KEN M. MORGAN*
DONALD R. MORRIS-JONES
GERHARD B. LEE
RALPH W. KIEFER
University of Wisconsin-Madison
Madison, WI 53706

Airphoto Analysis of Erosion Control Practices

Assessment of cropland erosion management systems is accomplished in a watershed using color and color infrared 70 mm photography.

ABSTRACT: *The Universal Soil Loss Equation (USLE) is a widely accepted tool for erosion prediction and conservation planning. In this study, airphoto analysis of color and color infrared 70 mm photography at a scale of 1:60,000 was used to determine the erosion control practice factor in the USLE. Information about contour tillage, contour strip cropping, and grass waterways was obtained from aerial photography for Pheasant Branch Creek watershed in Dane County, Wisconsin.*

INTRODUCTION

SEDIMENT is a major pollutant of surface waters in this country (LaFlen and Maldenhauer, 1971). National attention was focused on this problem when Congress passed the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500). This legislation calls for local planning agencies throughout the country to identify and control nonpoint sources of pollution, including soil loss from agricultural fields (Section 208). This has been a difficult task for many state and local planning agencies because of the diffuse nature of sediment pollution and the constantly changing land use that may occur in a watershed.

To compute long-term soil loss from agricultural fields due to sheet and rill erosion, soil conservation agencies use the Universal Soil Loss Equation (USLE) developed by Wischmeier and Smith (1965) and given in the form

$$A = R \cdot K \cdot L \cdot S \cdot C \cdot P$$

In this equation, A is the estimated average annual soil loss in terms of weight of soil lost per unit area of land per year (typically expressed as kg/m^2 per year or tons/acre per year). The factors R, K, L, and S are the hydrologic and watershed parameters of rainfall, soil erodibility, slope length, and slope gradient, respectively. Vegetation cover or cropping management is represented by C, and the factor, P, relates the possible cropland erosion control practices used on cropland.

For a given area, the factors R, K, L, and S essentially remain constant. However, C and P may change from year to year depending upon the land use management employed by a farm operator.

In a previous paper we reported on the usefulness of airphoto interpretation for determining C factors (Morgan *et al.*, 1979). Our research now focuses on P factor determination utilizing airphoto analysis. This is possible because of the characteristic photo patterns produced by the erosion control

* Now Assistant Professor of Geology at Texas Christian University, Fort Worth, TX 76129.

PHOTOGRAMMETRIC ENGINEERING AND REMOTE SENSING,
Vol. 46, No. 5, May 1980, pp. 637-640.

practices used by most farmers. Our study shows that aerial photography can provide up-to-date accurate information on erosion control practices throughout a watershed. This information is traditionally gathered by laborious and time consuming field observations and farmer interviews.

BACKGROUND

The predominant cropland erosion control practices used in the United States are contour tillage, strip cropping, terrace systems, and stabilized grass waterways (Hudson, 1971). If properly installed and maintained, these land management practices slow runoff velocity and reduce the sediment carrying capacity of water.

An important consideration in determining *P* factors for the USLE is the relationship that exists between slope and erosion control practice (Wischmeier and Smith, 1965). Table 1 shows the effectiveness of contour tillage, contour strip cropping, and grass waterways for five slope categories. Terracing is omitted from this table because this land management practice did not occur in the study area. When all other soil loss factors for the USLE are the same, low *P* values indicate less erosive conditions in a field. A brief discussion of each erosion control practice is presented below.

CONTOUR TILLAGE

Contour tillage is the practice of plowing and planting perpendicular to the slope so that runoff is ponded and flows gently around the slope rather than down slope (Willrich and Smith, 1969). This erosion control practice has generally been effective in reducing erosion except during occasional severe storms on steep slopes which may result in breaching of the contoured rows (Wischmeier and Smith, 1965). As shown in Table 1, contouring produces its maximum effect on slopes in the 2 to 8 percent range. At slopes of less than 1 percent, the land approaches equality with the contour row slope, and the *P* value approaches 1.0.

CONTOUR STRIP CROPPING

In contour strip cropping, strips of meadow are alternated with strips of row crops across a hillside. When constructed properly, the meadow acts as a filter strip that traps sediment. As water flows across the meadow strips, runoff velocity is reduced causing sediment to drop out (Jacobson, 1969). This practice is more effective than contouring alone for reducing erosion over an entire field (see Table 1).

GRASS WATERWAYS

The object of this practice is to channel runoff away from cropland by means of artificially constructed grass waterways. These waterways run down slope and are often bermed to contain the water (Hudson, 1971). When used in conjunction with contour tillage, grass waterways are very effective in reducing erosion.

ANALYSIS

In this study, airphoto analysis was used to determine the location and extent of cropland erosion control practices throughout a watershed. Our research was performed in Pheasant Branch Creek watershed in Dane County, Wisconsin on randomly distributed 65 hectare tracts (160 acre quarter sections), using a representative sampling method (95 percent confidence level). The results of this sampling procedure, developed by the Wisconsin River Basin Planning Staff, represent the current land management in the study area (Morgan *et al.*, 1979).

Information on cropland erosion control practices was obtained from color and color infrared aerial photography (camera focal length = 6 inches) taken in October 1977, and provided coverage of the research area at a scale of 1:60,000. Photo analysis of 70 mm transparencies was performed with a zoom stereoscope and hectare-size cell overlays.

Identification of contour tillage, contour strip cropping, and grass waterways was ac-

TABLE 1. RELATIONSHIP BETWEEN THE CONSERVATION PRACTICE, *P*, AND SLOPE

Slope (%)	No Practice	Contour Tillage *P*-Value	Contour Strip Cropping *P*-Value	Grass Waterways *P*-Value
1-2	1.00	0.60	0.30	0.20
2-8	1.00	0.50	0.25	0.17
8-13	1.00	0.60	0.30	0.20
13-19	1.00	0.80	0.40	0.26
19-25	1.00	0.90	0.45	0.30

Source: Wischmeier and Smith, 1965.

TABLE 2. INTERPRETIVE KEY FOR EROSION CONTROL PRACTICE IDENTIFICATION

Erosion Control Practice	Land Cover Characteristics	Photo Identification
Contour Tillage	Row Crops Planted on Contour	Crop Rows Distinguishable
Contour Strip Cropping	Alternating Strips of Meadow and Row Crops	Characteristic Strip Pattern
Grass Waterways	Grass Grown in Field Drainageways	Grass Channelways

complished utilizing the interpretive key in Table 2. This key was developed from field observations and analysis of characteristic photo patterns produced by each erosion control practice. The percentage of cropland protected by each land management practice was determined from the photos using a hectare-size grid cell analysis on the 65 hectare parcels.

Location and extent of conservation practices was optically transferred onto a USGS topographic map (scale 1:62,500) by means of a Zoom Transfer Scope. This procedure made it possible to correlate the erosion control practices to slope information extracted from topographic maps of Pheasant Branch Creek watershed. *P* factor values were then selected from Table 1 for eventual use in the USLE.

RESULTS AND DISCUSSION

Figure 1 is a black-and-white copy of a color infrared photo of a portion of the study area. Contour tillage, contour strip cropping, and grass waterways are easily located on the photo and are labeled A, B, and C, respectively.

Results obtained from airphoto interpretation of cropland erosion control practices throughout the watershed are presented in Figure 2. The amount of cropland protected by conservation measures is expressed as a percent in each of six slope categories. Figure 2 also provides a visual representation of where contour tillage, contour strip cropping, and grass waterways were currently employed by farm operators in Pheasant Branch Creek watershed. There is a notable absence of the latter two conservation practices at the lower slopes. As shown in Table 3, 45 percent of the total cropland in our study area was unprotected by erosion control practices. Aerial photographic analysis indicated that 62 percent of this unprotected cropland occurred in the low slope range.

Our results are useful to agencies responsible for land management and soil conser-

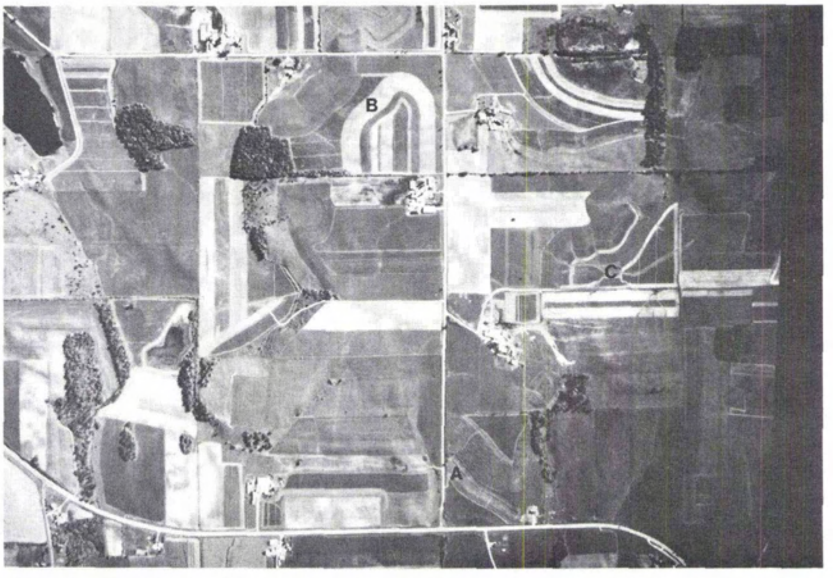

FIG. 1. Black-and-white copy of a color infrared photo showing the predominant erosion control practices in Pheasant Branch Creek watershed. A = contour tillage, B = contour strip cropping, and C = grass waterways. (Scale = 1:24,370)

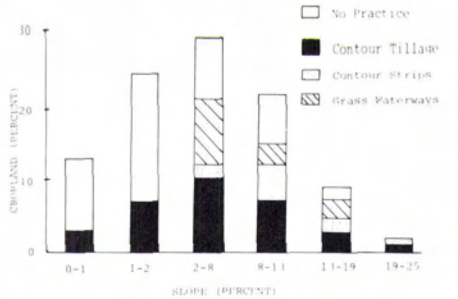

FIG. 2. Graph showing amount of cropland protected by each erosion control practice according to slope in Pheasant Branch Creek watershed.

vation in Pheasant Branch Creek watershed. Airphoto interpretation of color and color infrared photography revealed the need for more attention to erosion control practices on cropland at slopes less than 2 percent. This included 38 percent of the total conventionally tilled land in our study area (see Table 3). Computed soil loss estimates by the Soil Conservation Service showed that most of these relatively flat areas were continuously farmed and often exceeded allowable erosion rates.

CONCLUSIONS

According to P. L. 92-500, planning agencies throughout the country must develop and implement best management practices (BMP's) to control sediment loss from agricultural fields. The Environmental Protection Agency (EPA) has determined contour tillage, contour strip cropping, and grass waterways to be effective BMP's for cropland (Krivak, 1978). Also, the Clean Water Act of 1977 encourages the proper installation of cropland erosion controls to impede runoff velocity and reduce sediment carrying capacity of water in rural areas.

In this study, airphoto analysis of 70 mm color and color infrared photography at 1:60,000 provided accurate information about cropland erosion control practices in Pheasant Branch Creek watershed in Dane County, Wisconsin. This research illustrates the usefulness of remote sensing for determining the location and extent of current cropland management practices and for determining areas where more attention to erosion control measures may be needed.

Many agencies concerned with erosion problems are in need of accurate information about land management over large areas, while faced with a shortage of personnel. Our study shows that remote sensing can be useful to agencies involved in nonpoint pollution studies for areawide erosion studies.

TABLE 3. CROPLAND IN PHEASANT BRANCH CREEK WATERSHED UNPROTECTED BY CROPLAND EROSION CONTROL PRACTICES

Slope Range[a]	Cropland (%)	No Erosion Control Practice[b] (%)
Low	38	28
Medium	51	15
High	11	2
Total	100	45

[a] Low = 0-2 percent, Medium = 2-13 percent, High = 13-25 percent.
[b] Expressed as a percent of the total cropland in the watershed.

ACKNOWLEDGMENT

This report was funded in part by the University of Wisconsin-Madison College of Agricultural and Life Sciences, the U. W. Water Resources Center, Region V of the Environmental Protection Agency (Grant #G005139-01), and the NASA Office of University Affairs (Grant #NGL 50-002-127).

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(Received 4 April 1979; revised and accepted 11 December 1979)