Kitephotography as a Tool for Land Surface Observation in the White Volta Region

Fujio NAGUMO[1], Lamourdia THIOMBIANO[2]

1. Graduate School of Environmental Earth Science, Hokkaido University, Japan.
2. Institut d'Etudes et de Recherches Agricoles (INERA), Burkina Faso.

Abstract

Among various methods for land surface observation, differing in observation size and scale, aerial photographs taken from low altitude are effective to obtain more detailed information on the land surface at a large scale. Kitephotography is one of techniques to obtain large scale imagery. It has the following advantages:

- It costs less than other techniques such as photography by a remote-controlled airplane,
- Kite is easy to make, to handle, to repair, and to transport. Although its practice depends on:
  - wind condition (wind speed and its stability) and,
  - space condition (wide enough to extend string of the kite), it has a lot of potentiality as a tool for land surface observation, if the condition of the study area and object allows to use it.

The study shows an example of its application: the land degradation research along the White Volta river in Burkina Faso. Based on the kitephotographs and the on-site research, the extension of bare ground and of other land surface features were mapped. Their distribution was compared with the toposequences of soils along a transect from the riverine plain to the valley-side slope.

Résumé

Parmi les diverses méthodes d'observation de la surface du terrain, qui diffèrent selon leur étendue et leur échelle, les photographies aériennes prises à basse altitude sont utiles pour obtenir une information plus détaillée à une échelle large. La photographie aérienne par cerf-volant est une de ces techniques.

Cette méthode a deux avantages :

- Elle coûte moins chère que les autres méthodes comme la photographie par avion télécommandé.

- Le cerf-volant est facile à fabriquer, à manier, à réparer, et à transporter. Bien que son application dépende des conditions de vent (vitesse et stabilité), et de la condition spatiale (grand espace pour allonger le cordon des cerfs-volants), elle a une potentialité importante pour l'observation de la surface du terrain, si les conditions du site et de l'objet d'étude permettent de l'utiliser.

Cette étude montre un exemple de l'application de cette méthode : la recherche sur la dégradation du terrain au long de la rivière Volta Blanche au Burkina Faso. En se basant sur des photographies aériennes par cerf-volant et la recherche sur le terrain, l'extension des sols nus et des autres états de surface ont été tracés et cartographiés. Leur distribution a été comparée à la toposéquence des sols le long d'une ligne mesurée de la plaine alluviale au versant de la vallée.

Introduction

Since aerial photographs from low altitude at a large scale offer detailed information on land surfaces, it may contribute to many research items. For example, the information on land surfaces can be used as indices of environmental condition in the area. In the field of agronomy, crop coverage rate can be measured to estimate crop growth, which may be influenced by spatial variation of soil quality.

Concerning satellite remote sensing analysis, accuracy of ground truth is very important. Aerial photographs from low altitude may be effective as one of the ground truth methods. For example, ESCADAFAL (1989) took aerial photographs of soil surfaces by kite in Tunisia in order to obtain plant coverage rate, taking pixel size of satellite data (TM with 30 x 30 m) into consideration.

Since desertification has become a serious issue all over the world, especially in Africa, monitoring of the land surface must be intensified. Detailed analysis by aerial photographs from low altitude may increase accuracy. In particular, it is important to get coverage rate of vegetation on the surface to analyze vegetation indices.

Aerial photographs from low altitude are often taken by a remote-controlled airplane, or by a balloon. Kitephotography, photography from a camera suspended to the string of a kite, is quite different from the above ones in its characteristics. In particular, its easiness is very important.

This paper presents the design and method of kitephotography, and also its advantages and defects. Moreover, an example of its application to the land degradation research along the White Volta river in Burkina Faso is briefly presented.

Design and method

A system of kitephotography is shown in figure 1. A kite of the delta type was made from rip-stop nylon (base 4.7 m, height 2.2 m). According to MUROOKA (1989), this type is suitable for low wind speed (3 to 5 $m.s^{-1}$). Four frames of the kite were made from carbon rods of about 20 mm in diameter. A string of 4 mm in diameter and of 300 m length, was set to the kite. The shutter of the camera can be released by remote-controlled microswitch. A camera which has a release jack (RICOH, XR-10M) was used in order to join the microswitch electrically with the camera. The focusing distance was fixed at infinitely far, and the iris was adjusted according to brightness (about from f. 5.6 to f. 11). The shutter speed was set to more than 1/500 second so that the photographs hardly become fuzzy due to the swing of the camera. The focal length of the lens used was 28 mm.

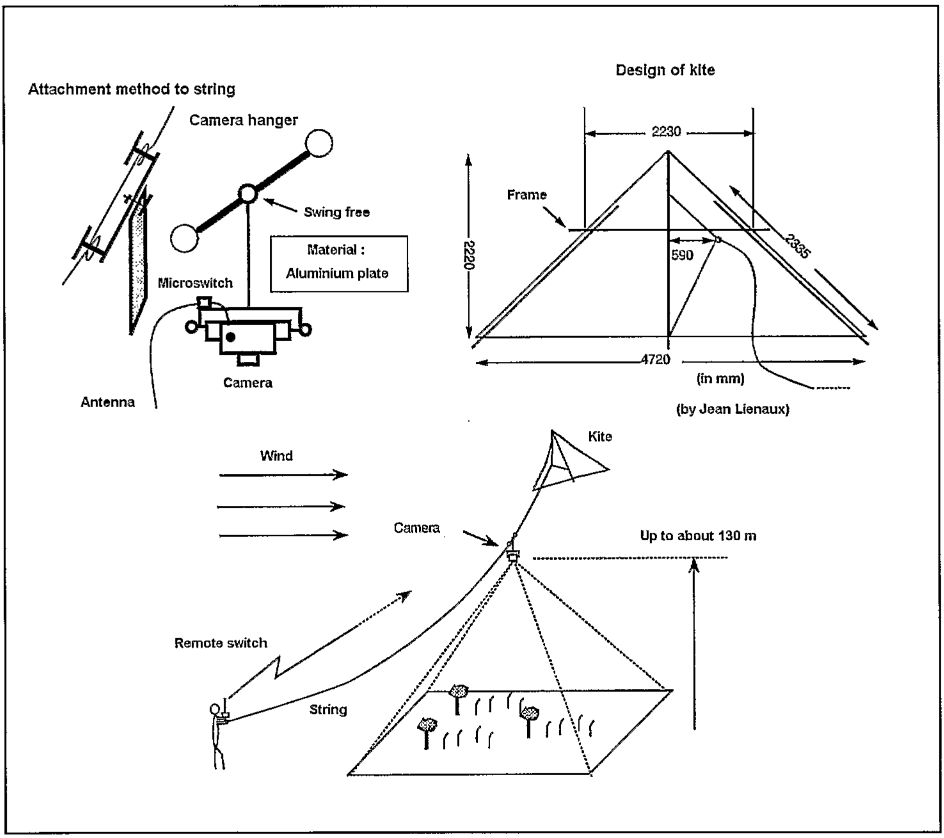

Figure 1. Method of kitephotography.

The camera was attached to the string by a camera hanger about 20 to 30 m below the kite. When the wind is stable, the camera directs itself to the ground almost vertically due to its weight (about 1 kg for camera and camera hanger). In order to assure the quality of photographs, several scenes at one site were taken. Distance between two objects in the surveyed area must be measured to obtain the scale of the photographs. The altitude of photography can be estimated roughly from length and slope angle of the string extended, or from the scale of scene and the focal distance of the lens used.

Characteristics

The characteristics of kitephotography are quite different from other methods because of its principle. The advantages are as follows:

- Low cost: the system is quite cheaper than any other methods such as a remote-controlled airplane or a balloon. The author prepared the system with about $1,000 including the cost of camera. The working cost is null.

- Easiness: the system is easy to make, to handle, to maintain, and to transport. The kite can be made easily by hand if the materials are available. Only a few days of practice are needed. Since the system is simple, it is also easy to repair. The system has a light weight and is compact, thus it is easy to transport to any research sites. These advantages are important for field surveys.

On the contrary, the following conditions are needed for its practice due to its defects:

- Wind condition: Since the kite flies by wind, it can not be used when wind speed is too low. Moreover, if wind conditions are unstable, the camera swings and may lose the research object. This limits the number of days suitable for operation.

- Space condition: The kite must be handled in an open space wide enough to extend the string without obstacles such as high trees.

Although the kitephotography system has the above-mentioned defects, it has a lot of potentiality, if conditions allow to use it. For example, the semi-arid region in West Africa is suitable for its practice thanks to frequent moderately strong winds and low density of high tree coverage.

Application to land degradation research

Study site

Burkina Faso is divided into three zones, i.e. Sudanese, Sudano-Sahelian and Sahel zone (Fig. 2). The study site is located in the Central plateau, 70 km north from Ouagadougou. Along the White Volta river which flows the study site, wide bare grounds, and spot bare ones are observed on an aerial photograph (Fig. 3, taken in 1988 by IGB). In order to study their detailed distribution and their forming process, an on-site research was carried out.

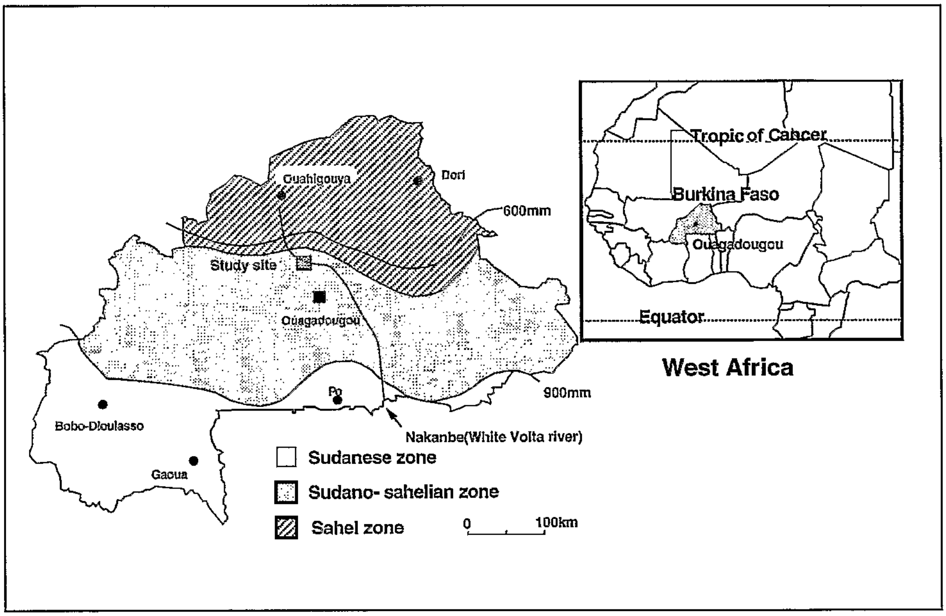

Figure 2. Location of study site.

The landforms of the study site consist of higher slope, lower slope, residual plateau, inselberg, etc. A transect was located from the foot of an inselberg toward the White Volta river, and a part of that is shown in Fig. 3 (from a lower part of the slope to the river). According to the soil map with a scale of 1:500,000 (BOULET, 1968), the soil type of riverine plain in this area is "hydromorphic soil with pseudogley and well developed structure".

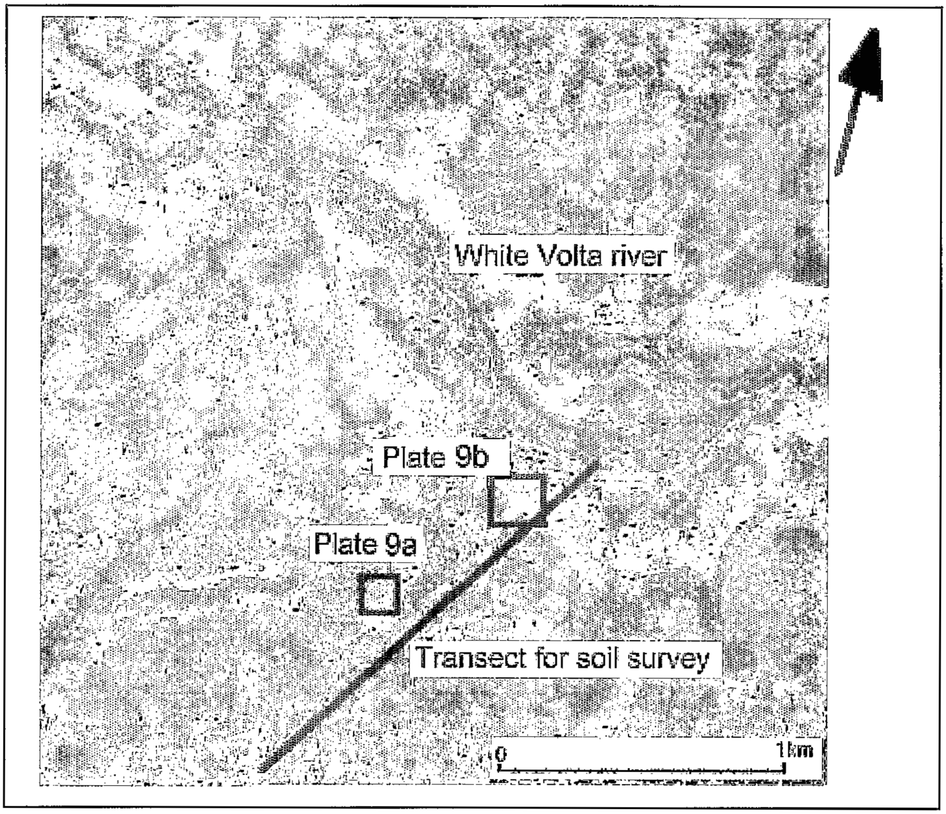

Figure 3. Aerial photograph showing the study area near the White Volta river (clear zones are bare ground).

Soil profiles along the transect

Soil profiles were observed in order to survey the soils along the transect (Fig. 4). Some soil layers were distinguished simply by soil texture, and hydromorphic features in deep horizons.

Sorghum and/or pearl millet fields extend from pit G1 to pit G4 (slope: 0.7%). The surface layer of the slope was sandy loam in soil texture. A petroferric layer was observed at a depth of 20 to 30 cm at the upper slope, and it deepened gradually at the lower part of the slope. From pit G4 to G6, the relief was almost flat (slope: 0.2% to 0%), and bare grounds extended around pit G4. The surface layer consisted of silty loam or loam and a hydromorphic layer with light grey mottles was observed in the deep horizons. From pit G5 to pit G7, grassland with low trees or fields was present and at places waterlogging. The slope became 0.2% around and from pit G6 to pit G7. The surface layer became again sandy loam in soil texture. The valley wall (slope: 2 to 3%) was degraded by gully erosion and covered by very few low trees and to a low extent by grasses.

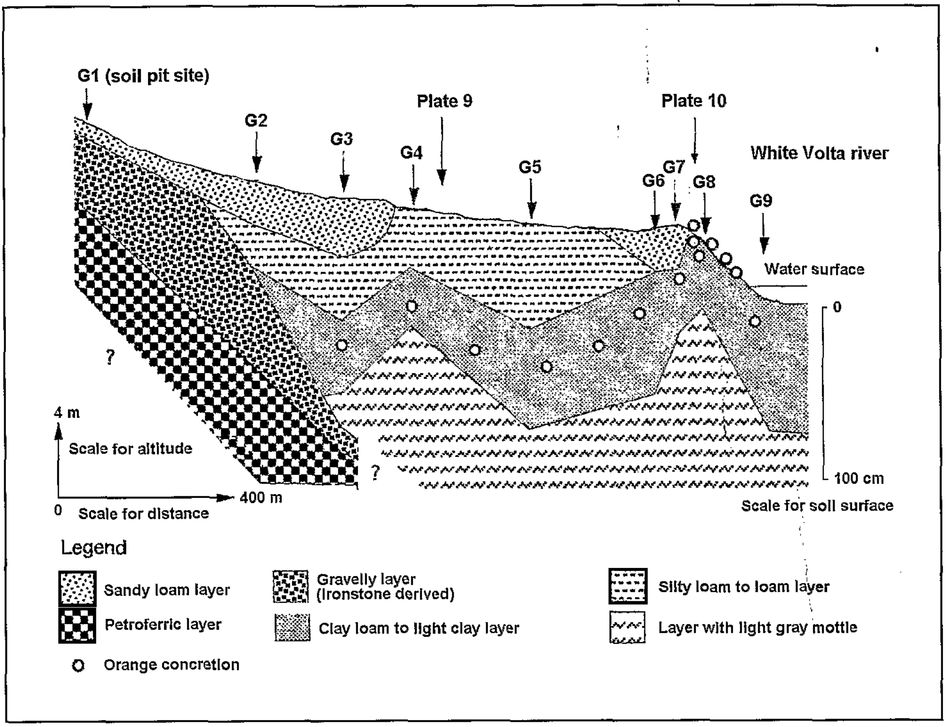

Figure 4. Toposequence of soil structure along the transect.

Interpretation of aerial photographs taken by kite

Two photographs were treated to obtain detailed land surface observation (Plate 9a and Fig. 5 ; Plate 9b and Fig. 6). The locations of these photographs are shown in figure 3. Since distortion of the photographs was not corrected in this study, surface areas of components on the land surface (e.g. bare ground, grassland area) were not measured.

Riverine plain (Plate 9a, Fig. 5)

Plate 9a shows a boundary zone between a wide bare ground body and a grassland area, including spots with bare grounds. The clear zone and the dark zone express bare ground and grassland with low trees, respectively. Distribution of bare ground was thus traced easily on the photograph.

Wide bare grounds like this extend in the riverine plain (Fig. 3). They resulted possibly from removal of vegetation by cultivation, because some traces of cultivation were observed on the surface. Once the land surface becomes bare, the surface crust can form easily due to its soil texture, and vegetation may not recover easily due to its low infiltration rate and mechanical resistance to shooting of plant (CASENAVE et VALENTIN, 1989). As the wide bare ground area on plate 9a is observed on an aerial photograph (1:50,000) taken in 1955, it means that it has been existing at least for about 40 years.

Spot bare grounds (about 5 to 20 m in diameter) were distinguished into two types by the on-site research, i.e. related with termite mounds, and not related with termite mounds.

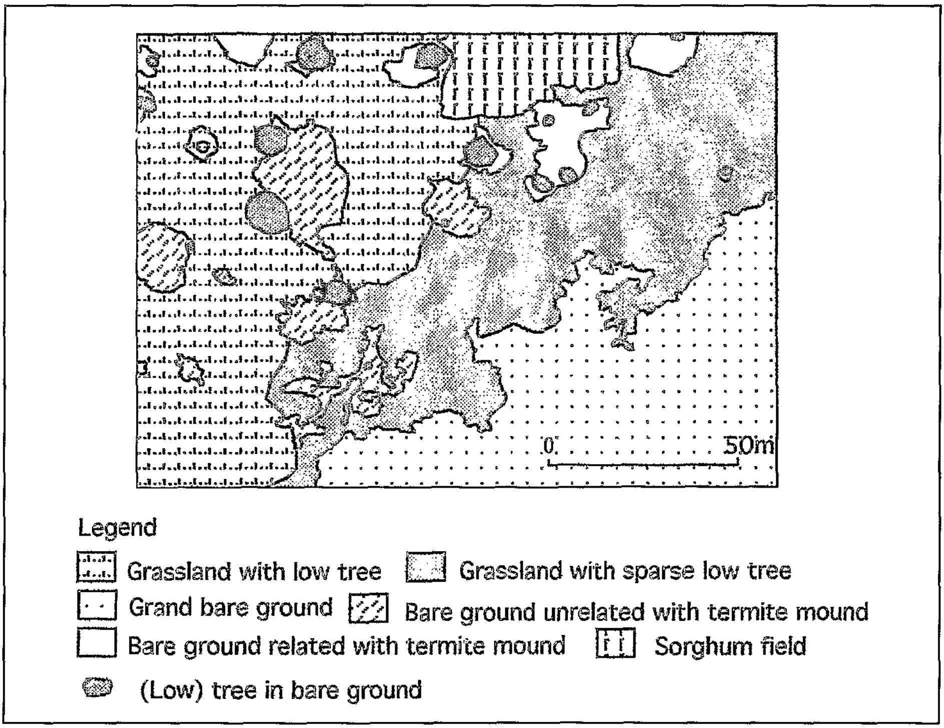

Figure 5. Distribution of bare ground at the riverine plain (see Plate 9a).

The former was derived from abandoned or active termite mounds, and the surrounding areas were gently sloping. The surface of the bare grounds was crusted with fine soil materials. Active termite mounds (about 20 to 50 cm) were always observed under the trees, and the surrounding bare ground was small. Most remnants of termite mounds were with dead stumps or dead blanches, and the surrounding areas extended wider. The latter did not have a recognizable slope, small sandy loam mounds (5 to 10 cm high), however, existed at the bottom of trees which are located in or around bare grounds.

Grasses (5 to 20 cm in height) were invading in and around the latter bare ground, while they were limited in the former relatively to the boundary area with grassland. Since invasion of grasses into the bare ground can be observed on the photograph, rough classification of the two spot ground types without on-site research may be possible. Seasonal, and yearly aerial photographs by kite may be also effective to monitor extension or shrinkage of bare ground.

Valley wall (Plate 9b, Fig 6)

The gully system is expressed clearly on the photograph (color in original). Some steps at gully heads (about 50 cm in height) were also recognized. Where the bare ground is covered with reddish brown semirounded gravel (1 to 2 cm in size) derived from ironstone, the land surface becomes dark (reddish brown on color photo, plate 9b). Some small mounds covered with carbonate concretions were also recognized by a dark color (grey on color photo, plate 9b).

Since irregularly-shaped, many orange concretions (1 to 2 cm in size) similar to those in the subsurface horizon at pit G7, were exposed on the land surface of the gully wall, retreat of the riverine plain must have been occurring. As the aerial photographs from low altitude express the gully system clearly, seasonal, or yearly aerial photographs by kite may be effective to monitor it.

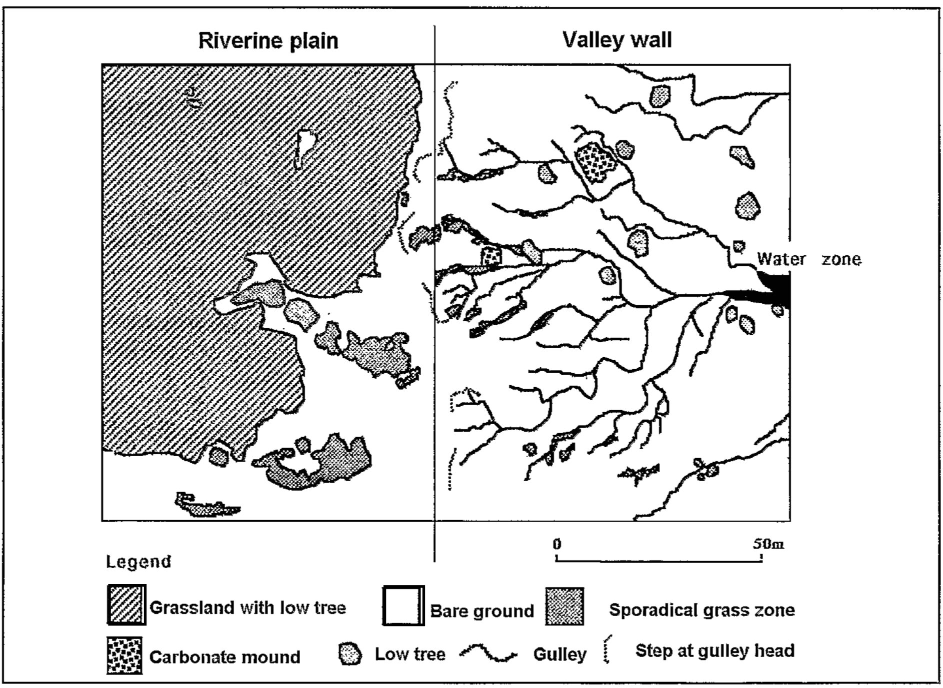

Figure 6. Gully system of valley side (see Plate 9b).

Perspective

A method and characteristics of kitephotography were presented, and its application to land degradation research was also briefly shown. The aerial photographs by kite expressed the distribution of bare ground zone, vegetational zone, and other land surface features. Taking their advantages into account, kitephotography may contribute to detailed land surface researches in a field, if the condition of research sites allows to use it.

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