~~Exhibit 1-b~~

watershed planning

Iowa

models

erosion model

Watersheds

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WATERSHED EROSION MODEL VALIDATION FOR SOUTHWEST IOWA

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WATERSHED EROSION MODEL VALIDATION FOR SOUTHWEST IOWA

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ABSTRACT

Watershed erosion data from two ARS watersheds near Treynor, Iowa are used to test an erosion model developed by Onstad and Foster (1975). This model utilizes a distributed set of input variables and includes a detachment and a transport phase. Depending on the magnitude of each phase, soil is either eroded or deposited. Predicted sediment yields from sheet-rill sources were compared with measured yields for single events and with predictions by the univeral soil loss equation developed by Wischmeier and Smith (1965) and the Williams model (1972). A sensitivity analysis was performed for the fitted parameter in the Onstad-Foster model. Confidence intervals were also calculated for a wide range of single-event sediment yields.

INTRODUCTION

Erosion modeling for agricultural watersheds is rapidly being developed to meet guidelines for identifying and evaluating the nature and extent of agricultural pollution. Some models use fundamental fluvial hydraulic and hydrologic theories and others apply established empirical techniques. Prediction needs range from upslope erosion distribution on a storm basis for small watersheds to average annual sediment yields from large watersheds. A single model probably will not be suitable for all purposes nor universally applicable for a single purpose.

The model explained here and tested against two other models was designed to estimate the upslope erosion and sediment yield from small watersheds in the Corn Belt for single rainfall events. A mathematical procedure is described to estimate soil detachment and transport from each soil-slope unit of a system of units representing the watershed geometry. Sediment yields predicted by this model are compared with measured quantities for two watersheds near Treynor, Iowa and with estimates obtained by using two other prediction methods.

DESCRIPTION OF MODEL

This erosion model consists of relationships describing the two phases of the erosion process, detachment and transport. It has been described in detail by Onstad and Foster (1975) and Frere, et al. (1975). The basic equation used is the Universal Soil Loss Equation (USLE) with modifications described by Foster, et al. (1973).

$$A = WKCPSL \qquad [1]$$

where A is the soil loss in tons/acre (T/a), W is a hydrologic term and K, C, P, S, and L are the usual USLE parameters. The hydrologic term, W, is a function of both rainfall and runoff.

$$W = a\, R_{st} + (1 - a)\ 30\ Qq_p^{1/3} \qquad [2]$$

where R_{st} = storm rainfall factor (EI units of the USLE)
Q = runoff volume (in)
q_p = peak runoff rate (in/hr)
a = coefficient ($0 \leq a \leq 1$)

The numerical constant, 30, was evaluated from plot data obtained with artificial rainfall on 20 soils in Minnesota and Indiana (Foster, et al. 1973). The coefficient, a represents the relative importance of rainfall energy compared with runoff energy for detaching soil. Normally, a will be larger for watersheds having short slopes, no vegetative cover, and intense rains. Until more research is conducted, a must be evaluated by measured sediment yields.

The sediment yield for a complex slope depends on the detachment and transport of soil from upslope. If several approximately uniform segments represent the slope, Foster and Wischmeier (1974) have shown that the detachment capacity can be represented by

$$E_j = \frac{W_j(KCPS)_j}{185}\,(x_j^{1.5} - x_{j-1}^{1.5}) \qquad [3]$$

where E_j = detachment capacity for segment j (lbs/ft width)
x_j = distance from top of slope to lower end of segment j (ft), and all other terms are as described for equations [1] and [2]

Each slope segment may have a unique set of parameters, as shown in equation [3]. When a slope has n segments, the total detached soil capacity is the cumulative amount of all segments and this equals the slope sediment yield, provided that the soil transport capacity is not limiting.

The transport capacity used in this model is represented by the equation

$$T_{xj} = \frac{W_j(\tau SCP)_j}{185}\, x_j^{1.5} \qquad [4]$$

where T_{xj} = transport capacity at position x_j (lbs/ft width).
τ = transportability

Values for S, C, W_j, and P are the same as those used for calculating detachment.

Throughout this discussion, τ is assumed to be the same as K. If a slope has more than one soil type, τ is evaluated by calculating the average detachment weighted erodibility of each soil. This value reflects the transportability of material from upslope segments across the segment being evaluated.

Sediment yield is calculated to the bottom of each slope segment by comparing the total soil detachment and the transport capacity. If transport capacity exceeds the detached load of the segment plus contributions from upslope segments, then sediment yield is the sum of the detached load plus upslope contributions. If the transport capacity is less than the total soil available to be transported, the sediment yield equals the transport capacity and the remainder of the soil is considered to be deposited. Calculations are begun for the uppermost segment and continued until the channel is reached. The sediment yield for the watershed is assumed to be the sum of the yields of all the streamtubes at the channel. All sediment contributions reaching the channel are assumed transported from the watershed. The final results are the storm sediment yield from the watershed and the distribution of erosion throughout the watershed.

TESTING PROCEDURE

The sediment data used for model testing were obtained from Watersheds 1 (74.5 a) and 2 (82.8 a) of the Agricultural Research Service near Treynor, Iowa (Saxton, et al., 1971). These watersheds are single-cropped and typical of the deep loessial soil region of western Iowa. Detailed hydrologic and sediment data are available for each major event. These data include rainfall, hydrographs and sediment loads.

To divide the watershed into a series of slopes, we drew flow lines on topographic maps of the two watersheds. These flow lines were selected to separate different regions with respect to overland flow characteristics as described by Onstad and Brakensiek (1968). Each area between adjacent lines constitutes a complex slope along which detachment and transport capacities were calculated with equations [3] and [4]. The slopes were divided into segments to represent the major gradients. Each segment is considered to be homogeneous with respect to W, K, C, P, and S. The streamlines selected to represent the two watersheds are shown in Figures 1 and 2.

Watershed 1 was divided into 30 complex slope units and Watershed 2 into 48 units. The area and the length of the contour boundaries of each unit were measured, and the average slope length was determined by assuming each unit to be trapezoidal. Average slope gradient for each segment was determined by measuring the length and relief of a transect drawn within each segment. These geometric parameters allow computation of S and x of equations [3] and [4] for each slope.

Both watersheds are composed of Ida and Monona soils, using a soil erodibility factor, K, of 0.32. The practice factor, P, was assumed to be 1.0, because the contour farming was not effective. The cropping-management factor, C, was determined from Wischmeier and Smith (1965), using crop stage periods averaged over the years investigated.

Ideally, the runoff parameters, Q and q_p, for a particular storm would be estimated by using a reliable hydrologic model at all points needed on the watershed and the rainfall factor, R_{st}, would be determined from a rainfall histogram. The data available from these watersheds included rainfall histograms for determining R_{st}, the outlet hydrograph for determining Q and q_p, and the sediment yield from sheet-rill sources. Throughout the testing procedure, both the rainfall factor, R_{st}, and the runoff volume, Q, were assumed to be uniformly distributed over the

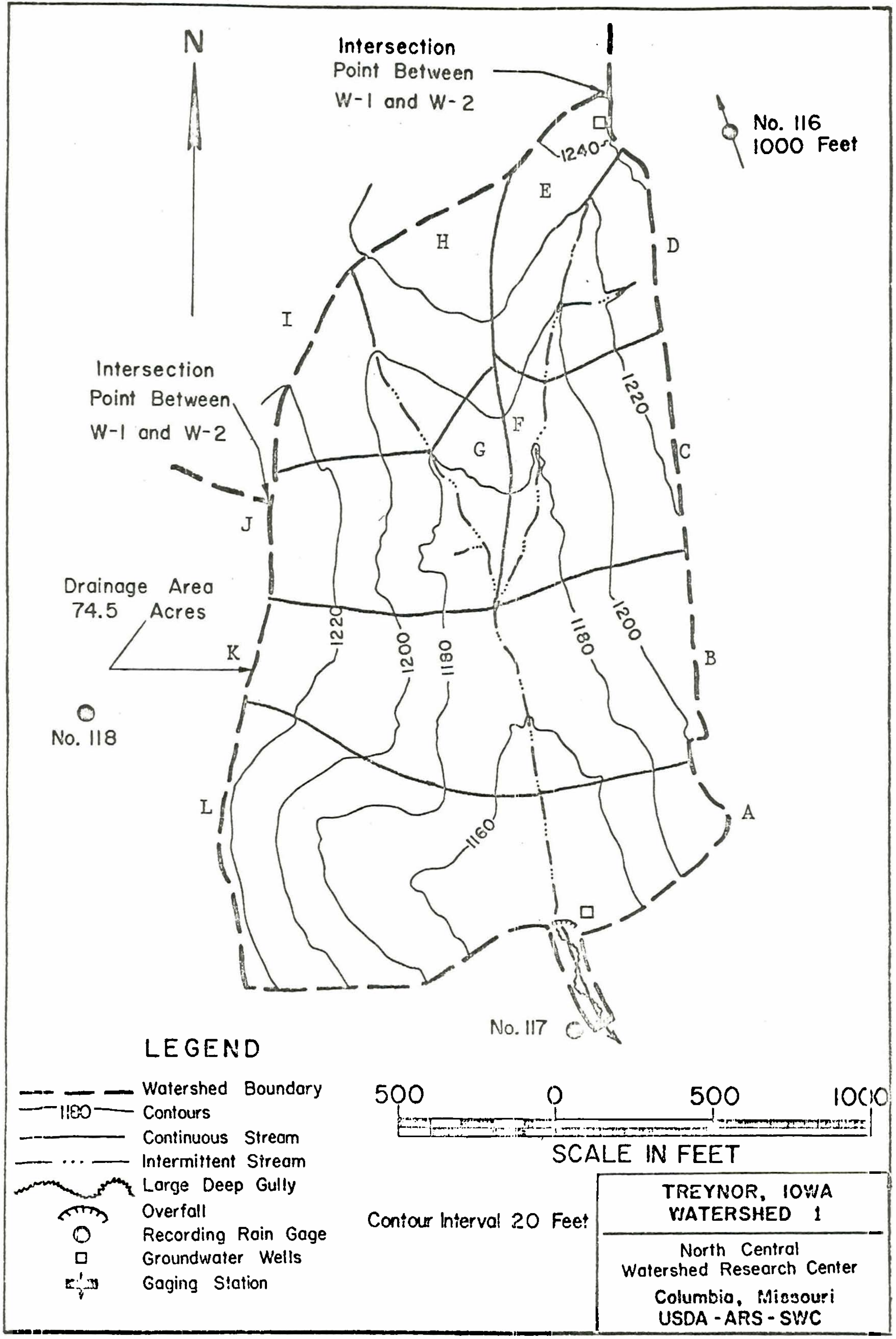
N
Intersection Point Between W-1 and W-2
No. 116
1000 Feet
1240
E
H
D
I
1220
Intersection Point Between W-1 and W-2
F
G
C
J
Drainage Area 74.5 Acres
1220
1200
1180
1180
1200
K
B
No. 118
L
A
1160
No. 117
LEGEND
Watershed Boundary
1180 Contours
Continuous Stream
Intermittent Stream
Large Deep Gully
Overfall
Recording Rain Gage
Groundwater Wells
Gaging Station
500
0
500
1000
SCALE IN FEET
Contour Interval 20 Feet
TREYNOR, IOWA
WATERSHED 1
North Central
Watershed Research Center
Columbia, Missouri
USDA - ARS - SWC

Figure 1

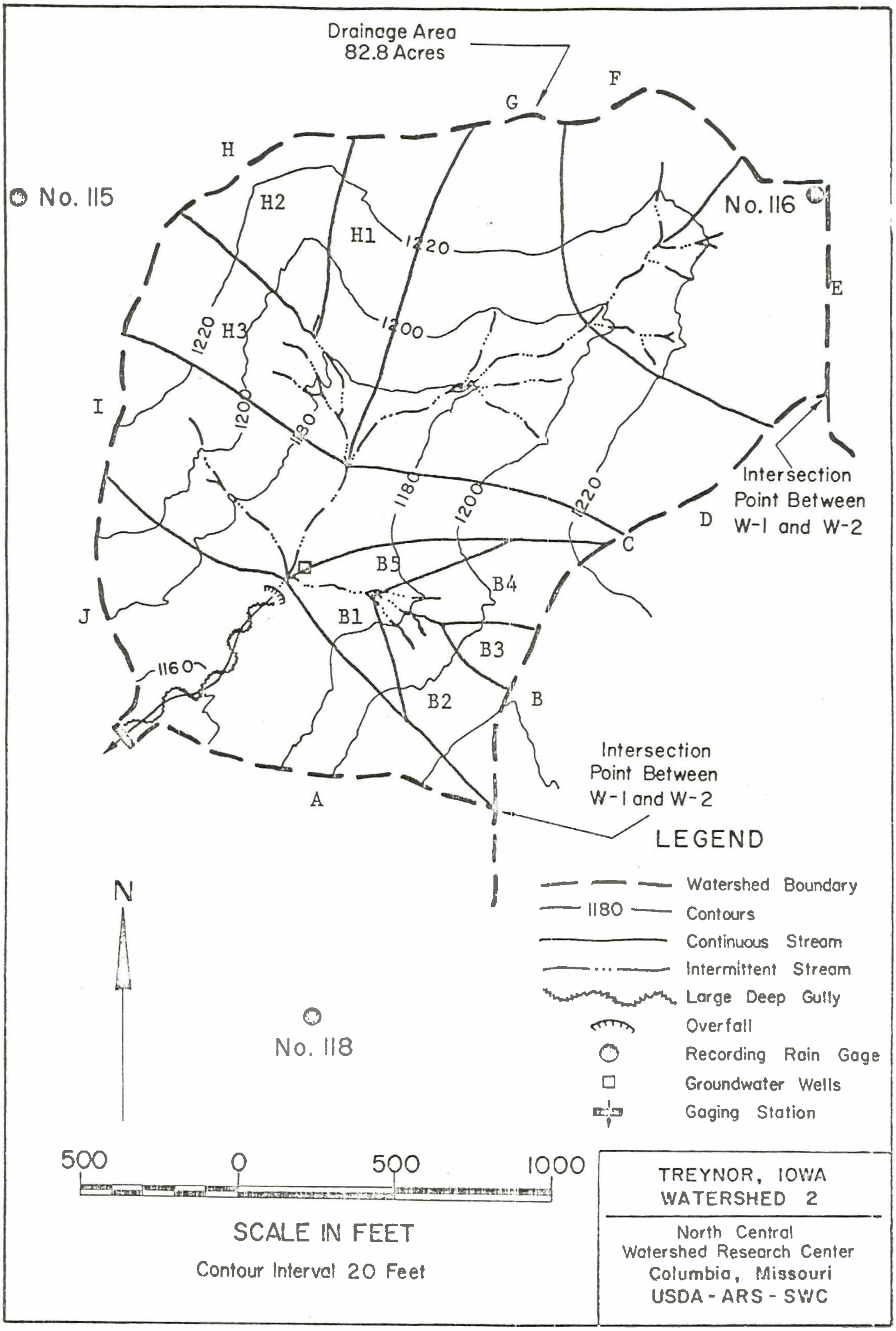
Drainage Area
82.8 Acres
G
F
H
No. 115
H2
H1
1220
No. 116
E
1200
H3
1220
I
1200
1180
1180
1200
1220
Intersection
Point Between
W-1 and W-2
D
C
B5
B4
J
B1
B3
1160
B2
B
A
Intersection
Point Between
W-1 and W-2
LEGEND
Watershed Boundary
1180 Contours
Continuous Stream
Intermittent Stream
Large Deep Gully
Overfall
Recording Rain Gage
Groundwater Wells
Gaging Station
N
No. 118
500
0
500
1000
SCALE IN FEET
Contour Interval 20 Feet
TREYNOR, IOWA
WATERSHED 2
North Central
Watershed Research Center
Columbia, Missouri
USDA - ARS - SWC

Figure 2

watershed so that these factors were constant and uniform for all segments.

The peak rate of runoff, q_p, was estimated at the bottom of each segment by using a weighting factor together with the measured peak rate from the watershed. Several resistance formulas, such as Manning's and Chezy's, use area or the square root of the slope gradient as independent prediction variables. Consequently, the peak flow rate weighting factor for each segment was $a_s s^{1/2}$, where a_s is the segment area and s, the slope gradient. If the segment bordered the divide, its weight was that calculated. Proceeding downslope, the weighting factor was accumulated for each segment encountered. The peak flow rate for each segment was then calculated to be the product of the measured watershed peak flow rate and the accumulated weighting factor.

The parameter, a, of equation [2] was determined for each watershed by minimizing the variance between measured and predicted sediment yield for half of the selected events. The selected events were those considered to be well sampled in terms of sediment concentration for 1965 through 1972 -- 62 storms on W-1 and 48 storms on W-2. The parameter, a, was determined for W-1 and W-2 separately and then combined because the watersheds are similar in location, soils, topography, and crop. The optimization was done to minimize the sum of the squared deviations expressed as

$$SD = \sum_{i=1}^{n} (\hat{Y}_i - Y_i)^2 \qquad [5]$$

where $\hat{Y}_i$ is the estimated sediment yield and Y_i, the measured yield. The results of these optimizations for the a value are shown in Table 1. The values of a determined by optimizing yields were 0.14 for W-1 and 0.08 for W-2, and their combined value was 0.10.

Table 1. Results of optimization runs for the determinations of a

		Sum of squared deviations		
	a	First half events	All events	r^2 (all events)
W-1	0.14	36.68	82.86	0.97
W-2	0.08	15.86	98.18	0.96
W-1 and W-2	0.10	54.50	252.60	0.94

Figure 3 shows the sensitivity of the fitted parameter, a. The curve indicates the amount of error to be expected when the value of a is varied. For example, for a range in a from 0.05 to 0.15, the change in squared deviations is 10 percent or less.

Tables 2 and 3 list each event and its measured sediment yield for Watersheds 1 and 2, respectively. The measured sediment yields range from 0.01 to 49.72 tons/acre. Also listed are individual predicted sediment yields and associated SD using the Onstad and Foster model described previously. The storms used in obtaining the value of a were events

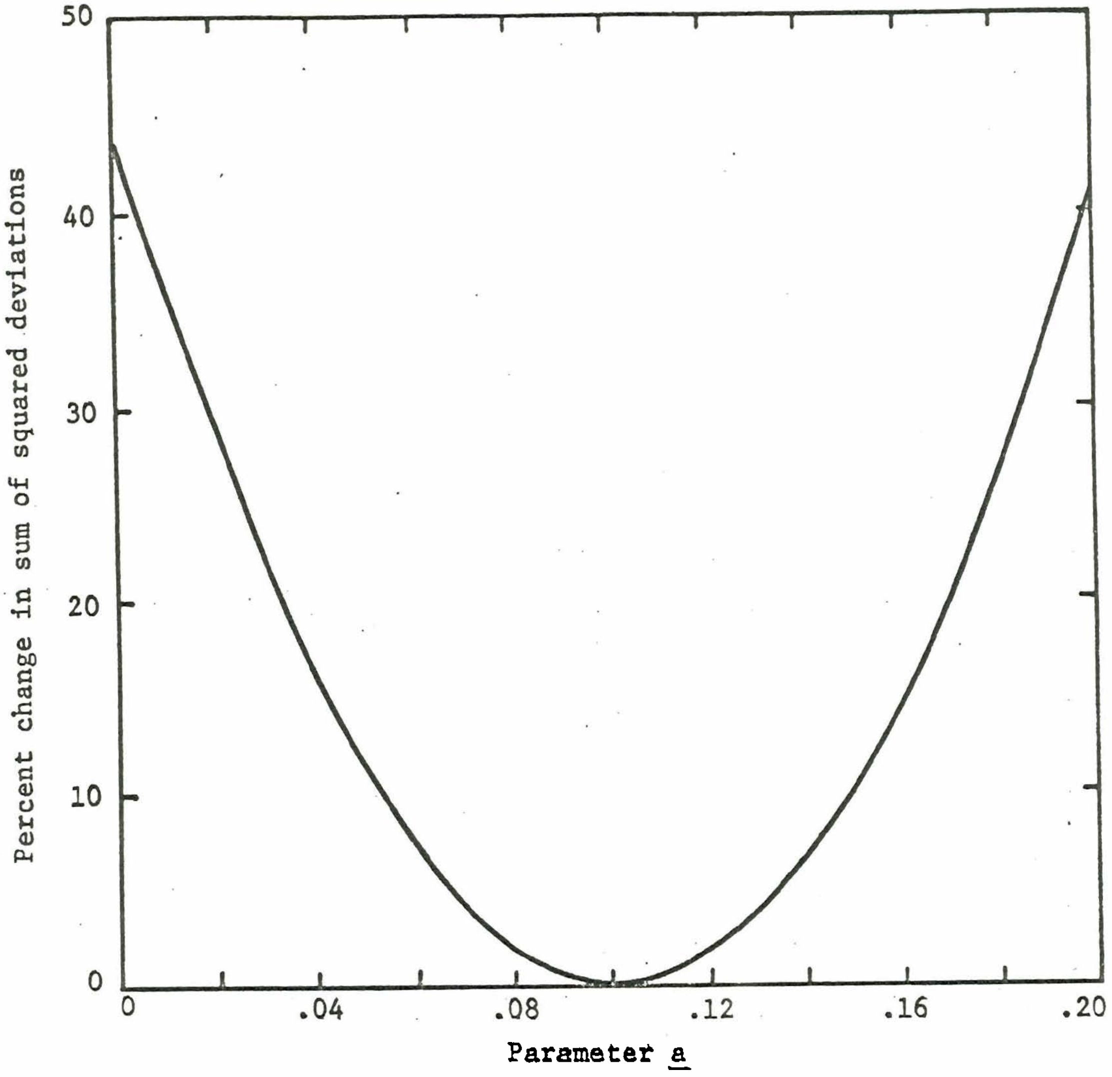

Figure 3. Sensitivity of parameter a

1 through 31 on Watershed 1 and 1 through 24 on Watershed 2. Neither of these intervals included the large storm of June 20, 1967. Deposition was calculated on six of the segments in each watershed. These values, as pointed out earlier, are those obtained using the combined watershed optimized value of a equals 0.10. All other storms on these two watersheds can be considered to be predicted because they did not enter into any parameter determinations.

The Williams model for sediment yield (1972) is expressed as

$$G = \alpha(Qq_p)^{\beta} \text{ KLSCP} \qquad [6]$$

where G = sediment yield for an individual storm (tons)
Q = runoff volume (acre-ft.)
q_p = peak flow rate (cfs)
α, β = model parameters

and K, L, S, C, and P are as defined previously.

This is a lumped model, because constant average values of K, L, S, C, and P

Table 2. Comparison of measured sediment yields with those predicted by three models, Watershed 1, Treynor, Iowa.

Event No.	Measured sediment yield	Onstad and Foster model		Williams model		USLE	
		Yield	Deviation squared	Yield	Deviation squared	Yield	Deviation squared
	(T/a)	(T/a)		(T/a)		(T/a)	
1	3.81	1.77	4.16	0.88	8.58	4.55	0.54
2	6.76	2.87	15.14	3.30	11.97	1.22	30.70
3	0.92	0.69	0.06	0.36	0.31	0.42	0.26
4	1.26	0.67	0.36	0.48	0.61	0.22	1.08
5	3.01	1.95	1.14	1.53	2.19	2.26	0.56
6	1.19	0.54	0.42	0.33	0.74	0.46	0.54
7	0.02	0.03	0.00	0.01	0.00	0.02	0.00
8	0.12	0.18	0.00	0.03	0.01	0.60	0.24
9	2.39	2.35	0.00	1.89	0.25	1.83	0.32
10	1.11	0.64	0.22	0.28	0.69	1.79	0.46
11	4.58	3.39	1.42	2.16	5.86	6.76	4.76
12	0.69	0.53	0.02	0.33	0.13	0.53	0.02
13	0.24	0.17	0.00	0.10	0.02	0.10	0.02
14	0.24	0.73	0.24	0.13	0.01	3.25	9.06
15	0.07	0.17	0.02	0.05	0.00	0.46	0.16
16	0.32	1.04	0.52	0.48	0.03	3.08	7.62
17	0.10	0.26	0.02	0.11	0.00	0.48	0.14
18	0.26	0.73	0.22	0.36	0.01	1.25	0.98
19	0.16	0.20	0.00	0.11	0.00	0.18	0.00
20	1.01	0.87	0.02	0.16	0.72	3.61	6.76
21	0.50	0.37	0.02	0.08	0.18	1.42	0.84
22	4.69	2.43	5.10	2.18	6.30	3.64	1.10
23	15.40	14.80	0.36	10.43	24.70	19.84	19.72
24	13.70	13.64	0.00	18.26	20.79	14.63	0.86
25	1.92	2.64	0.52	2.04	0.01	1.42	0.26
26	2.08	2.33	0.06	2.23	0.02	1.23	0.72
27	1.60	1.80	0.04	1.65	0.00	0.58	1.04
28	7.38	9.74	5.58	9.94	6.55	7.69	0.10
29	1.73	3.26	2.32	2.91	1.39	1.58	0.02
30	3.06	3.39	0.10	4.26	1.44	2.86	0.04
31	0.81	0.81	0.00	0.59	0.05	0.60	0.04
32	49.72	42.29	54.98	42.91	46.38	70.38	417.66
33	0.38	0.46	0.00	0.06	0.10	2.06	2.82
34	2.56	1.45	1.24	0.70	3.46	4.85	5.24
35	0.08	0.81	0.54	0.02	0.00	9.38	86.50
36	0.12	1.48	1.84	0.30	0.03	5.62	30.26
37	0.05	0.15	0.02	0.00	0.00	1.04	0.98
38	0.08	0.26	0.04	0.01	0.00	1.40	1.74
39	0.48	0.70	0.04	0.15	0.11	5.29	23.14
40	6.27	4.50	3.12	1.99	18.32	9.19	8.52
41	0.63	0.30	0.10	0.18	0.20	0.17	0.11

Table 2. Continued.

Event No.	Measured sediment yield	Onstad and Foster model		Williams model		USLE	
		Yield	Deviation squared	Yield	Deviation squared	Yield	Deviation squared
	(T/a)	(T/a)		(T/a)		(T/a)	
42	0.01	0.12	0.02	0.00	0.00	1.29	1.64
43	4.28	5.74	1.14	5.54	1.59	15.78	132.26
44	0.56	0.41	0.02	0.08	0.23	1.60	1.08
45	0.27	0.12	0.02	0.05	0.05	0.13	0.02
46	0.64	0.30	0.12	0.17	0.22	0.17	0.22
47	0.98	0.52	0.20	0.34	0.41	0.36	0.38
48	0.36	0.37	0.00	0.28	0.01	0.13	0.06
49	2.93	1.79	1.30	1.76	1.37	1.29	2.70
50	2.67	2.55	0.02	2.53	0.02	1.90	0.60
51	0.79	0.93	0.02	0.71	0.01	0.52	0.08
52	7.19	9.08	3.56	9.97	7.73	7.45	0.06
53	0.27	0.62	0.12	0.28	0.00	0.20	0.00
54	0.08	0.08	0.00	0.02	0.00	0.17	0.00
55	0.50	0.83	0.12	0.20	0.09	3.81	10.96
56	0.14	0.30	0.02	0.01	0.02	1.54	1.96
57	5.31	1.64	13.44	1.67	13.25	1.22	16.72
58	0.36	0.24	0.02	0.11	0.06	0.08	0.08
59	0.04	0.06	0.00	0.01	0.00	0.03	0.00
60	0.07	0.25	0.04	0.01	0.00	1.32	1.56
61	0.04	0.08	0.00	0.01	0.00	0.30	0.06
62	0.01	0.16	0.02	0.00	0.00	1.84	3.34

Table 3. Comparison of measured sediment yields with those predicted by three models, Watershed 2, Treynor, Iowa.

Event No.	Measured sediment yield	Onstad and Foster model		Williams model		USLE	
		Yield	Deviation squared	Yield	Deviation squared	Yield	Deviation squared
	(T/a)	(T/a)		(T/a)		(T/a)	
1	5.68	2.87	7.92	2.60	9.49	1.84	14.74
2	0.72	0.66	0.00	0.30	0.18	0.30	0.18
3	2.13	1.51	0.38	0.94	0.32	1.31	0.68
4	1.08	0.51	0.32	0.30	0.09	0.30	0.60
5	0.08	0.12	0.00	0.02	0.00	0.27	0.02
6	0.51	0.44	0.00	0.06	0.20	1.58	1.14
7	1.84	0.97	0.76	0.55	1.66	1.54	0.10
8	5.36	4.76	0.36	3.53	3.35	5.72	0.14
9	3.65	4.20	0.30	3.29	0.13	4.74	19.14
10	0.58	0.54	0.00	0.35	0.05	0.29	0.08
11	0.15	0.15	0.00	0.07	0.01	0.09	0.00

Table 3. Continued.

Event No.	Measured sediment yield	Onstad and Foster model		Williams model		USLE	
		Yield	Deviation squared	Yield	Deviation squared	Yield	Deviation squared
	(T/a)	(T/a)		(T/a)		(T/a)	
12	0.29	1.20	0.82	0.46	0.03	2.93	6.98
13	0.40	1.22	0.66	0.52	0.01	2.03	2.66
14	0.05	0.15	0.02	0.05	0.00	0.22	0.02
15	0.20	0.62	0.18	0.28	0.01	0.85	0.42
16	0.06	0.43	0.14	0.11	0.00	0.73	0.44
17	0.04	0.10	0.00	0.02	0.00	0.19	0.02
18	0.05	0.16	0.02	0.05	0.00	0.25	0.04
19	2.18	1.04	1.30	0.32	3.46	2.53	0.12
20	1.06	0.58	0.24	0.17	0.79	1.53	0.42
21	3.44	2.76	0.46	2.28	1.35	3.11	0.10
22	14.70	15.01	0.10	8.88	33.87	19.91	27.14
23	10.00	11.55	2.40	12.28	5.20	13.21	10.30
24	1.65	1.85	0.04	1.13	0.27	0.97	0.46
25	2.62	1.90	0.52	1.62	1.00	0.78	3.34
26	1.30	1.53	0.06	1.22	0.01	0.47	0.68
27	8.13	11.25	9.74	12.41	18.32	5.66	6.10
28	3.08	3.10	0.00	3.07	0.00	2.42	0.44
29	1.35	1.04	0.10	0.78	0.32	0.70	0.42
30	29.10	38.69	92.02	33.63	20.52	55.08	674.96
31	0.40	0.38	0.00	0.03	0.14	1.68	1.64
32	3.43	1.98	2.10	1.10	5.43	4.41	0.96
33	0.04	0.75	0.52	0.01	0.00	6.64	43.56
34	0.03	0.06	0.00	0.01	0.00	0.18	0.02
35	0.06	1.91	3.42	0.32	0.07	6.13	36.84
36	0.39	0.67	0.08	0.09	0.09	4.25	14.90
37	0.63	0.40	0.06	0.21	0.17	0.22	0.16
38	0.04	0.41	0.14	0.01	0.00	1.90	3.46
39	2.05	4.36	5.34	3.15	1.21	9.95	62.42
40	0.08	0.04	0.00	0.01	0.00	0.10	0.00
41	0.30	0.12	0.04	0.03	0.07	0.18	0.02
42	0.34	0.23	0.02	0.09	0.06	0.28	0.00
43	1.90	1.22	0.46	0.98	0.85	1.15	0.56
44	0.99	0.91	0.00	0.47	0.27	1.26	0.08
45	0.34	0.36	0.00	0.15	0.04	0.43	0.00
46	6.34	6.18	0.02	6.23	0.01	3.85	6.20
47	0.01	0.00	0.00	0.01	0.00	0.03	0.00
48	0.14	0.17	0.34	0.06	0.01	2.70	6.56

are applied to the entire watershed. Only sediment yield predictions at the watershed outlet are calculated. Therefore, once the parameters have been evaluated, equation [6] must be calculated only once for each event.

Williams (Personal Communication, June 23, 1975) has calculated average SL values for Watersheds 1 and 2 to be 1.38 and 1.29, respectively. By using C values that depended on storm dates and assuming P equals one, he obtained the following equation by nonlinear least squares optimization for 213 events on W-1 and W-2.

$$G = 7.24\ (Qq_p)^{0.84}\ KLSCP \qquad [7]$$

The coefficient of determination was 0.93. Tables 2 and 3 include the results using Williams model as evaluated by equation [7].

The last set of data on Tables 2 and 3 depicts the predictions of these same storms using the USLE. The USLE parameters were determined in the same manner as in the Williams model. A sediment delivery ratio was not used because, of the 110 storms shown in Tables 2 and 3, the sediment yield from 45 was already underestimated by the USLE.

COMPARISON OF THREE MODELS

Several comparisons of results obtained with the three models are shown in Table 4. The first column lists the SD for the storms over which the parameter a was calculated in the Onstad-Foster model (OF) for both watersheds taken together. This value is minimum. The corresponding minimum value for the Williams model would probably be those utilizing all the storms, since about this number of storms were used to calculate α and β for each of the watersheds. All fittings for the USLE were previously done in its development using other data from small plots.

Table 4. Comparisons of different models for computing sediment yields at Treynor, Iowa.

Watershed 1

Models	Summation of squared deviations (SD)						
Events:	1-31	32-62	1-62	1-62*	Best 56 events	Events 0.10T/a or less (12 events)	Events* 5.0 T/a or more (7 events)
Onstad and Foster Model	38.08	83.12	121.20	66.22	22.80	0.70	41.20
Williams Model	93.56	93.69	187.25	140.87	51.84	0.00	103.31
USLE	88.96	760.86	849.82	422.16	119.30	96.12	76.68

Watershed 2

Models	Summation of squared deviations (SD)						
Events:	1-24	25-48	1-48	1-48*	Best 43 events	Events 0.10T/a or less (11 events)	Events* 5.0 T/a or more (6 events)
Onstad and Foster Model	16.42	114.98	131.40	39.38	12.96	4.26	20.54
Williams Model	60.48	48.61	109.09	88.57	21.46	0.07	70.24
USLE	85.94	863.32	949.26	274.30	104.34	84.42	64.62

*Omitting storm of June 20, 1967.

The third column of Table 4 shows the results of the three models for all storms. Because a large amount of deviation is associated with the extreme event of June 20, 1967, the data in column four shows the results with this storm omitted. About 50 percent of the total variation in the OF model and USLE was due to this storm and about 25 percent in the Williams model for W-1. The total error variance of the OF model is about one-half of that for the Williams model and about one-sixth of that for the USLE.

Often it is contended that just a few outlying points unduly influence the results of a statistical analysis. To check that effect here, the worst fits, 10 percent of the storms, were excluded. When this was done, the average variance per storm for all the models decreased. The decreases on Watershed 1 were from 1.95 to 0.41 for the OF model, from 3.02 to 0.93 for the Williams models, and from 13.71 to 2.13 for the USLE. Reductions in variance on Watershed 2 were similar. Again, the smallest amount of variance is associated with the OF model.

Because the energy term in the Williams model is associated only with runoff and that for the USLE is associated only with rainfall, difference in degree of fit may be associated with the magnitude of the runoff. Columns six and seven of Table 4 show the summation of variance for the small and large runoff events, respectively. The Williams model predicts the small events on both watersheds very accurately. The USLE predicts these small storms very poorly. For the large storms, the opposite is true. This suggests that runoff characteristics are the major influence on sediment yields for small storms and rainfall characteristics are the major factors for the large storms. In general, Table 4 clearly illustrates that a model containing an energy term that combines rainfall and runoff is superior to one containing only a rainfall or a runoff factor.

A linear regression of measured versus predicted sediment yield by the OF model using the data in Tables 2 and 3 (measured and OF predicted values), had a slope of 0.97 ± 0.05 at the 95 percent confidence level and an intercept of 0.06 ± 0.31 at the 95 percent level. Throughout the range of measured values, the 95 percent confidence belt includes the line of equal values.

Table 5 shows the confidence range and the percent of the estimated value. For predicted values of less than 0.25 tons per acre, the confidence belt is about ± 100 percent or larger. For larger values, the confidence belt narrows so that at a predicted value of 1.0 ton per acre, the range is about ± 30 percent, and further decreases to a constant width of about 10 percent at predicted values of between 5 and 10 tons per acre.

SUMMARY

Validation tests of the Onstad-Foster (OF) sheet-rill watershed erosion model on two watersheds in southwest Iowa showed encouraging results. The model predicts sediment yield from single storms. The storms tested produced sediment yields from 0.01 tons per acre to nearly 50 tons per acre. In general, the OF model predicted storm sediment quite accurately. Also shown were sensitivity relations for single fitted parameter in the OF model and confidence intervals throughout the range of predicted even events. The results from the OF model were compared with the Williams model and the USLE. These results showed that OF model performed better than the other two models for the storms tested.

Table 5. Confidence limits about the line of equal values for the Onstad-Foster Model on Watersheds 1 and 2, Treynor, Iowa.

sediment yield (T/a)	95% confidence limits			
	Lower limit		Upper limit	
	Tons/acre	% of estimate	Tons/acre	% of estimate
0.25	0.00	-100	0.59	136
0.50	0.23	- 54	0.83	66
1.00	0.73	- 27	1.31	31
2.00	1.71	- 14	2.27	14
3.00	2.68	- 11	3.24	8
5.00	4.60	- 8	5.20	4
10.00	9.31	- 7	10.19	2
20.00	18.59	- 7	20.31	2
50.00	46.32	- 7	50.78	2

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