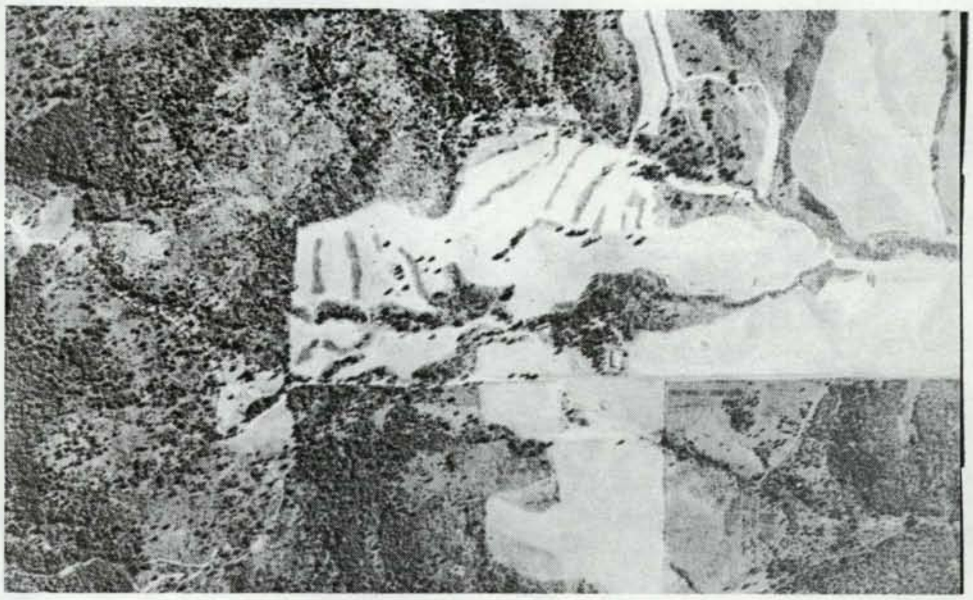
Research Technical Completion Report Project A-080-IDA

THE USE OF REMOTE SENSING TECHNIQUES AND THE UNIVERSAL SOIL LOSS EQUATION TO DETERMINE SOIL EROSION



by

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University of Idaho
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We would also like to extend our appreciation to the USDA Soil Conservation Service and the Agriculture State Conservation Service personnel at the St. Maries, Idaho offices. Special thanks go to Tom Remington of the Soil Conservation Service and Bob Playfair of the Bureau of Indian Affairs for providing information and for their interest; and to Judy Hart and Dave Wherry for their assistance with the image processing.

ABSTRACT

Satellite data with ancillary watershed information was used to determine soil erosion of agriculture, forest and range lands in the southern portion of the Hangman Creek watershed, Benewah County, Idaho. Vegetation cover types derived from satellite data and the VICAR/IBIS image processing computer software package were determined with 89% accuracy. The vegetation cover types identified on the study area were dense-mixed forest, medium density mixed forest, ponderosa pine forest, wheat, lentils, barley, bluegrass, pasture and brush. Soil erosion (tons/acre/year) was estimated with the Universal Soil Loss Equation. Annual soil loss in the study area ranged from 0.003 tons/acre/year in the dense to mixed-forest cover type to 18.7 tons/acre/year in the wheat and lentil cover types. Annual erosion was compared with the annual soil loss tolerance to determine critical erosion areas.

INTRODUCTION

Soil erosion is a serious problem in the United States. Loss of top soil from agriculture, forest and range lands can reduce site productivity and increase sediment in our waterways, often producing degredation of water quality and increased sedimentation of reservoirs. The ever-increasing demand for use of the water and soil resources has necessitated more intensive management of these resources and the need for more efficient methods of obtaining watershed inventory data.

Presently, land managers utilize the Universal Soil Loss Equation (USLE) developed by Wischmeier and Smith (1978) to predict erosion on agriculture lands. Several studies have investigated the models use on agriculture lands including those by Harker and Michalson (1977), McCool et al. (1977), and Stephens et al. (1977). The USLE equation has also been used to predict soil erosion on range lands by Branson et al. (1981), Dyer (1977), Faletti (1977), and Singer et al. (1977). Modifications of the USLE have been developed to make the model compatible for use on forest lands (Dyer 1977, Falleti 1977, Patric and Brink 1977, Wischmeier and Smith 1978 and USDA 1980b).

As the USLE is applied and modified, new methods for acquisition of data for model input are being investigated. Remote sensing techniques have provided an accurate and timely method of data collection for the cropping management, C-factor. Ripple in 1978 used low altitude aerial photography to determine land cover and aspect data for use in the USLE model. In a succeeding study, Ripple and Erickson (1981) used high altitude photography to successfully determine the C-factor for the USLE. Morgan et al. (1978, 1979, 1980) also used high altitude photography to attain land cover data for prediction of the C-factor.

Morgan et al. (1978) concluded that remote sensing is an effective tool for erosion prediction and conservation planning, and that satellite data would be an excellent source for estimating the C-factor in the USLE model. Development of this technique would provide a mechanism for rapid estimation of the cropping management parameter with subsequent timely evaluation of soil erosion on large tracts of land. This method would provide up-to-date land coverage information over large areas in a shorter time period than traditional field techniques.

The purpose of this study was to investigate the potential for using satellite data with ancillary watershed information to estimate soil erosion with the USLE equation. The three major objectives of the study included: 1) the utilization of satellite (Landsat) data for classifying land use, vegetation type and density information into a format compatible with the USLE; 2) the estimation of soil erosion on agriculture, forest and range lands in the Hangman Creek watershed in northern Idaho using remote sensing techniques and existing hydrologic, edaphic and physiographic data, incorporated into the USLE; and, 3) to identify the critical erosion areas with information derived from the land use classification and the USLE model.

Description of the Study Area

The investigation was conducted on the south eastern portion (approximately 58,000 acres) of the Hangman Creek watershed located in Benewah County, Idaho (Figure 1). This drainage was chosen because of its designation as a 208 planning unit established in compliance with the Federal Water Pollution Control Act, Amendments of 1972 and the Clean Water Act of 1977. Agriculture, forest and range lands are well

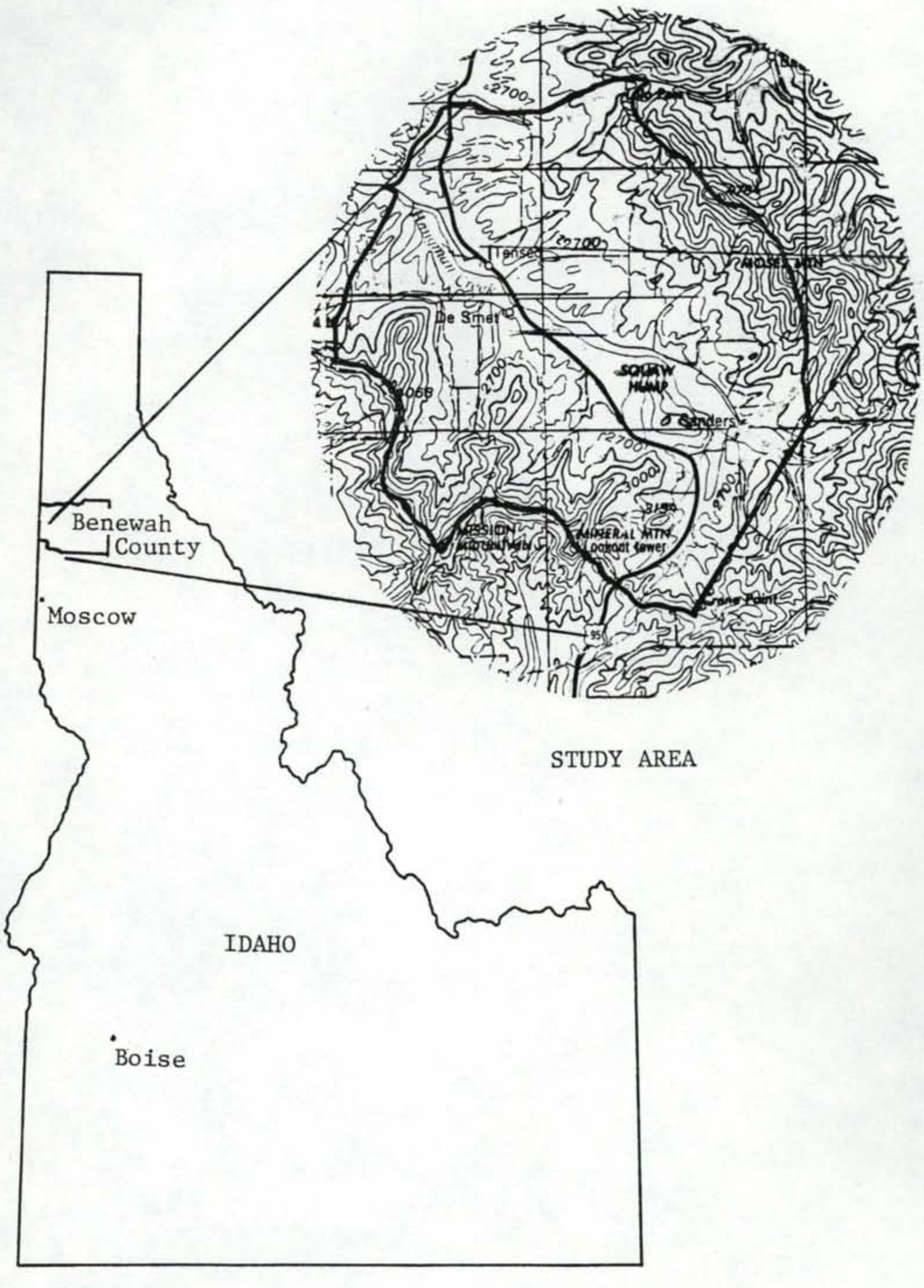


Figure 1. Location of the Hangman Creek study area.

represented within this area. Major agricultural crops include wheat, lentils, barley and bluegrass. Abundant pastureland are scattered throughout the valley and hillsides. Elevation in the watershed ranges from 2557 ft to 4949 ft, with the highest elevation along the ridge tops of the eastern boundary of the study area. As elevation increases in the drainage, vegetation changes from agriculture crops in the low-lands to brush, grasses and ponderosa pine (Pinus ponderosa Laws) at midslopes. The higher elevations are mainly covered with ponderosa pine and Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) forests. Annual daily temperatures average 47.5°F ranging from 34°F to 60°F. The average annual precipitation is 30.5 inches, with an average annual snowfall depth of 59.5 inches.

METHODS

Image Processing

Satellite data on computer compatible tape (CCT) were purchased and processed from the EROS Data Center, Sioux Falls, South Dakota. The date of imagery used for this project was August 10, 1981. This date was selected from examination of days the satellite passed over Hangman Creek (global coverage every 18 days) with consideration for the day with the least cloud cover.

The CCT was copied to a format compatible with the Washington State University Computer Service Center (WSUCSC) and the Digital Image Analysis Laboratory (DIAL). The DIAL Lab was used to delineate the study area and to produce color-enhanced photos of the scene for interpretive uses during classifications.

The VICAR (Video Image Communication and Retrieval) portion of the VICAR/IBIS software package was used to process the digital data.

The VICAR/IBIS Reference Manual developed at WSUCSC (1981) documents the specific VICAR programs used in the image processing phase.

The basic approach to classification used in this project began with selection of sample areas (referred to as training sites) which represented all of the spectral variation within the entire study area. The modified clustering classification technique was chosen to determine training sites. This technique has been documented as combining minimal computer time, high classification accuracy and the most effective analyst/data interaction (Fleming et al. 1975). The variation in the data is examined through computer analysis and manual interpretation utilizing the most efficient aspects of both with respect to the type of data.

The statistics generated from the training areas are ultimately used to classify the entire study area. Information such as statistical data of spectral reflectance values (mean, standard deviation, variance, covariance and separability matrices) from the VICAR programs, verbal communications with Soil Conservation Service (SCS) and Bureau of Indian Affairs personnel, air photos, satellite image photos and map data were used during the classification process. Agriculture State Conservation Service (ASCS) records, field checking and graphical illustrations of mean reflectance curves for each band were also used to aid in classification.

Upon completion of the vegetation classification, the study area was geometrically corrected to a United States Geological Survey 7.5 minute quadrangle. This procedure involved correction of both the scale and skewness of the data. Following this modification, the computer printout map, at a scale of 1:24,000, was used to draft a cover type map.

In order to check the accuracy of this classification, five random (one square mile) areas were chosen, representing approximately 5% of the total study area. Ground truth data from the accuracy check were available at the ASCS and SCS offices in St. Maries, Idaho. Pixel (picture element, 57m x 57m) area in meters was converted to acres for comparison of predicted and actual cover type acreages.

Application of the Universal Soil Loss Equation

Annual soil loss was estimated for each vegetation cover type with the USLE; $A = R_tKLSCP$

where A = annual soil loss (tons/acre/year)

R_t = precipitation factor for rain and snow

K = soil erodibility factor

LS = slope and length of slope factor

C = cropping management factor

P = erosion control practice factor

Values for the variables in the equation were developed in the following manner.

The R_t variable was estimated from information presented in USDA, TN-19 (1975). Three Rt zones (30, 40 and 50) were identified within the study area (Figure 3). Average R_t values of 35, 45 and 55 were used for those areas which were located within the respective zones.

Soils information for the study area were obtained from the Benewah County Soil Survey (USDA 1980a). The total area for the soil association located within each cover type and R_t zone were determinmined using map overlays and digitizing techniques. The soil erodibility factor (K) for each soil association was obtained from the soil survey publication. A soil survey map and topographic overlay map were used to estimate average slope and slope length data for each soil association located within the R_t zone.

Slope lengths were highly variable, therefore, an average slope length of 100 ft was used with average slope values to determine the LS factor for a soil association within an R_t zone. This factor was estimated according to procedures described in TN-19.

Field investigations were conducted to generate the vegetation and soil cover data needed for estimating the cropping management factor (C) on the forest and range cover types. Three randomly located 100 ft transects were inventoried for each cover type in these classes. Vegetation type, height, percent ground cover and slope were measured for each transect. These data were used to develop the C-factor following the procedures in USDA, TN-10, (1977). The C-factors for agriculture cover type were obtained from the TN-19 report.

The estimated C-factors for the forest and range cover types were high compared to C-values in other reports (USDA 1979 and USDA 1980b). Additional investigation of the procedures in TN-10 indicated that a representative estimate of C-values for forest and range conditions could not be obtained with these procedures. The range of possible C-values in the TN-10 procedures did not include the relatively low C-values present on the forest and range lands at Hangman Creek. Similar results have been reported (USDA 1979). Because of this discrepancy, the C-factor for the forest cover types was estimated by using existing annual soil erosion data (A) from research conducted on forested land in north-central Idaho (McMurtray et al. 1982). The appropriate R_t, K, LS and P values were used with the measured A to calculate the C-value. The C-factors for the range cover types were obtained from data presented in a USDA report (1980b).

The inability to obtain on-site C-factors for forest and range lands prohibited meaningful statistical comparisons between cover types, C-values and satellite reflectance data. Therefore, correlation analysis of these parameters anticipated as an original part of the data analyses were not conducted.

The erosion control practice factor (P) for agriculture lands varies with the types of conservation practices used and the slope of the land surface (USDA 1975). Due to several agriculture cover types and varied conservation practices conducted in the study area, it was decided to use contour farming as the average practice. The P value for this practice, 0.5, was used for all agriculture cover types. The erosion control practices were considered to be nonexistant on forest and range lands therefore this parameter was omitted from the equation for these cases.

Annual soil loss (A) was calculated (tons/acre/year) for each cover type and soil association within the study area.

Critical erosion areas were determined by comparing the A values for each cover type and soil association within an R_t zone with the soil loss tolerance values (T) for each soil association (Benewah County Soil Survey, USDA 1980a). Soil loss tolerance is defined as the maximum amount of soil loss in tons/acre/year that can occur without creating a decrease in site productivity.

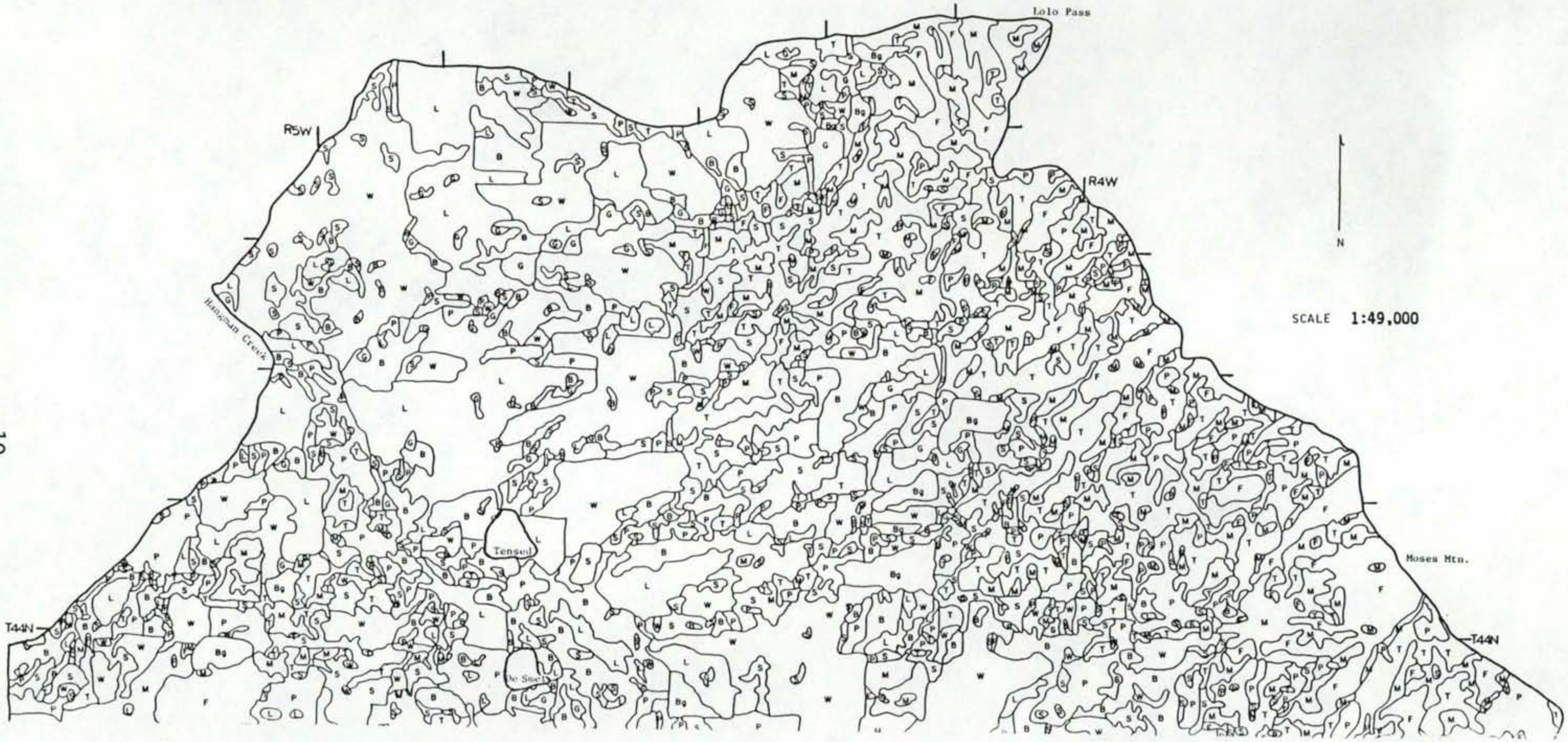
RESULTS

Image Processing

Ninety two spectral groups were derived from the satellite data using the modified clustering approach. Upon completion of the image processing procedure, statistics from 40 spectral groups were used to classify the data into ten major cover types. Agriculture cover types included lentils, winter wheat, barley and bluegrass. Forest cover types included dense mixed-forest (predominately Douglas fir) with a canopy cover greater than 70% and medium mixed forest (50 - 70% canopy cover) composed primarily of Douglas fir and Ponderosa pine. Also identified were Ponderosa Pine stands with varying canopy coverage. Range land cover types included pasture composed of annual grasses and hay. Shrub lands and bareground areas (tilled fields) were also identified.

The final image was geometrically corrected to account for the skewness in data, and the scale was adjusted to a map base of 1:24,000. The VICAR processed image data was subsequently displayed on a computer printout map which was used to draft a vegetation cover type map of the study area (Figure 2).

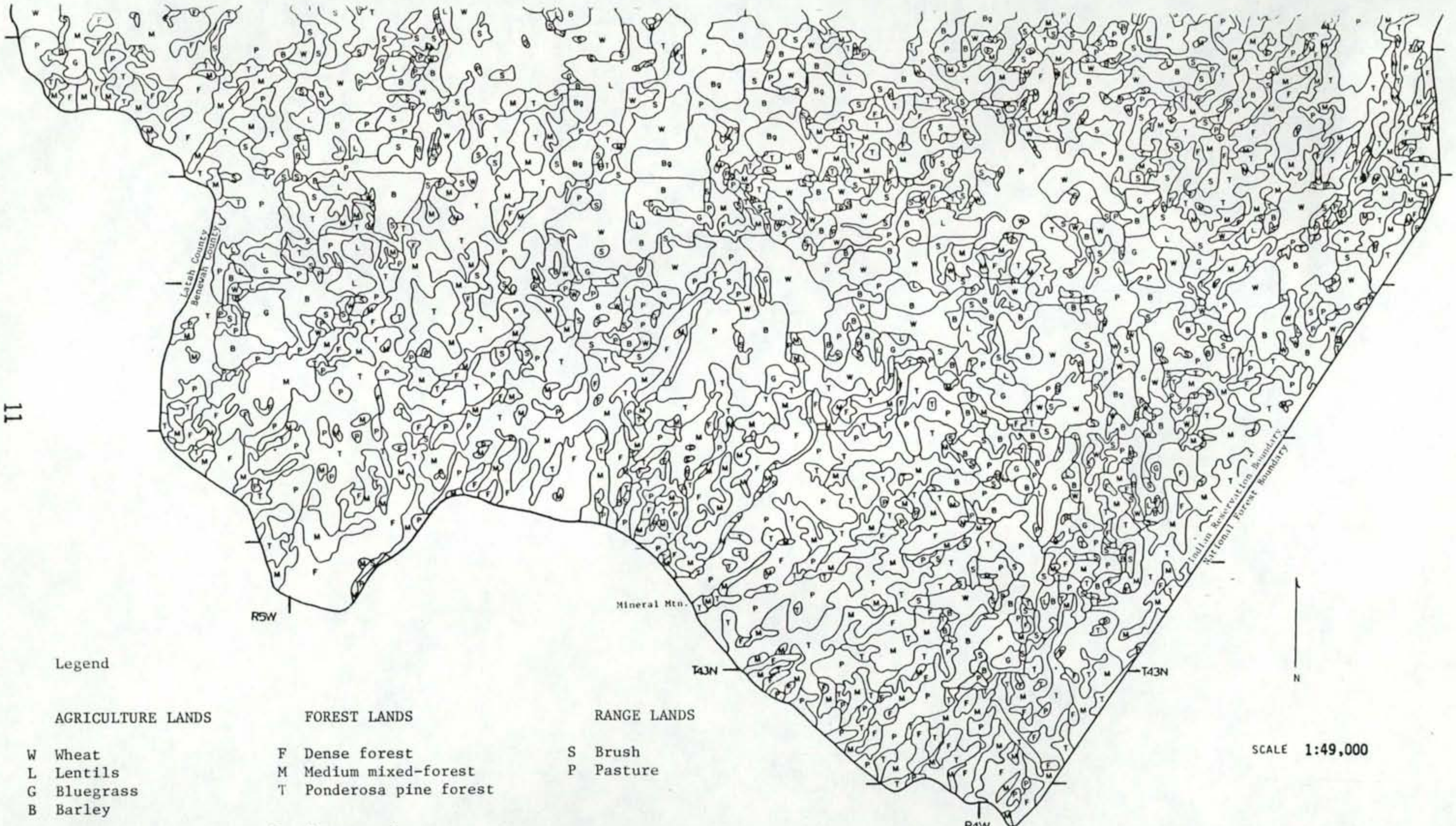
Ground truth data from the ASCS and the SCS permitted evaluation of the accuracy of the vegetation classification. The accuracy ranged from 87% for forest type, 88% for range types and 91% for agriculture types, with a weighted average of 89% for all cover types.



Legend

AGRICULTURE LANDS		FOREST LANDS		RANGE LANDS			
W	Wheat	F	Dense forest	S	Brush		
L	Lentils	M	Medium mixed-forest	P	Pasture	Bg	Bareground
G	Bluegrass	T	Ponderosa pine forest				
B	Barley						

Figure 2. Vegetation cover types of the southern portion of Hangman Creek Watershed, Benewah County, Idaho.



Legend

AGRICULTURE LANDS

W Wheat
L Lentils
G Bluegrass
B Barley

FOREST LANDS

F Dense forest
M Medium mixed-forest
T Ponderosa pine forest

RANGE LANDS

S Brush
P Pasture

Bg Bareground

Figure 2. (continued)

Application of the Universal Soil Loss Equation

Annual soil loss was estimated for each cover type within the the Hangman Creek study area. The soil associations found in the Hangman Creek study area are listed in Appendix 1. The estimates of soil loss

for each cover type and soil association within a cover class are presented in Appendix 2.

The C-factors selected for use in the equation were 0.20 for wheat and lentils, 0.03 for bluegrass and 0.10 for barley. The C-values for pasture and bushlands were 9×10^{-4} in the $R_t = 55$ zone, 2×10^{-4} for $R_t = 45$ and 3.5×10^{-4} for $R_t = 35$. The forest cover type C-values were 5.5×10^{-5} in the $R_t = 55$ zone, 8.5×10^{-5} for $R_t = 45$ and 1.5×10^{-4} for $R_t = 35$. An erosion control practice (P) factor of 0.5 was used for all of the agriculture cover types (wheat, lentils, barley and bluegrass). Erosion control on the forest and range-brush lands was considered nonexistent. Therefore, the P factor was not used in the equation for these cover types.

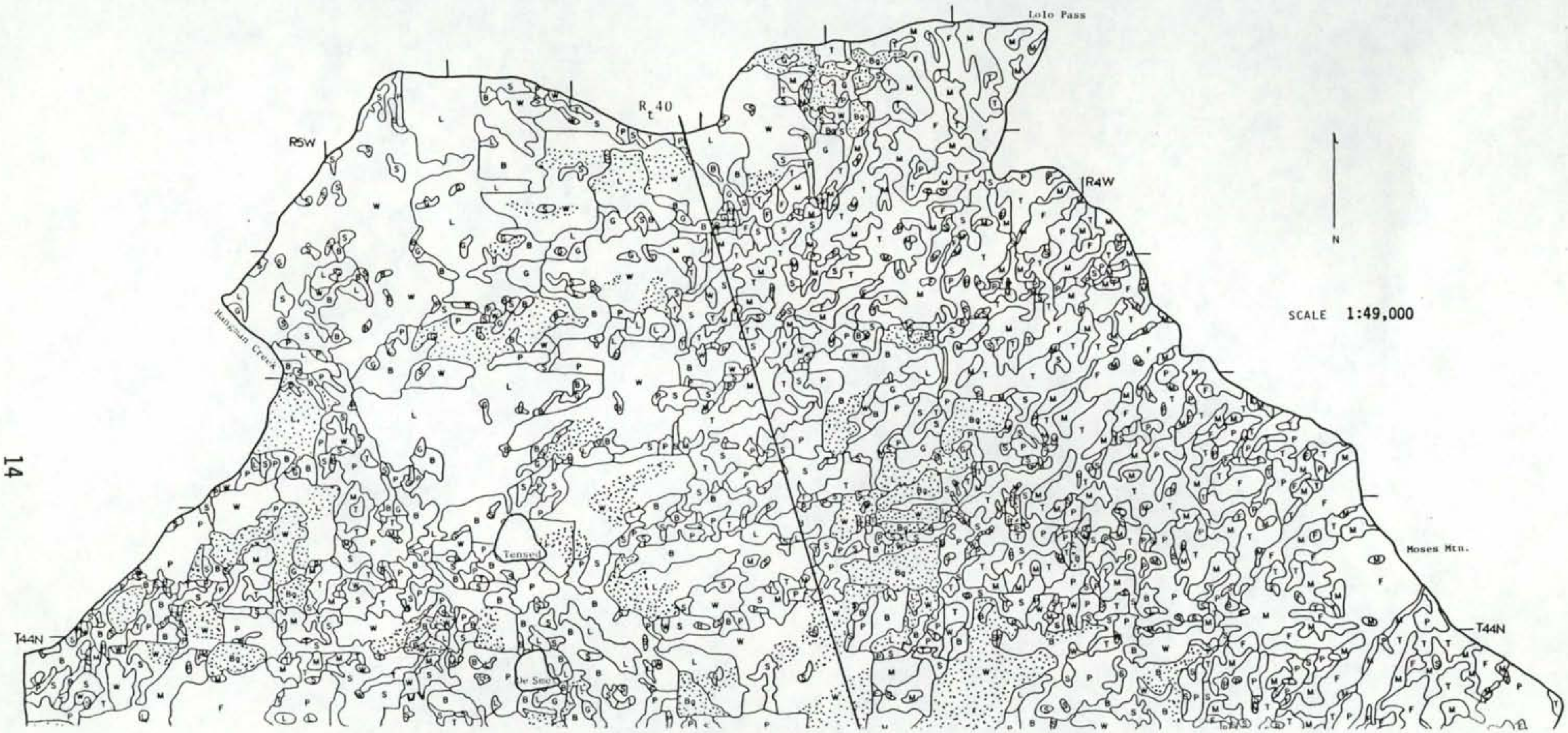
Annual soil loss ranged from 0.003 tons/acre/year on dense mixed-forest cover to 18.6 tons/acre/year on wheat and lentil fields (Appendix 2). Soil loss was estimated for bareground fields (1.4 to 88 tons/acre/year). These values represent the erosion rate if the fields were without vegetation cover for the entire year. These areas do not lack cover for extended time periods, thus, these estimates of the erosion rate for bareground with the USLE which predicts average annual erosion are not indicative of what occurred on these fields.

The USLE predicts a quantity of soil loss as related to site factors which effect the degree of surface erosion on a watershed. The amount of these surface eroded sediments which are subsequently delivered downslope to existing stream channels is not quantified by this model. Thus, interpretation of the sediment yield data produced by this model is limited to erosion on watershed surfaces. Also all soil loss values estimated with this equation were predicted on 100 ft length slopes and an erosion control practice factor of 0.5 (agriculture cover classes).

The critical erosion areas were determined by comparing the estimated annual soil loss (tons/acre/year) for a given soil association and cover type with the respective soil loss tolerance (T) values (Appendix 2). Critical erosion was identified on lentil, barley, wheat and bareground fields. The critical erosion areas are illustrated in Figure 3.

SUMMARY

Satellite data was used in conjunction with watershed data and the USLE to determine soil erosion in the southern portion of the Hangman Creek watershed in northern Idaho. August 1981 imagery was used to map approximately 58,000 acres of agriculture, forest and range lands. Ten cover classes were identified and mapped with 89% accuracy. Input data for the USLE were derived from soil survey data, map calculations, field measurements and information from the SCS and ASCS in St. Maries, Idaho. The greatest amount of soil loss on vegetation cover types occurred on wheat and lentil fields (18.7 tons/acre/year); and the dense-mixed forest cover type had the least amount of soil loss (0.003 tons/acre/year). Critical erosion occurred on wheat, lentil, barley and bareground fields.



Legend

AGRICULTURE LANDS	FOREST LANDS	RANGE LANDS	
W Wheat	F Dense forest	S Brush	Bg Bareground
L Lentils	M Medium mixed-forest	P Pasture	
G Bluegrass	T Ponderosa pine forest		⊡ Critical Erosion
B Barley			

Figure 3. Critical erosion areas in the southern portion of the Hangman Creek Watershed, Benewah County, Idaho.

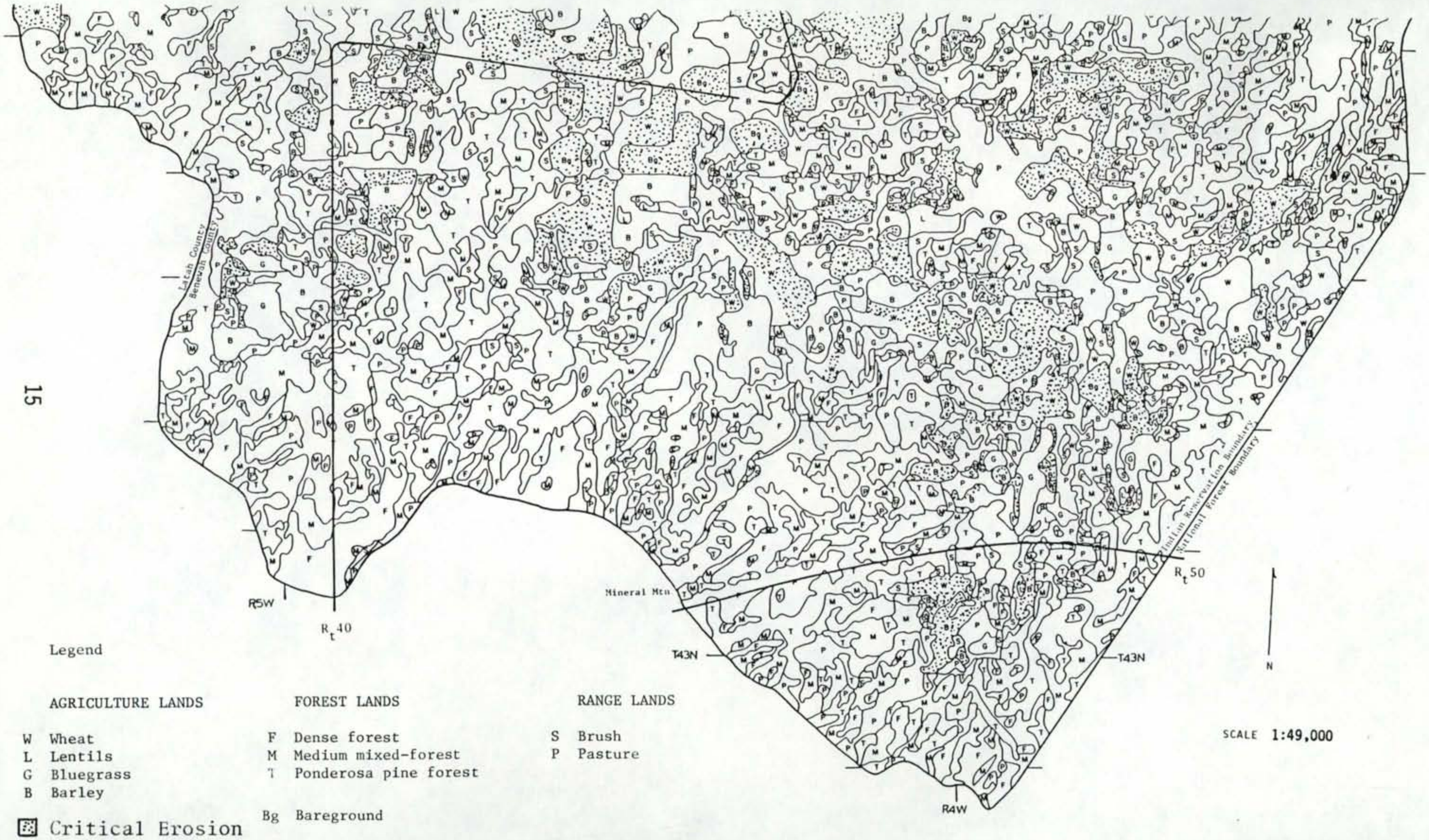


Figure 3. (continued)

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APPENDIX 1. Soil Associations Located on the Hangman Creek Study Area [1/]

Identification Number	Soil Association
2	Ardenvoir - Huckleberry (steep)
3	Ardenvoir - Huckleberry (very steep)
4	Ardenvoir - McCrosket (steep)
5	Ardenvoir - McCrosket (very steep)
6	Benewah - Rasser (5-20% slopes)
7[2/]	Benewah-Rasser (20-35% slopes)
12	Cald
13	Cald - Thatuna
16	Divers
20	Garfield - Tilma
21	Helmer (3-20% slopes)
23[2/]	Huckleberry (5-20% slopes)
24	Huckleberry (20-35% slopes)
25	Huckleberry (35-65% slopes)
27	Huckleberry - Ardenvoir (very steep)
32	Larkin (3-12% slopes)
33	Larkin (12-20% slopes)
34	Larkin (eroded)
35[2/]	Latahco
36	Latahco - Lovell
37	Lovell
38	McCrosket - Ardenvoir (steep)
39	McCrosket - Ardenvoir (very steep)
40	McCrosket - Tekoa
43[2/]	Moctileme
44	Naff - Palouse
49	Palouse (3-7% slopes)
50	Palouse (7-25% slopes)
52	Porrett
57	Santa (2-30% slopes)
58	Santa (20-35% slopes)
62	Setters
63	Southwick (3-12% slopes)
64	Southwick (12-20% slopes)
66	Taney (3-7% slopes)
67	Taney (7-25% slopes)
68	Taney (eroded)
69	Tekoa (5-20% slopes)
70	Tekoa (20-35% slopes)
72[2/]	Tekoa - Rock
73	Tensed - Pedee (3-25% slopes)
74	Tensed - Pedee (25-35% slopes)
75	Thatuna - Naff (7-25% slopes)
76	Thatuna - Naff (25-40% slopes)
78	Worley (10-25% slopes)
79	Worley (eroded)

1/ Adapted from Benewah County Soil Survey 1980

2/ Soil erosion was not estimated for these soil associations due to a lack of data needed for the Universal Soil Loss Equation

APPENDIX 2. Annual Soil Loss for the Hangman Creek Study Area

COVER TYPE

SOIL EROSION (tons/acre/year)

Soil Association	Precipitation Zone	Dense Forest (F)	Medium Forest (M)	Ponderosa pine Forest (T)	Wheat (W)	Lentils (L)	Barley (B)	Bluegrass (G)	Pasture (P)	Brush (S)	Soil Loss Tolerance (T) (tons/acre/year)
2	1 (55)	.009	.009	.009	–[1/]	–	8.1[2/]	–	–	–	3
	2 (45)	.008	.008	.008	–	–	6.6[2/]	2.0	.02	.02	3
	3 (35)	.010	.010	.010	–	–	–	–	–	.36	3
3	1	.009	.009	.009	16.1[2/]	16.1[2/]	8.1[2/]	–	.15	.15	3
	2	.010	.010	.010	13.1[2/]	13.1[2/]	6.6[2/]	–	.02	.02	3
	3	–	–	–	–	–	–	–	–	–	3
4	1	–	.009	.009	18.7[2/]	18.7[2/]	9.4[2/]	–	.17	.17	3
	2	.012	.012	.012	14.1[2/]	14.1[2/]	7.0[2/]	–	.03	.03	3
	3	–	.016	–	–	–	–	–	–	–	3
5	1	–	–	–	–	–	–	–	–	–	3
	2	.011	.011	.011	–	–	–	2.4	.56	–	3
	3	.013	.013	.013	–	–	–	–	–	–	3
6	1	–	–	–	–	–	–	–	–	–	5
	2	.003	.003	.003	3.7	3.7	1.9	0.6	.01	.01	5
	3	–	–	–	–	–	–	–	.10	–	5
7	1	–	–	–	–	–	–	–	–	–	5
	2	–	.009	–	10.4[2/]	10.4[2/]	–	1.6	–	–	5
	3	–	–	–	–	–	–	–	–	–	5
13	1	–	–	–	–	–	–	–	–	–	3
	2	–	–	–	1.6	1.6	–	–	–	–	3
	3	–	–	–	1.2	–	0.6	0.6	.04	.04	3

1/ - Cover type not found on this soil association in this precipitation zone.

2/ The annual soil loss was $\geq$ 0.5 tons/acre/year than the T value.

APPENDIX 2. Annual Soil Loss for the Hangman Creek Study Area (continued)

COVER TYPE

SOIL EROSION (tons/acre/year)

Soil Association	Precipitation Zone	Dense Forest (F)	Medium Forest (M)	Ponderosa pine Forest (T)	Wheat (W)	Lentils (L)	Barley (B)	Bluegrass (G)	Pasture (P)	Brush (S)	Soil Loss Tolerance (T) (tons/acre/year)
16	1	-	-	-	-	-	-	-	-	-	3
	2	.010	.010	-	-	-	-	-	.03	-	3
	3	-	-	-	-	-	-	-	-	-	3
20	1	-	-	-	-	-	-	-	-	-	3
	2	-	-	-	-	-	-	-	-	-	3
	3	-	-	-	1.2	-	-	.17	-	.04	3
21	1	-	.003	.003	-	-	-	-	-	-	5
	2	.004	.004	.004	-	2.9	1.5	-	.006	-	5
	3	.006	.006	.006	-	-	1.1	-	.08	-	5
24	1	.005	.005	.005	-	-	-	-	.08	-	2
	2	.004	.004	.004	-	7.8[2/]	-	-	.01	.01	2
	3	-	.006	.006	-	-	-	-	-	-	2
25	1	.009	.009	.009	-	-	-	-	.15	-	2
	2	.017	.017	.017	-	-	-	-	-	-	2
	3	-	-	-	-	-	-	-	-	.03	2
27	1	.009	.009	.009	-	-	-	-	.15	.15	2
	2	.012	.012	.012	-	-	-	-	.03	.03	2
	3	.10	-	.016	-	-	-	-	.38	-	2
32	1	-	-	-	-	-	-	-	-	-	5
	2	-	-	-	7.5[2/]	7.5[2/]	-	1.1	-	-	5
	3	-	.009	.009	5.9[2/]	5.9[2/]	2.9	2.9	.20	.20	5
33	1	-	-	-	-	-	-	-	-	-	5
	2	-	-	-	-	-	-	.06	-	-	5
	3	.004	-	-	3.0	3.0	1.5	1.5	.11	.11	5

1/ - Cover type not found on this soil association in this precipitation zone.

2/ The annual soil loss was ≥ 0.5 tons/acre/year than the T value.

APPENDIX 2. Annual Soil Loss for the Hangman Creek Study Area (continued)

COVER TYPE

SOIL EROSION (tons/acre/year)

Soil Association	Precipitation Zone	Dense Forest (F)	Medium Forest (M)	Ponderosa pine Forest (T)	Wheat (W)	Lentils (L)	Barley (B)	Bluegrass (G)	Pasture (P)	Brush (S)	Soil Loss Tolerance (T) (tons/acre/year)
34	1	-	-	-	-	-	-	-	-	-	5
	2	-	-	-	-	-	-	-	-	-	5
	3	-	-	.003	2.0	2.0	1.0	1.0	.07	.07	5
36	1	-	-	-	-	-	-	-	-	-	5
	2	-	.000	.000	0.3	0.3	0.1	0.04	-	.001	5
	3	-	.000	.000	0.2	0.2	0.1	0.03	.001	.001	5
37	1	-	-	-	-	-	-	-	.007	-	5
	2	-	.000	.000	-	-	-	-	-	-	5
	3	-	.000	-	0.2	0.2	0.1	0.03	.001	.001	5
38	1	-	-	-	-	-	-	-	.01	-	2
	2	-	.364	.364	7.4[2/]	-	3.7[2/]	-	-	.01	2
	3	-	-	-	-	-	-	-	-	.26	2
39	1	-	.008	.008	-	-	-	-	.14	.14	2
	2	-	.010	.010	-	12.5[2/]	6.6[2/]	-	.03	.03	2
	3	.016	.016	.016	-	-	4.9[2/]	-	-	.37	2
40	1	-	-	-	-	-	-	-	-	-	2
	2	.012	.012	.012	17.5[2/]	17.5[2/]	8.7[2/]	2.6[2/]	.03	.03	2
	3	.019	.019	.019	13.6[2/]	13.6[2/]	6.8[2/]	2.0	.48	.48	2
44	1	-	-	-	-	-	-	-	-	-	5
	2	-	-	-	-	-	-	-	.01	.01	5
	3	-	-	-	2.8	-	-	0.4	-	.10	5

1/ - Cover type not found on this soil association in this precipitation zone.

2/ The annual soil loss was ≥ 0.5 tons/acre/year than the T value.

APPENDIX 2. Annual Soil Loss for the Hangman Creek Study Area (continued)

COVER TYPE

SOIL EROSION (tons/acre/year)

Soil Association	Precipitation Zone	Dense Forest (F)	Medium Forest (M)	Ponderosa pine Forest (T)	Wheat (W)	Lentils (L)	Barley (B)	Bluegrass (G)	Pasture (P)	Brush (S)	Soil Loss Tolerance (T) (tons/acre/year)
49	1	-	-	-	-	-	-	-	.03	-	5
	2	-	-	-	-	-	1.5	-	-	-	5
	3	-	-	-	2.4	2.4	-	0.4	.08	.08	5
50	1	-	-	-	-	-	-	-	-	-	5
	2	-	-	-	-	3.4	-	0.5	-	-	5
	3	-	-	-	2.6	2.6	-	0.4	-	.09	5
52	1	-	-	-	-	-	-	-	-	-	5
	2	.000	.000	.000	0.5	0.5	0.2	0.1	.001	.001	5
	3	.000	.000	.000	-	-	-	-	-	-	5
57	1	.003	.003	.003	5.4[2/]	5.4[2/]	2.7	-	.05	.05	3
	2	.004	.004	.004	4.4[2/]	4.4[2/]	2.2	0.8	.01	.01	3
	3	.005	.005	.005	-	-	-	-	.12	.12	3
58	1	.009	.009	.009	16.6[2/]	-	-	-	.15	-	3
	2	.012	.012	.012	13.6[2/]	13.6[2/]	-	-	.03	.03	3
	3	-	-	-	10.6[2/]	-	5.3[2/]	-	-	.37	3
62	1	-	-	-	-	-	-	-	-	-	2
	2	.002	.002	.002	2.2	2.2	1.1	0.3	.004	.004	2
	3	-	-	.003	1.7	1.7	-	0.3	-	-	2
63	1	-	-	-	-	-	-	-	-	-	5
	2	-	.007	.007	8.8[2/]	8.8[2/]	4.4	1.3	.02	.02	5
	3	-	.010	.010	6.8[2/]	6.8[2/]	3.4	1.0	.24	.24	5

1/ - Cover type not found on this soil association in this precipitation zone.

2/ The annual soil loss was $\geq$ 0.5 tons/acre/year than the T value.

APPENDIX 2. Annual Soil Loss for the Hangman Creek Study Area (continued)

COVER TYPE

SOIL EROSION (tons/acre/year)

Soil Association	Precipitation Zone	Dense Forest (F)	Medium Forest (M)	Ponderosa pine Forest (T)	Wheat (W)	Lentils (L)	Barley (B)	Bluegrass (G)	Pasture (P)	Brush (S)	Soil Loss Tolerance (T) (tons/acre/year)
64	1	-	-	-	-	-	-	-	-	-	5
	2	-	.004	-	4.5	4.5	-	-	.01	.01	5
	3	-	.005	.005	3.5	3.5	1.7	0.5	.12	.12	5
66	1	-	-	-	-	-	-	-	-	-	3
	2	.003	.003	.003	4.1[2/]	4.1[2/]	2.0	0.6	.01	.01	3
	3	.005	.005	.005	3.2	3.2	1.6	0.5	.08	.08	3
67	1	-	-	-	-	-	-	-	-	-	3
	2	.004	.004	.004	4.5[2/]	4.5[2/]	2.2	0.7	.01	.01	3
	3	.005	.005	.005	3.5[2/]	3.5[2/]	1.8	0.5	.11	.11	3
68	1	-	-	-	-	-	-	-	-	-	3
	2	-	.003	.003	3.8[2/]	3.8[2/]	1.9	0.6	.01	.01	3
	3	-	-	.004	3.5[2/]	-	1.7	0.5	.10	.10	3
69	1	-	-	-	-	-	-	-	-	-	2
	2	-	.003	.003	3.8[2/]	-	1.6	-	.01	.01	2
	3	-	-	-	-	-	-	-	-	-	2
70	1	-	-	-	-	-	-	-	-	-	2
	2	.008	-	-	-	-	-	-	-	-	2
	3	.011	.011	.011	-	-	3.5[2/]	-	-	-	2

1/ - Cover type not found on this soil association in this precipitation zone.

2/ The annual soil loss was ≥ 0.5 tons/acre/year than the T value.

APPENDIX 2. Annual Soil Loss for the Hangman Creek Study Area (continued)

COVER TYPE

SOIL EROSION (tons/acre/year)

Soil Association	Precipitation Zone	Dense Forest (F)	Medium Forest (M)	Ponderosa pine Forest (T)	Wheat (W)	Lentils (L)	Barley (B)	Bluegrass (G)	Pasture (P)	Brush (S)	Soil Loss Tolerance (T) (tons/acre/year)
73	1	-	-	-	-	-	-	-	-	-	4
	2	-	.003	.003	4.1	-	2.0	-	.01	.01	4
	3	-	.005	.005	14.4[2/]	-	0.7	-	.11	.11	4
74	1	-	-	-	-	-	-	-	-	-	4
	2	.009	.009	.009	10.9[2/]	10.9[2/]	5.5	1.6	-	-	4
	3	-	.013	.013	8.5[2/]	8.5[2/]	4.2	1.3	.02	.02	4
75	1	-	-	-	-	-	-	-	-	-	3
	2	-	-	-	3.6[2/]	-	-	-	-	-	3
	3	-	-	-	2.8	2.8	1.4	-	.10	-	3
76	1	-	-	-	-	-	-	-	-	-	3
	2	-	-	-	-	-	-	1.3	-	-	3
	3	-	-	-	-	-	-	-	-	-	3
78	1	-	-	-	-	-	-	-	-	-	5
	2	-	-	-	4.3	4.3	2.2	0.7	-	.01	5
	3	-	.005	.005	3.4	3.4	1.7	0.5	.12	.12	5
79	1	-	-	-	-	-	-	-	-	-	5
	2	-	-	-	-	-	-	-	-	-	5
	3	-	-	-	3.4	-	-	-	-	.12	5

1/ - Cover type not found on this soil association in this precipitation zone.

2/ The annual soil loss was ≥ 0.5 tons/acre/year than the T value.

Selected Water Resources Abstracts

Input Transaction Form

1. Report No.	2.	3. Accession No. W

4. Title: THE USE OF REMOTE SENSING TECHNIQUES AND THE UNIVERSAL SOIL LOSS EQUATION TO DETERMINE SOIL EROSION

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Idaho Water and Energy Resources Research Institute Completion Report, Moscow, January 1983. 25 p., 3 fig, 22 ref.

16. Abstract

Satellite data with ancillary watershed information was used to determine soil erosion of agriculture, forest and range lands in the southern portion of the Hangman Creek watershed, Benewah County, Idaho. Vegetation cover types derived from satellite data and the VICAR/IBIS image processing computer software package were determined with 89% accuracy. The vegetation cover types identified on the study area were dense-mixed forest, medium density mixed forest, ponderosa pine forest, wheat, lentils, barley, bluegrass, pasture and brush. Soil erosion (tons/acre/year) was estimated with the Universal Soil Loss Equation. Annual soil loss in the study area ranged from 0.003 tons/acre/year in the dense to mixed-forest cover type to 18.7 tons/acre/year in the wheat and lentil cover types. Annual erosion was compared with the annual soil loss tolerance to determine critical erosion areas.

17a. Descriptors

*Soil erosion, *Remote sensing techniques, *Landsat (satellite) data, Agriculture, forest and range lands, VICAR/IBIS image processing, Cover type identification, Universal soil loss equation, Annual soil erosion, Annual soil loss tolerance.

17c. COWRR Field & Group

02J

18. Availability	19. Security Class. (Report) / 20. Security Class. (Page)	21. No. of Pages / 22. Price	Send to:
IWERRI		25	Water Resources Scientific Information Center OFFICE OF WATER RESEARCH AND TECHNOLOGY U.S. DEPARTMENT OF THE INTERIOR Washington, D.C. 20240

Abstractor K.M. Schuchard | Institution Idaho Water & Energy Resources Research Inst.