Long-Term Erosion Trends on Cropland in the Pacific Northwest

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INTRODUCTION

The Northwestern Wheat and Range Region (NWRR) comprises much of eastern Washington, north-central Oregon, and northern and southern Idaho and includes approximately 4 million ha of non-irrigated cropland (Figure 1). The region's hydrologic and erosion processes are dominated by winter storms, particularly freeze-thaw events. In the most productive cropped areas, soils are silt loams, have low organic matter content, and traditionally have been intensely managed with multiple tillage operations. As a result, these soils are weakly aggregated and are highly susceptible to erosion during freeze/thaw events. Rills, the predominant erosion process in the region, develop quickly when low-intensity rain or snow-melt occurs as the soil thaws from the surface.

Figure 1. Non-irrigated grain producing areas of the Northwestern Wheat and Range Region.

OBJECTIVES

- Examine the question of whether erosion has decreased in the past 20 years, and if so, is it due to a change in weather pattern, of cyclical or long-term nature, or changes in management practices caused by research and education programs and/or farm program compliance requirements.
- Examine what is unique about the Pacific Northwest non-irrigated cropping area as compared to areas influenced by continental air mass rather than coastal weather patterns.

➢ Long-term Erosion Trends in Whitman County, Washington

During the 43-year period from water year 1940 through 1982, major precipitation or snowmelt events on previously frozen soil were a dominant factor in soil erosion during each of the 11 years in which approximately 42 percent of the total erosion occurred, coinciding with the highest erosion seasons (Figure 2). Also, many high volume runoff events occurred independently of frozen soil conditions. Winters with very long frozen periods actually had less erosion than did those with slightly shorter frozen periods. Analysis of the data indicated that soil loss was not correlated with diurnal freeze-thaw cycles, or with annual snowfall, or with snow at the time of thaw. Winter soil erosion was positively correlated with precipitation during thaw, as well as with annual precipitation.

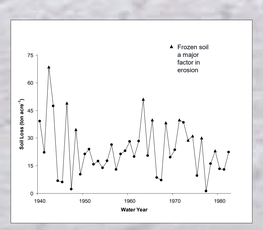

Figure 2. Winter soil loss from Water Years 1940 through 1982 in seeded small grain areas in Whitman County, Washington.

Water Year	Avg Precip (inches)	Avg Snowfall (inches)	Avg Freeze/Thaw Cycles	Avg Total Freezing Index (°F)	Avg Total Days with Mean Temp < 32°F	Avg Number of Extended Frozen Periods (>45dd °F)	Total Major Freezing Events Followed by Rains of 1 Inch or More
1940-1982	22	39	103	410	50	2.4	17
1983-2004	20	31	100	362	46	2.0	7

Table 1. Pullman, Washington weather comparisons, WY1940-1982 vs. WY1983-2004.

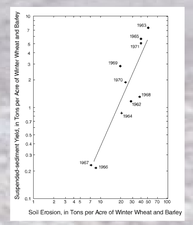

Figure 3. Soil erosion estimates correlate with suspended sediment yields from the Palouse River, 1962-71 (Ebbert and Roe, 1998).

Erosion control practice	Acres under erosion control[1]		Predicted average annual reduction in erosion[2]	
	1979	1994	Tons per acre	Total tons [3]
No-till seeding	600	56,000	9	500,000
Crop Reserve Program	6,400	60,600	5	270,000
Stripcropping divided slopes	0	239,000	1	240,000
Terraces	680	4,500	2	7,600
Grass waterways	*82	*1,550	*1	1,500
Planting trees and shrubs	0	3,670	10	37,000
Conservation tillage	0	81,000	8	650,000
Totals[3]	7,680	445,000		1,700,000

1 U.S. Department of Agriculture progress records for 1979 and 1994.
2 Prediction based on Universal Soil Loss Equation (Wischmeier and Smith, 1978). For grass waterways, based on gross erosion prediction method (Renard and others, 1997).
3 Numbers have been rounded.
4 Linear feet.
5 Tons per linear foot.

Table 2. Erosion control practices in the Palouse River Basin (Ebbert and Roe, 1998).

➢ HAS EROSION DECREASED?

Soil erosion estimates correlate well with suspended-sediment yield from the Palouse River (Ebbert and Roe, 1998) as shown in Figure 3. Suspended-sediment yield in the Palouse River at Hooper decreased from the value for the 1962 through 1971 period to a value of one-half that for the 1993 through 1996 period (Figure 4). Assuming the relationship in Figure 3 is also applicable to the more recent Palouse River data indicates a major reduction in soil erosion in the Basin. Data on erosion control practices applied in the Palouse River Basin are presented in Table 3 (Ebbert and Roe, 1998). Based on estimates using the Universal Soil Loss Equation (Wischmeier and Smith, 1978), erosion control practices in the Basin in 1994 might reduce total erosion by 1,700,000 U S tons annually as compared to 1979. Data in Table 1 indicates there are minor differences in the mean winter weather of water years 1940 through 1982 and 1983 through 2004. Precipitation is less, average snowfall is less, freeze/thaw cycles are slightly less, total freezing index is less, total days with mean temperature < 0 degree C are less, and the number of extended frozen periods is less during the latter period. The major freezing events followed by rains of 25 mm or more were about 20% less in 1983 through 2004. The cause of this erosion reduction appears to be a combination of a more benign weather pattern and increased application of conservation practices, with conservation practices showing more impact.

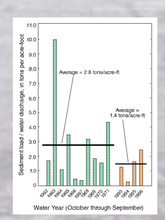

Figure 4. Comparing the historical record (1962-71) to recent years (1993-96) from the Palouse River at Hooper shows a decrease in the average annual concentration of suspended sediment (Ebbert and Roe, 1998).

➢ COMPARISON OF PACIFIC NORTHWEST AND EASTERN U. S. WEATHER PATTERNS

For WY 1971 through 2004, Pullman, WA mean monthly winter temperatures were lower in November and March, but higher in January than in Columbia, MO (Table 3). Precipitation data show the same pattern, with Pullman showing lower values in November and March but higher in January than Columbia (Table 4). On the average, one would consider these differences of minor importance. But, during the 34-year WY 1971 through 2004 period, Pullman had 14 occurrences of more than 25 mm of precipitation during the early stages of soil thaw, whereas Columbia had only 2 such occurrences (Table 5). The Whitman County erosion data showed a strong correlation between winter erosion and precipitation during thaw. This would suggest that opportunities for winter erosion at Columbia are much less than at Pullman, and by inference, this difference would hold true for the Pacific Northwest region and the Eastern U.S. in general.

Weather Station	Mean Monthly Temp (°F) November	Mean Monthly Temp (°F) December	Mean Monthly Temp (°F) January	Mean Monthly Temp (°F) February	Mean Monthly Temp (°F) March
Pullman	36.9	30.0	29.7	33.8	40.1
Columbia	43.7	32.7	28.0	33.6	43.9

Table 3. Mean monthly temperature (°F) comparisons between weather stations in Pullman, Washington and Columbia, Missouri in WY1971-2004.

Weather Station	Mean Monthly Precip (in) November	Mean Monthly Precip (in) December	Mean Monthly Precip (in) January	Mean Monthly Precip (in) February	Mean Monthly Precip (in) March
Pullman	2.8	2.7	2.5	2.0	2.1
Columbia	3.3	2.5	1.7	2.2	3.2

Table 4. Mean monthly precipitation comparisons between weather stations in Pullman, Washington and Columbia, Missouri in WY1971-2004.

Weather Station	WY1940-1982 (43 years)	WY1983-2004 (22 years)	WY1941-2004 (64 years)	WY1971-2004 (34 years)
Pullman	17	7	24	14
Columbia	--	--	--	2

Table 5. Major freezing events followed by rains of 1 inch or more at weather stations in Pullman, Washington and Columbia, Missouri.

CONCLUSIONS

- Available data presented in this research indicates that erosion has indeed decreased in the past 20 years, and that it is a result of a combination of a slightly more benign weather pattern and increased application of conservation practices. Our analysis indicates improved conservation practices have had more impact than cycles or changes in the weather pattern.
- Data from a 43-year erosion survey in southeastern Washington and analysis of climate records indicates that major precipitation or snowmelt events on previously frozen soil were a factor in erosion during each of the 11 years in which approximately 42 percent of the total erosion occurred during the 43-year period. Precipitation during thaw was positively correlated with soil erosion. During the 34-year WY 1971 through 2004 period, Pullman, WA had 14 occurrences of more than 1 inch of precipitation during the early stages of soil thaw, whereas Columbia, MO had only 2 such occurrences. Assuming that each location is representative of its region, there is much less opportunity for winter runoff and erosion in the Midwestern U.S. than in the Pacific Northwest. Rain or snowmelt on thawing soil is one of the unique characteristics of winter hydrology of the Pacific Northwest.