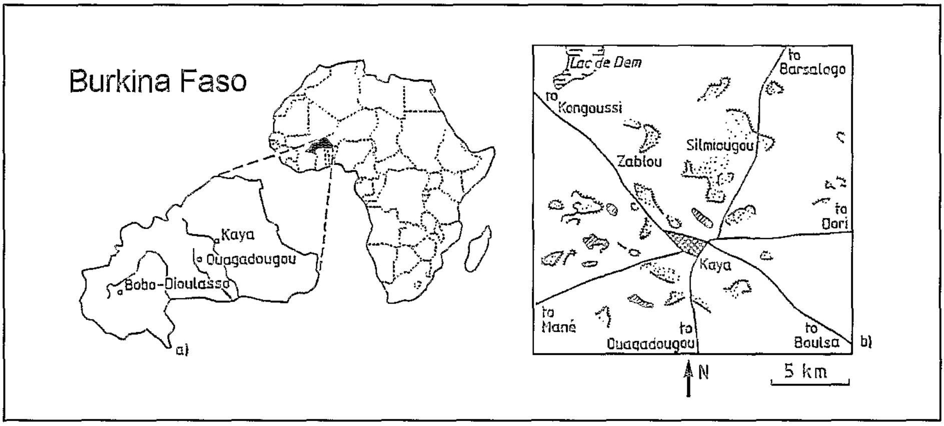

Figure 1. Location of the Zablou study area.

2. Results of first field reconnaissance

The landscape of the Zablou study area was subdivided into four units :
- A: high steeply dissected land with ironcaps;
- B: moderately high plateauland with ironcaps;
- C: land with elongated hills as dominant features;
- D: valley bottom land.

The landscape units were subdivided into physiographic components according to position and slope. Coding of the units and their components according to their relative elevation from high too low, enabled orthographic display by the ORTHO programme in IDRISI (EASTMAN, 1992). Plate 3a presents a view towards the north-east.

A terrain database was developed in dBase IV, showing columns per row, or observation number, with data on:

- x and y coordinates;
- physiography a.o. slope %;
- soil code indicating, respectively soil depth, surface stoniness, soil texture and profile development;
- surface stoniness (%), crusted surface (%), gravel at surface (%);
- soil texture and coarse fragments with 20 cm interval;
- matrix colour with 20 cm interval; if colour is registered according hue, value and chroma in separate columns, calculations are possible;
- 1st and 2nd dominant colour of mottles;
- type and depth of blockage in cm;
- % of area with sheet and rill erosion;
- % of coverage by trees, shrubs, grass and herbs;
- % of coverage by agricultural fields;
- % of coverage by millet, sorghum or by other crops;
- % of coverage by bare soil;
- % of coverage by rock outcrops (+ type);
- height (cm) and % of coverage by dunes;
- length of stone dikes m/3600 m^2.

3. Results of processing after the first fieldwork

Digitizing the information represented on aerial photographs was done according to GEO-PAKKET, software developed by the Dept. of Landsurveying and Remote Sensing and the Centre for Geographic Information processing (Wageningen Agricultural University) to correct for radial distortion on aerial photographs in digitizing.

Since there were no other topographic data available than those at scale 1:200,000, a Landsat TM (Thematic Mapper) image (acquisition 8th January 1991), corrected by GPS data, was used as base map (reference map). For registration, identical points had to be identified on the TM image and the aerial photograph. This was done in the ERDAS programme (ERDAS, 1991).

Resulting digitized maps were those on physiography and observation points.

Part of the map on physiography (with 14 units) is shown in plate 3b. The units reproduced in plate 3b are the following:

- *chs* or remnants of high ironcaps (5);
- *che* or eroded high ironcaps (3 + 13);

- *cpr* or steep slopes of high ironcaps (12);
- *l* or elongated hills with steep slopes (2);
- *n* or relatively low hills (14);
- *bpw* or footslopes with colluvial material (4);
- *bpv* or footslopes with fluviatile deposits derived from aeolic and colluvial materials (10);
- *pfd* or faintly sloping area with weak erosion (8);
- *p'fg* or faintly sloping and sloping areas with moderate erosion (1);
- *pfd* or faintly sloping areas with moderate erosion (11);
- eroded low ironcaps (6);
- *cbs* or remnants of low ironcaps (9);
- *ak* or valley bottoms (7).

ERDAS was used to produce different TM images for interpretation. After translation of ERDAS format into IDRISI format, IDRISI enables easy coverage of remote sensing and GIS imagery, that is by simple key operation. An example (colour print) is given in plate 4.

4. Image interpretation

The time of acquisition of TM data was at the start of the dry season. Valley bottoms contained at that time green vegetation at many places, as witnessed by reddish tones (Plate 4).

The footslopes at the foot of the ironcaps in the northern part of the area are pictured on this figure in white tones, being sandy soil surfaces with scarce vegetation.

The ironcapped plateaux are represented in dark tones, having low reflection in all bands of the combination. There is no difference in tone between the elongated hills of landscape C and the ironcaps of landscape B. These units, however, could be discriminated by a combination of the first three principal components (PC 1-2-3) of the same TM acquisition. For general principles on satellite image interpretation, the reader is referred to MULDERS (1987).

Possibilities of interpretation are highly influenced by image production. In this research, the Canon laser printer CLC 300 was compared with the Tektronix 4693dDX. The latter has a dotty character and enables direct printing of ERDAS imagery with reasonable detail in dark tone areas like ironcaps. The former is able to produce high quality imagery if properly treated in ARC/INFO.

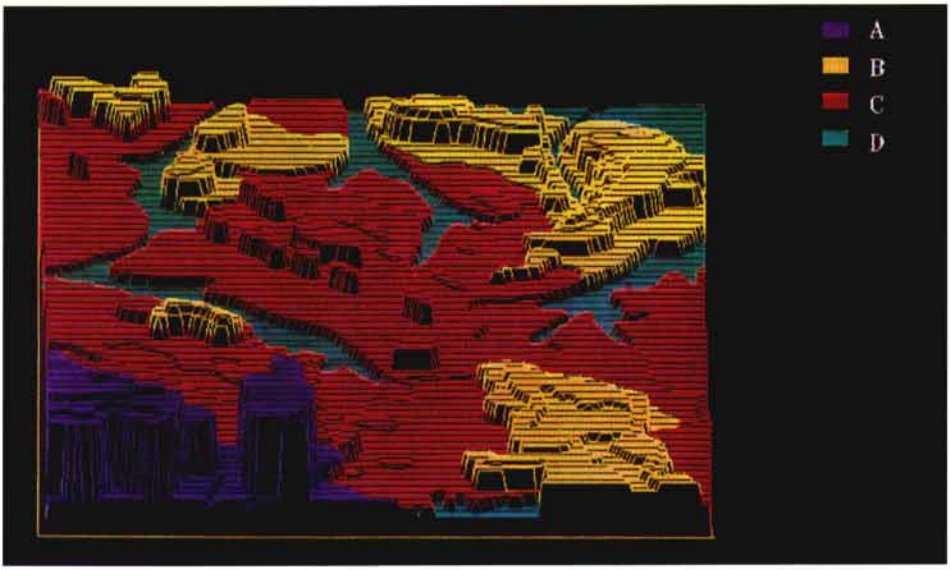

Plate 3a. Ortho-view towards the north-east of the Zablou area in Burkina Faso (p. 197).

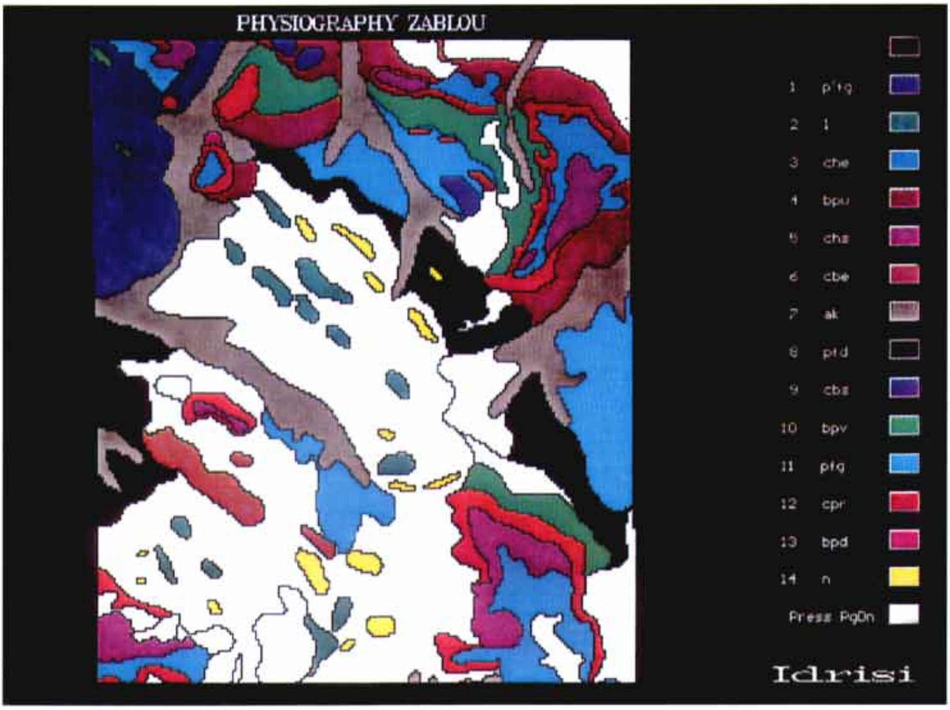

Plate 3b. Physiographic map, showing 14 units of the Zablou area, Burkina Faso (p. 197).

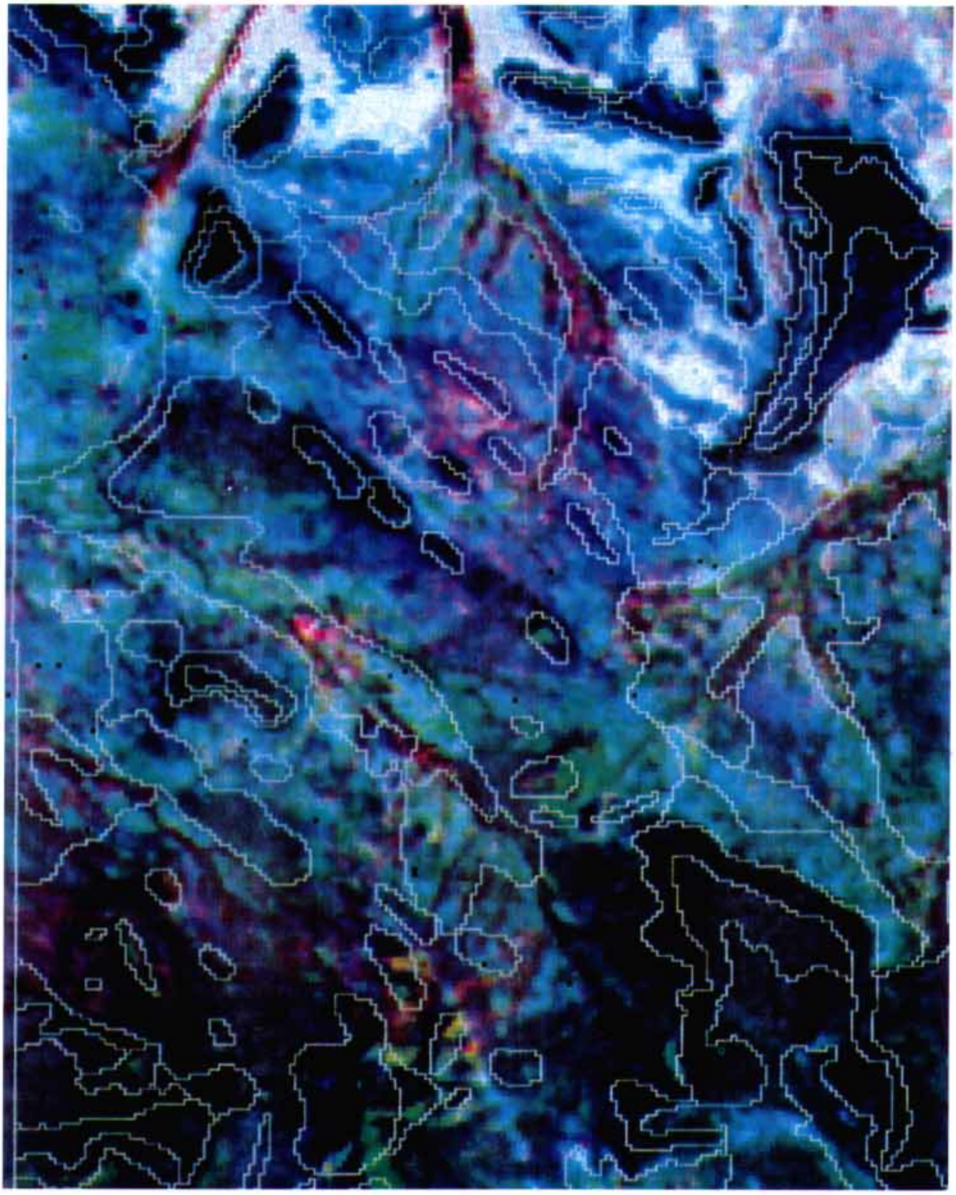

Plate 4. Landsat TM 4-5-3 image of 8 January 1991 overlain by a map on physiography, Zablou area, Burkina Faso (p. 198).

5. Combination of terrain data with remote sensing and GIS data

IDRISI 4.01 enables to combine one attribute per observation point with identifiers (x and y coordinates). For creating a highly informative complex attribute, the soil depth and soil texture columns were checked for the following:

Code:	Check for:
1	Blockage <= 30 cm;
2	Horizons with clayey texture in profiles deeper than 60 cm;
3	Loam, loamy sand, sandy loam or clay loam in 0-40 cm or 0-60 cm.

The result for a small part of the image of plate 4 is given in Fig. 2.

In IDRISI, the data of figure 2 were superimposed on the TM 453 image (Plate 4) enabling the checking of boundaries by the complex soil attribute and by the multispectral information of the TM image. The latter provides for a means to control boundaries if relationships with terrain properties are understood.

For example, a dark tone on the hill units may be related to the exposure of bare rock. Checking the TM image with physiographic boundaries proves that the same multispectral signature is present on part of the footslope area. Interpretation of aerial photographs demonstrates bare rock to be likely in those parts. It was missed in interpretation because physiography was based on analysis of site (position in toposequence) and slope. Apparently, the footslope has to be divided in more than one unit as it first became apparent by multispectral analysis.

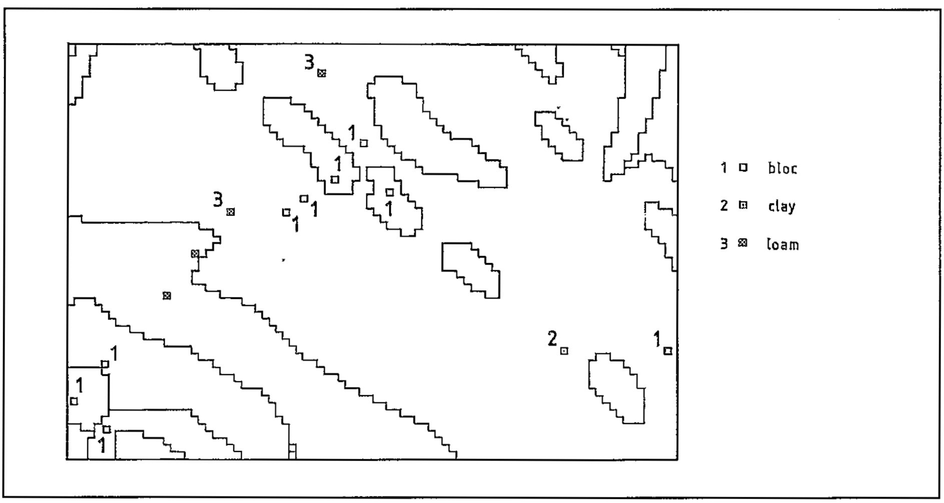

Figure 2. Observation points with code of complex attribute projected on physiography.

Another possible application of multispectral capability for this purpose is found in the magenta-red colours of plate 4. These colours indicate relatively abundant vegetation cover, which often point towards relatively deep soils. However, exceptions exist on this rule since protection measures may be the underlying cause of abundance of vegetation.

A plan for field check in the second fieldwork phase can be made as based on this and other evidence of comparison between multispectral data and interpretation of aerial photographs. An image can be made in IDRISI showing a remote sensing image at background, covered by physiographic soil boundaries and showing the areas to be checked during the second fieldwork in different colours.

Conclusions

The combination of terrain data with remote sensing data in GIS is promising to direct field observations in the second phase of fieldwork to those places, where observations are most likely to be effective for improving accuracy and for raising the informative value.

Five phases can be recognized in the approach to soil mapping using modern techniques besides the conventional ones, these being:

- pre-fieldwork with processing satellite data and interpretation of aerial photographs;
- first fieldwork with terrain observations guided by the interpretation products and production of a terrain database;
- digitizing of the interpretation maps and GIS for control of boundaries between mapping units with the aid of the information contained in the terrain database to construct a plan for fieldcheck in the final fieldwork phase;
- final fieldwork to complete terrain observations and database;
- final digital data processing and interpretation.

It is worthwhile to pay much effort into understanding the relationships between remote sensing data and actual terrain conditions in key areas with the purpose to speed up mapping of adjacent areas.

References

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