

Vegetational Interpretation of Remotely Sensed Images in Syria

Shigeru TAKAHATA^{a)} and Afmed El Tayeb OSMAN^{b)}

^{a)} *Japan International Research Center for Agricultural Sciences
(Ohwashi 1-2, Tsukuba, Ibaraki, 305 Japan)*

^{b)} *Pasture, Forage and Livestock Program, International Center
for Agricultural Research in the Dry Areas
(P.O.Box 5466, Aleppo, Syria)*

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Abstract

The study was conducted to determine the possibility of interpreting images for investigations of vegetation and landuse. Remotely sensed data in Syria acquired by LANDSAT Satellite and by a balloon aerial photography system, were analyzed and color-composed by image processing. Vegetation maps which were constructed from large-scale aerial photographs and verified against LANDSAT images, indicated detailed species distribution and boundaries. A balloon photo-system was used at Maraga, 120km southwest of Aleppo, on natural rangelands and improved ones by the planting of saltbushes. As a result, it was found that image interpretation was an effective method for surveying the range vegetation not only in a small-scale area but also in a large-scale test field.

Additional key words : rangeland, conservation, saltbush, grazing, balloon aerial photography, LANDSAT

Introduction

In Syria (Fig. 1), sheep raising is the most important industry, and there are 8.7million ha of rangelands where 12million sheep are grazed. It is necessary to apply remote sensing techniques for

the planning of rehabilitation of degraded rangelands.

Since 1990, the Japan International Research Center for Agricultural Sciences (JIRCAS) (formerly TARC) and the International Center for Agricultural Research in the Dry Areas (ICARDA)^{*1}

^{a)} Present address : (2-19, Tsukisamuhigashi, Toyohiraku, Sapporo, 062 Japan)

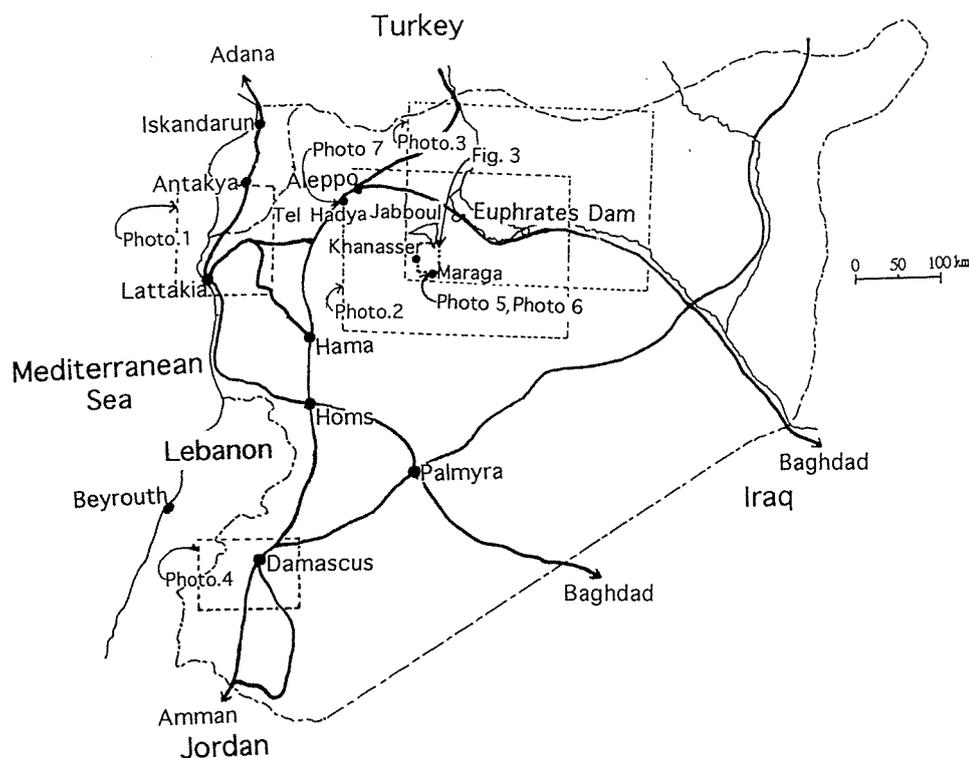


Fig. 1. Map of Syria and location of images

have implemented a collaborative project using remote sensing. The objectives of this project included the identification of vegetation types on rangelands by aerial photography and ground surveys, and classification of these lands using satellite imagery.

The study aimed at assessing the remote sensing techniques, with emphasis placed on their suitability for rangeland trials. ICARDA conducted a rangeland improvement trial with phosphate fertilization, and a grazing capacity test on a man-made planted saltbush^{*2} field. Image interpretation studies were carried out on these fields and compared with a conventional ground survey method⁶⁾.

Methods

Satellite data: A series of LANDSAT MSS and TM data Path 173, Row 35 on September 8, 1975, March 29, 1986, April 3, 1988, March 21, 1989, April 22, 1989, March 8, 1990, July 14, 1990

and April 28, 1991 were obtained for data processing. LANDSAT MSS data, Path 174 Row 37, July, 1989 (Damascus) and Path 174 Row 35, April 3, 1988 (Latakia) were obtained to compose the infra-red color imagery.

Balloon aerial photographs: The photograph platform consisted of a helium-filled plastic balloon, equipped with a 35mm film camera and a video-monitoring camera, mounted on a radio-controlled apparatus for free shooting directions and free angles. (Fig. 2)

Balloon aerial observation sites and dates: Tel Hadya phosphate trial range; Oct. 28, Dec. 17, 1990 and Mar. 9, 1991 Maraga grazing capacity test range; Mar. 9, 1991

Image processing hardware: ACER personal computer, compatible IBM PC/AT 386CPU, 100MB HDD, graphic board MATROX PG1281, high-resolution color display 1024x1280 dots, mathematical co-processor 80387, color image scanner Epson GT 4100, digitizer GRAPHTEC KD4300, printer HP 3630A Paint Jet, plotter

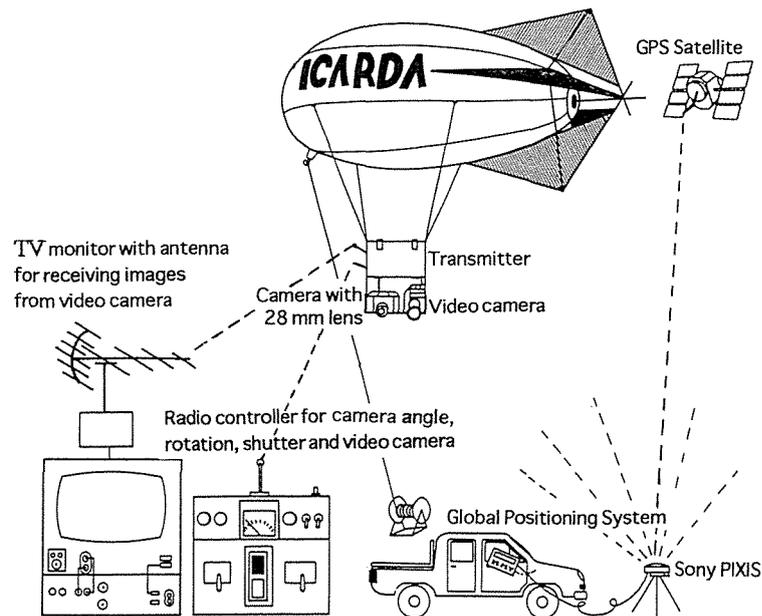


Fig. 2. Balloon Aerial Photography System¹⁾

GRAPHTEC MP4400

Software: ILWIS (The Integrated Land and Water Information System) issued by the International Institute for Aerospace Survey and Earth Sciences (ITC) in The Netherlands with the following main functions; Geographic information (digitizing, polygonization, vector to raster conversion) Internal database and interface (table manipulation, database operation), and Remote sensing (enhancement, classification, geographical correction, image arithmetic)

Normalized Vegetation Index: NVI was calculated by the following formula, $NVI = (NIR - R) / (NIR + R)$ NIR: TM4, MSS7 R: TM3, MSS5. Processing area was 42km (West to East) by 51km (South to North) in Maraga, Syria.

Test-site positioning: The exact location of the observed area was determined using a SONY PYXIS Global Positioning System (GPS), which consists of a receiver of signals from GPS satellites, and of a processor for the calculation of the positioning. GPS indicates the latitude, longitude and elevation with an accuracy of $\pm 3m$ (Fig. 2).

Ground truth survey: Plant height and coverage were measured on the 60m line

interception. Using these two parameters, the Summed Dominant Ratio (SDR2) of each species was calculated for a relative dominant ratio as compared with the most dominant species.

Grassland trials: 1) Maraga Test Range (Fig. 1); Improved area (improved by direct seeding of *Atriplex halimus*^{*2} and *Salsola vermiculata*^{*2}), Natural area (unimproved). Grazing intensity; Heavy grazing (0.75 ha/sheep), Medium grazing (1.5 ha/sheep), Light grazing (2.25 ha/sheep) 2) Tel Hadya Test Range (Fig. 1); three rates of triple superphosphate (0, 25, and 60 kg P2O5/ha) and two stocking rates, Low (0.91 ha/sheep), High (0.43 ha/sheep). The fertilizer was broadcast every year in November.

Results and Discussion

1. Interpretation of small-scale satellite images

Latakia Area: Plate 1 shows the infrared color composite image. Although the mountainous area beside the Mediterranean Sea receives a rainfall amount of more than 1000mm/year, there is no forest except for the Latakia Reserve Forest. Main landuse of this area includes crop fields and maqui

vegetation for sheep grazing.

The bright red color in Al Gahb Valley corresponds to barley/wheat and green-vegetable fields. This valley was improved by the construction of a large drainage and irrigation system⁷⁾.

Aleppo Area: The upper part of Plate 2 corresponds to the northern barley area in the an annual rainfall of 500-300mm, and the rangelands distributed in the southeastern part in an area with 260mm precipitation. Due to the amount of rainfall in the barley areas, the reflectance of infrared increased in spring. In the summer image (Plate 3), the reflectance of the green vegetation persisted only on the riversides and in the irrigation areas. The Jabboul Salt Lake was completely dry in the summer.

Damascus Area: Plate 4 shows the Lebanon Mountains and Damascus Oasis. The Barata River

flows down to Damascus and branches into small channels. Out of the irrigation area (guhta), there are several well-water oases (malgi)³⁾. They can be differentiated by the pattern of infrared reflectance. The irrigation area corresponds to a plane pattern and the well-water oases appear as a spotted pattern.

In the mountainous areas vegetation is scarce. In ancient times, the Lebanon Mountains were famous as a habitat of the Lebanon cedar (*Cedrus libani*) which can no longer be observed.

2. Medium-scale interpretation of satellite images

Fig. 3 shows a NVI map of Maraga (2142km²). Dark black areas indicate a high NVI. Density level expressed by NVI in each spring season was higher in the following order, '88 > '90 > '86 > '91 > '89. The amount of annual rainfall was higher in the following order, '88 > '86 > '91 > '89, '90.

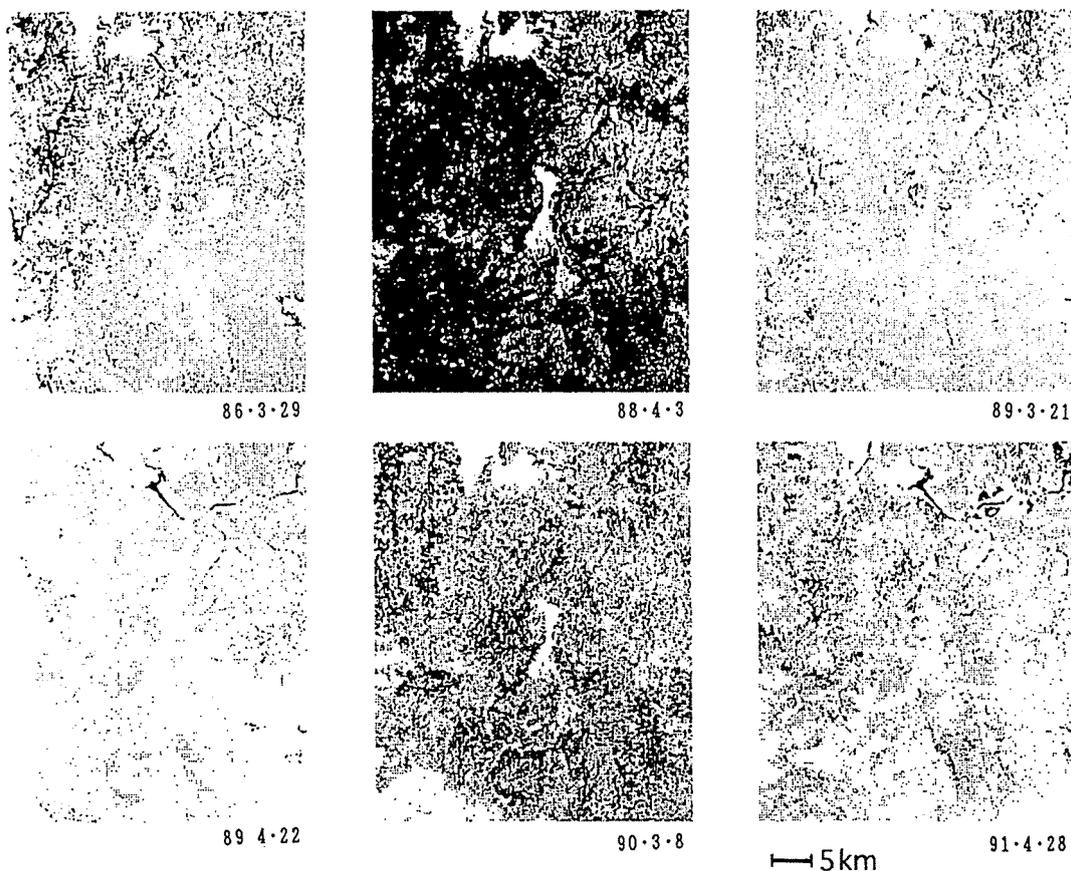


Fig. 3. Yearly changes of vegetational index in spring in Maraga⁴⁾
Black: high NVI

Considering the changes of monthly rainfall (Fig. 4), '90 had enough rainfall in spring, though the annual amount of rainfall was low. In contrast, '86 had less rainfall in spring but the annual amount of rainfall was average. Spring rainfall affects the NVI of the range. In reference to the monthly rainfall, barley fields and rangelands showed a different response to rainfall. Growth of grasses was promoted by spring rainfall, and sowed barley germinated well with autumn rainfall.

Near Khanasser (Fig. 1) in the area under 200mm annual rainfall, trace of cultivation of barley on the rangelands showed a stripe pattern. After cultivation, sometimes rangelands became barelands. This phenomenon referred to as over-cultivation, is one of the causes of desertification in the dry areas. Monitoring of over-cultivation by remote sensing is important for the prevention of desertification.

3. Large-scale interpretation

Large-scale LANDSAT images of the Maraga Experimental Field: The fields with man-made planted saltbush*² could be differentiated into *Atriplex halimus* and *Salsola vermiculata* species along with their densities (Plate 5).

The results were verified by balloon aerial photography and the ground truth survey (Fig. 5).

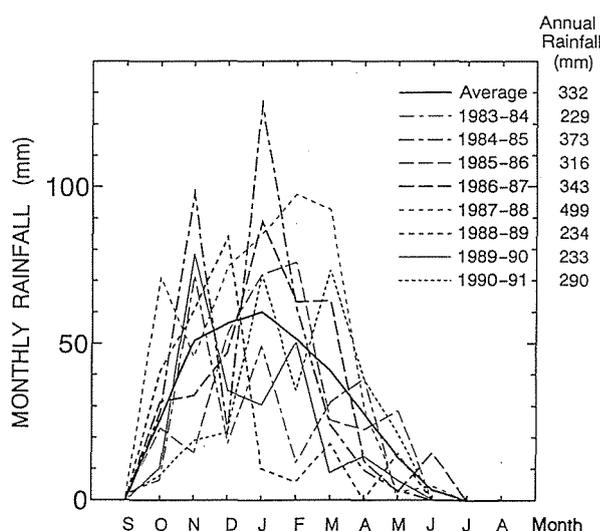


Fig. 4. Annual and monthly rainfall

In the natural rangelands, the vegetational conditions varied depending on the microtopography of the area. Dense and luxuriant vegetation in small valleys (playa topography) showed a high reflectance of infrared rays, where the soil moisture remained relatively high. (Plate 5).

Balloon aerial photographs over the Maraga Experimental Field: Fig. 5 depicts the interpretation of the density of the man-made planted saltbush*². The estimation of the bio-mass in the grazing capacity trial should be introduced by remote sensing methods to compare the overall condition of the field.

Fig. 6 was taken in the improved plot of Maraga, and converted to black and white imagery, then the area of black spots was summed. Since the crown of *Atriplex* is larger than that of *Salsola*, the density of *Salsola* was higher than that of *Atriplex*, but the ratio of the ground cover was smaller than that of *Atriplex*.

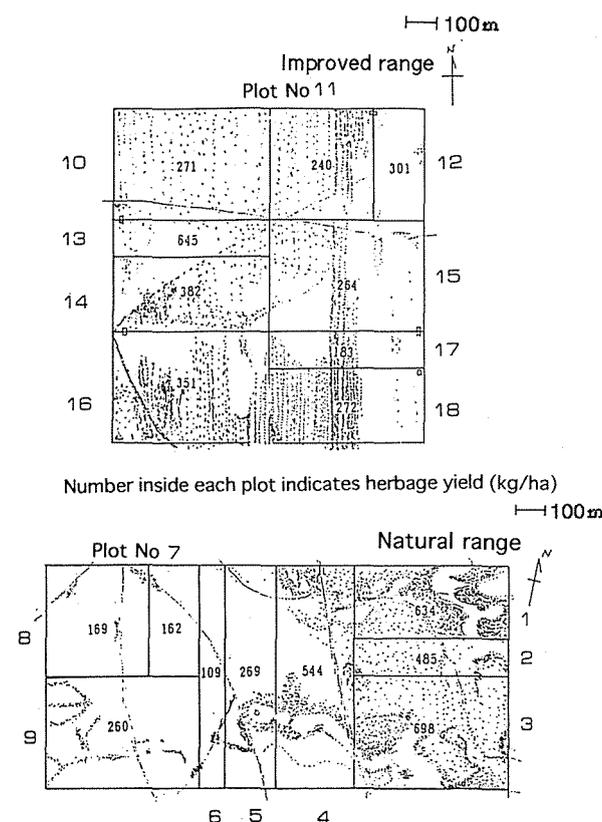


Fig. 5. Map of plant density in the Maraga Test Fields

Fig. 7 depicts the interpretation of the plant density of the natural range. The plant density varied depending on the micro-topography of the field. In an elevated area, the vegetation was scarce, and small coverage and low plant height were special features. In contrast to elevated areas, depressed or small valley areas were covered by dense and vigorous grasses. In the central part of the depressed areas, with a diameter of about 70m, *Carex* and *Peganum* communities predominated. In the periphery of the depressed center, *Hordeum*

and *Bromes* communities predominated (Plate 6).

The frequency, plant height, coverage and dominance were verified by the line-intercept method on the ground (Table 1).

Balloon aerial photographs in the Tel Hadya Grassland Trial.: An experiment was conducted at Tel Hadya to analyse the effect of phosphate fertilization on the two stocking rates. Plate 7 shows the test fields from an oblique angle.

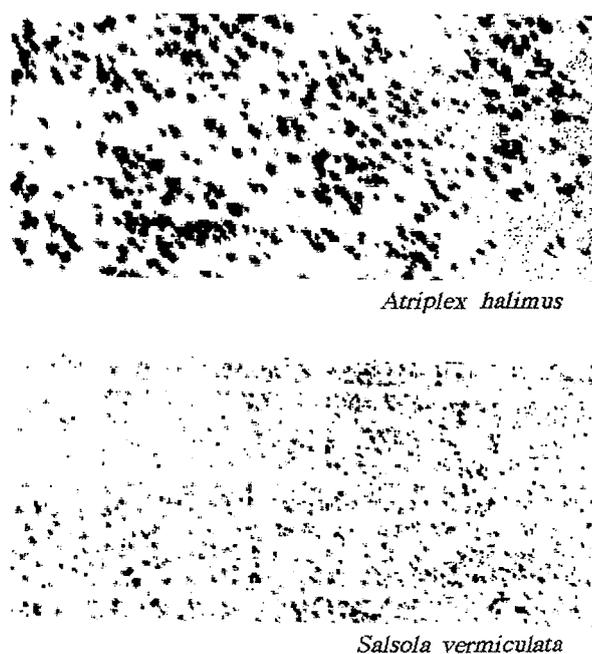


Fig. 6. Image depicting enhanced crown of planted saltbush, using balloon photography
Maraga Improved Plot No.10, 50X100m

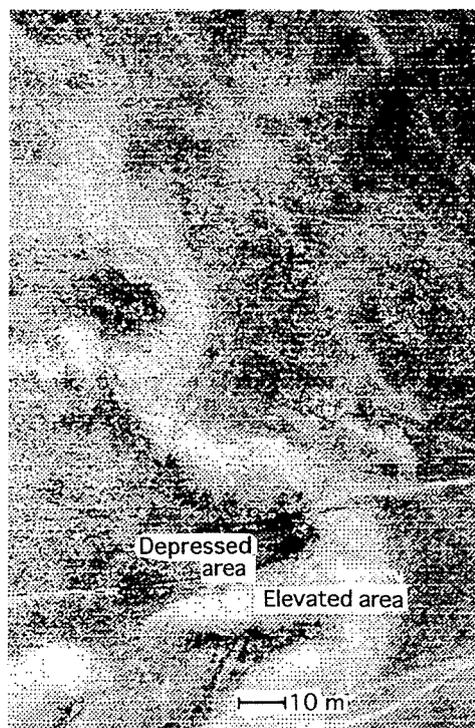


Fig. 7. Image depicting plant density, using balloon photo
Natural Plot No.1
Black: high density

Table 1. Dominant species in inner and outer part of depressed area

Genera	Outer (line 0-10m)				Inner (line 40-50m)			
	F%	Hcm	C%	SDR ₂	F%	Hcm	C%	SDR ₂
<i>Hordeum</i>	100	44.5	41.0	100	-	-	-	-
<i>Bromus</i>	20	30.0	0.3	7.1	10	8.0	1.5	3.2
<i>Plantago</i>	30	4.7	0.7	2.5	80	5.8	12.0	29.6
<i>Carex</i>	60	13.8	4.7	15.1	100	10.8	14.5	48.0
<i>Peganum</i>	20	33.5	7.0	16.1	80	26.8	32.0	100
<i>Others</i>	30	34.7	0.7	12.6	20	4.0	0.5	1.6

F: frequency, H: plant height, C: coverage

SDR₂: Summed Dominant Ratio with C% and Hcm Location of line-interception is shown on Plate6

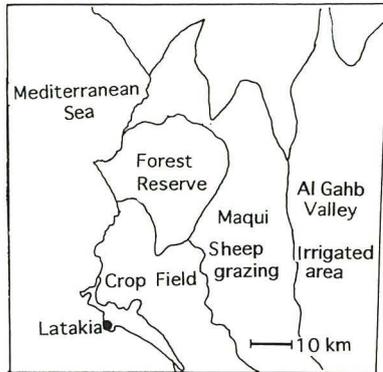


Plate 1. Latakia, Apr. 3 1988

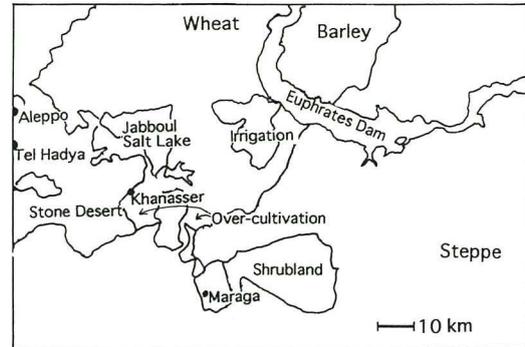


Plate 2. Aleppo, Mar.8 1990

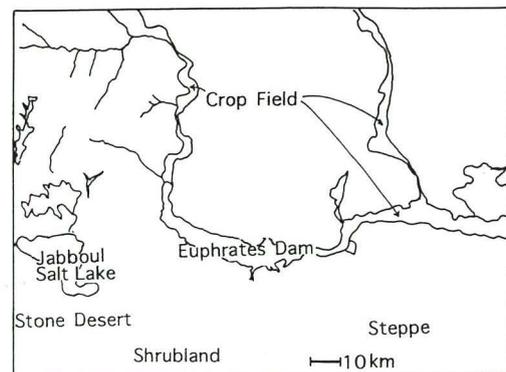


Plate 3. Aleppo, Sep.8 1975

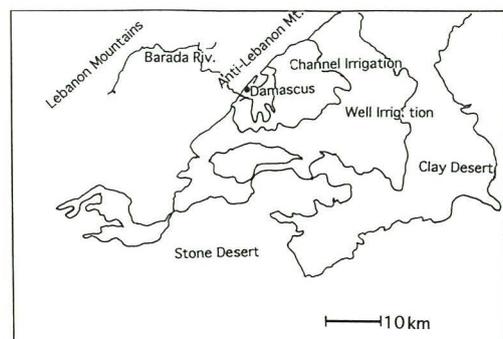
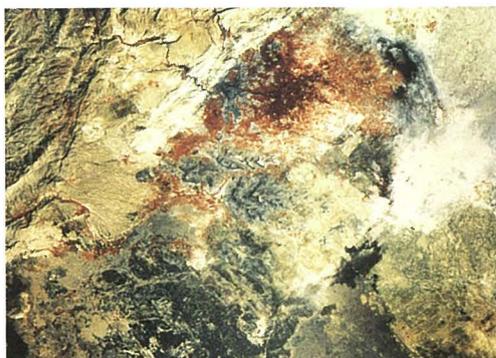


Plate 4. Damascus, July 1987

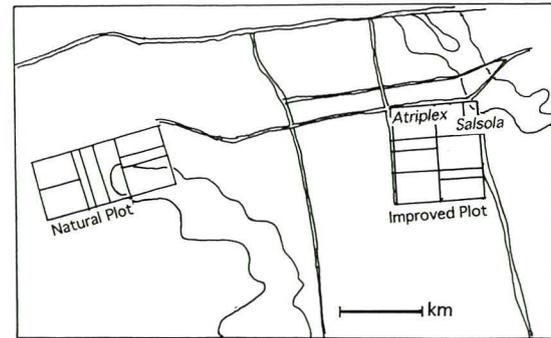
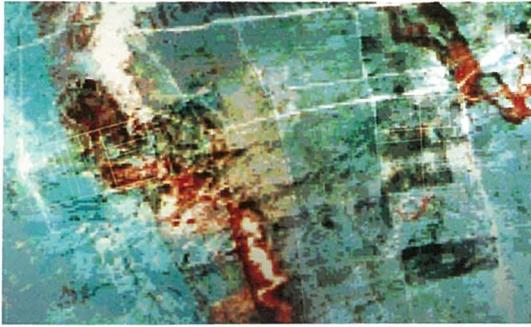


Plate 5. Maraga Experimental Range, Apr. 28 1991

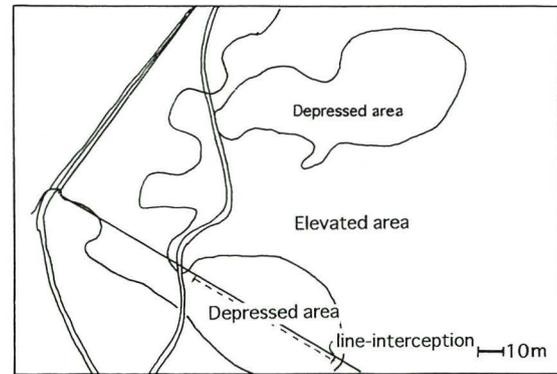
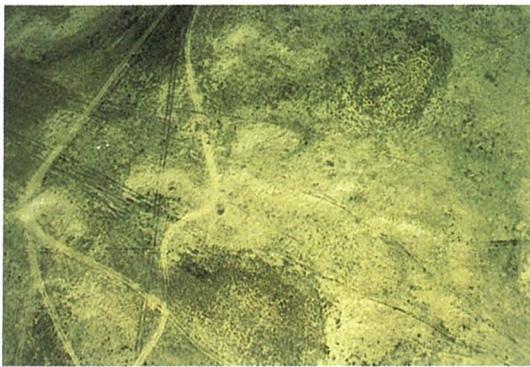


Plate 6. Maraga Natural Plot No.3, Dec. 17 1990

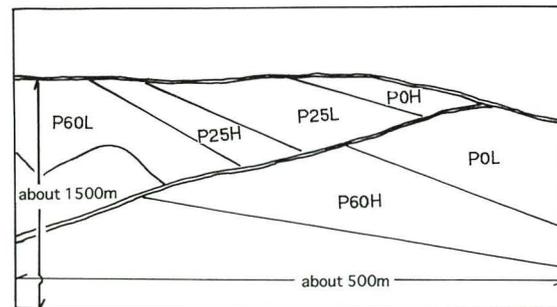


Plate 7. Tel Hadya Grassland Trial, Mar. 9 1991

It appears that the yield of grasses decreased for the heavy stocking rate and that phosphate fertilization did not alleviate this decrease. According to the ground survey, the effects of phosphate fertilization on the growth of legumes were very distinctive, and the legumes supported the heavy stocking rate¹⁾. It was difficult to interpret the growth of legumes using the images, and consequently, the bio-mass of the heavy

grazing plots was under-estimated by the photo-interpretation.

Conclusion

Vegetational conditions vary in rangelands. Small differences in the soil surface affect plant growth through soil moisture. In extensive ranges, a conventional survey of grass yield and coverage

may require much time and labor. Photo-interpretation of rangelands is a rapid method to estimate the vegetational condition over wide areas. Classification of plant cover based on the images is the first step of processing, and sampling from each class is second step. Comparison between two images before and after treatment of the test fields is an effective method for grassland trials⁵⁾.

Vegetation Index which indicates the plant coverage of a test site, combined with remote sensing data and rainfall forecast, enables to estimate the yield of barley and grasses²⁾.

Balloon aerial photography system is suitable for measurements of test fields. It is a convenient and low-cost method which is however limited in the case of strong wind.

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Annotation

*1 ICARDA, the International Center for Agricultural Research in the Dry Areas, conducts research on agriculture of the dry areas in West Asia and North Africa (WANA). Its objective is to develop plant varieties, livestock production systems, farming methods and local human resources in order to help the region increase domestic food production, minimize environmental degradation, and create a self-sustaining agricultural research infrastructure. ICARDA's research mandate covers the agriculture of the dry areas in the 200 - 600 mm annual rainfall zones. In areas receiving around 200 mm of annual precipitation, land use is restricted largely to

grazing. These areas, sometimes known as steppe or rangelands, are increasingly showing signs of severe overgrazing. In other parts of the steppe where the amount of rainfall is slightly higher, farmers are growing crops, principally barley. This inappropriate cultivation at the wetter margins of the steppe, and overgrazing at the drier margins, poses a serious threat to this environmentally fragile area.

*2 Saltbush is the common name of plant in the Chenopodiaceae family with *Atriplex*, *Salsola*, *Kochia* and *Chenopodium* genera. They are perennial shrubs and tolerate saline soils and drought. ICARDA carried out studies to identify suitable saltbushes for the dry range, and selected *Atriplex halimus* and *Salsola vermiculata*.

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シリアにおけるリモートセンシング画像の植生判読

高畑 滋^{a)}, アフマッド イー オスマン^{b)}

^{a)} 国際農林水産業研究センター
(〒305 茨城県つくば市大わし1-2)

^{b)} 国際乾燥地農業研究センター
(シリア国アレppo市 P.O.Box 5466)

摘 要

乾燥地域における牧野資源変動の解析と保全技術の開発研究の一環として、リモートセンシング画像の植生判読の試験を行った。牧野植生は広大な地域に点在し、季節変化が大きいため、リモートセンシングにより地表面を広く調査する方法が有効である。ランドサットデータを入手し、画像解析プログラムによって小縮尺から大縮尺まで各種画像を作成し判読に供した。衛星画像の判読検証のために、14m³の気球をあげて大縮尺空中写真を撮影し、小面積の試験地の植生詳細図を作った。小縮尺画像から土地利用、降水量と植生量との関係、季節変化、

オアシス分布などが判読できた。中縮尺画像の植生指数図と月別降水量とからオオムギ畑と牧野で好適降水分布がちがうことがわかった。大縮尺画像から詳細な植生の状況が判読できた。牧養力や肥効試験の検証のために有効な方法である。試験地の微地形と植生の関係や、採食状況、再生状況が判読できた。変異の大きい牧野植生では、地上調査点数を増やすよりも牧区全体の変化を比較する方法を取り入れるべきである。気球式空中写真撮影装置は、簡易に大縮尺空中写真を撮影することができて、植生調査以外にも広く利用出来ることがわかった。

キーワード：牧野植生，気球写真，ランドサット，画像解析，草地保全，乾燥地，ソルトブッシュ

^{a)}現在：(〒062 札幌市豊平区月寒東2条19丁目11-4)