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Comparative Erosion Rates of Loess Soils in Poland and Iowa

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ABSTRACT

THE erosion consequences of historic land management in the loess hills region of western Iowa were evaluated by comparison with similar loess terrain in Poland. Application of the Universal Soil Loss Equation, using inputs based on available cropping, management, topographic, soils and climatic data, indicate that the Iowa sheet-rill erosion rates are more than double those in Poland, primarily due to the greater rainfall erosivity (R) and field slope length (L). Gullying is serious at both locations, although present Polish gullying rates are probably less than historic rates and present Iowa rates.

INTRODUCTION

Any inquiry into erosion problems in the United States must ultimately focus on the intensively cropped agricultural heartland. Here sheet-rill erosion rates on row-cropped fields are most often excessive, and drainageways are incised and enlarged. This is especially true of the highly erodible loess-mantled regions bordering the major river valleys, although these regions have been subjected to agricultural operations for less than 150 yr.

Some erosion damages are the result of natural geologic processes. But man's cultural activities have accelerated sheet-rill and gully erosion. Downhill displacement of the arable layer of steep, cultivated fields in Poland, by tillage alone, has been estimated at 20 cm (7.9 in.) per year on soils that have been farmed for centuries (Bac, 1928). Hilgard (1860) cited the massive erosion in the loess-mantled cotton-producing areas of the midSouth before the Civil War.

By the turn of the century, erosion in the western Corn Belt was a serious problem—probably due to the increased runoff from cropland (Piest et al., 1977). By 1890, the farm acreage had "topped out"; i.e., nearly all the land now in production was then under cultivation, and erosion problems were already evident. Initial efforts to improve drainage of bottomland in western Iowa were limited to individual farmers, but by 1890, formal drainage districts began organizing to dredge and straighten entire channel systems—sometimes with disastrous results. For example, the pattern of channel deterioration (enlargement) in southwestern Iowa and northwestern Missouri was reconstructed from old land surveys, hydrographic and highway bridge records, and other sources. Some channel reaches have degraded more than 6 m (20 ft) since they were altered, with commensurate widening (Piest et al., 1977). Tributaries to these deepening channels also have entrenched so that upland dissection by gullying has increased.

Unlkie the United States, Polish soils have been farmed for centuries. By the 15th Century Poland's population density was already 30 persons/km^2 (78 persons/mi^2), which is greater than the present population density of Iowa. Since then, Poland's population has more than tripled.

To intelligently postulate future soil-conservation systems, we must consider the historic circumstances that have accelerated erosion of fields and drainageways. Another phase of this research should include inquiry into "Old World" erosion experiences where the same fields have been farmed for centuries. What changes have occurred on these lands that were susceptible to erosion? Were satisfactory solutions developed for land stewardship? If not, what has been the consequence of this adverse treatment, and what are the implications for American agriculture?

LOESS

Loess deposits cover large areas of several continents and include about 518,000 km^2 (200,000 mi^2) in the United States and 14,000 km^2 (5,400 mi^2) in Poland. Figs. 1 and 2, respectively, show the distribution of loess in the United States (Gibbs and Holland, 1960) and Poland.

The origin of much of the midcontinental loess in the Missouri River basin and adjacent to the upper Mississippi Valley is usually considered to be glaciofluvial. Receding glaciers left large areas along floodplains devoid

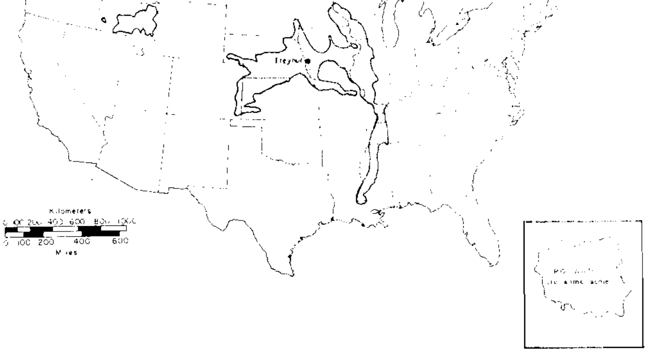

FIG. 1 Major loess deposits in the United States.

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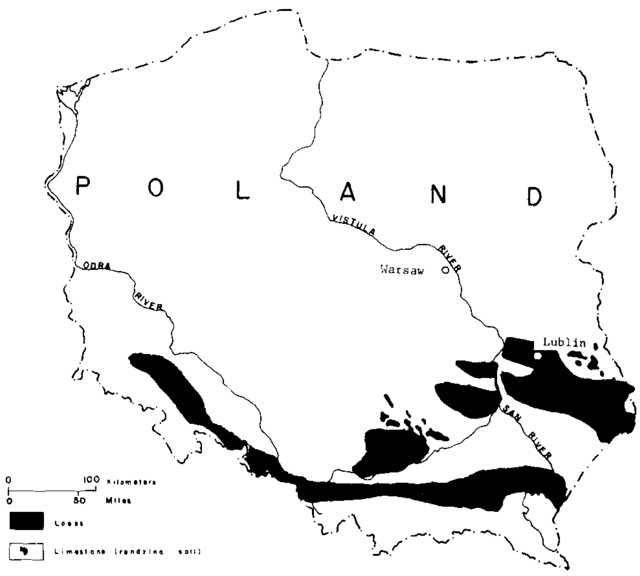

FIG. 2 Distribution of loess in Poland.

of vegetation and exposed to strong winds that moved glacial debris leeward. The most recent deposits occurred about 14,000 yr ago (Ruhe et al., 1967).

Loess deposits in central Europe occurred at the same time and extend from the Ukraine into southeastern Poland to the corner of Austria. The Vistula, Dnieper, and other river valleys were major source areas for these windblown deposits.

Factors contributing to the high erodibility of loessial regions include composition, depth, and location of the loess deposits. Loess mantles are often many meters (tens of feet) deep, and such depths of any low-density, unconsolidated material are highly susceptible to erosion. Because the loess is thickest near the river source, steep surface gradients exist that contribute to high runoff energies. Although loess has some cohesive strength, principally from clay coatings (Gibbs and Holland, 1960) and some carbonate bonding on predominantly silt-size particles, it is not water stable. Sidewalls and headscarps of rills and gullies readily collapse and are entrained at runoff velocities and tractive forces that would be insufficient to scour most cohesive soils (Piest et al., 1977).

Heavy erosion damages have been measured in loessial regions. Average annual soil losses from a 70.1-km^2 (17,300-a) watershed in the central Yellow River Basin, China, were 181 metric tons per hectare (t/ha) or 80.6 English tons per acre (t/a) (Kung and Chiang, 1977). Soil losses by source area within the basin were: farmland, 161 t/ha (72 t/a); steep grazing land, 195 t/ha) (87 t/a); other, including rough land, gullies, roads, and urban areas, 284 t/ha (126 t/a). In the United States, Hilgard (1860) reported accelerated erosion of the loess uplands of Mississippi as early as 1860, only about 20 yr after the area was settled. More recently, experiment station research at the same general location showed average annual soil losses of 211 t/ha (94 t/ha) from fallow plots (Carter et al., 1968). In Poland, Bac (1928) measured surface soil change from 1882 to 1925 on several cultivated sideslopes. He found an average degradation of more than 210 mm (8.5 in., or 28 t/a/yr) for this period; grassed valleys downslope aggraded at about double this rate. This soil-loss rate roughly compares with measured sediment yields from unterraced 32-ha (80-a) corn-cropped watersheds in the loess hills region of western Iowa (Piest and Spomer, 1968), which erode at about 45 t/ha/yr (20 t/a/yr), or slightly more than 0.3 m (1 ft) per century.

SHEET-RILL EROSION COMPARISON

Agricultural usage and erosion regimes of loessial soils in Poland and the United States are not easily compared. The loess of the Lublin Upland of Southeastern Poland was forested for more than a millennium before agricultural development. By 1830, only the steepest 30 percent remained in woodland; now, about 10 percent is wooded. Farmland has alternately been in feudal estates and small peasant holdings. Except for the state farms, which presently comprise only 17 percent of total farmland, the average holding is 5 ha (12.4 a) and consists of 5 to 10 separate fields. These fields are usually narrow and often run up and down hill, with little conservation treatment. The climate of the Polish loessial region is colder and drier than that of the American loessial zones east of the 95th meridian that were similarly forested, but is roughly equivalent to that of the loess prairie of south-central Nebraska.

Despite the differing cropping and management patterns which emerge between Polish and American agriculture—we have larger fields and heavy equipment to stir the soil deeply—the authors are confident that the simple act of plowing and rowcropping entire regions—whether shallow tillage by mule or deep tillage by 200 horsepower tractor—is much more significant to erosion rates (by several orders of magnitude) than the mode of plowing. Also, since we are trying to learn from the Polish experience, we must realize that until recently we were using draft animals in the United States—essentially from settlement about 1850 to 1930.

Besides the sheet-rill erosion rates cited previously, we can compare the basic erodibility of Polish and American loess by applying the Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1965) to both situations. The USLE is based on thousands of plot-years of erosion measurement; it is a widely used tool for soil conservation planning and is very often a basic ingredient of more complex erosion-sediment yield models. The equation is:

$$E = RKLSCP \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [1]$$

where E is the soil loss per unit area, R is a factor expressing the erosion potential of rainfall, K is the soil erodibility factor, L and S are topographic factors of slope length and steepness, C represents the vegetative influence, and P accounts for such conservation practices as strip-cropping and contouring.

Erosivity or Climatic Factor, R

Climatic erosivity is generally correlated with the product of rainfall energy and intensity for much of the Eastern United States. Where rainfall intensities or drop sizes vary from this norm or where snowmelt runoff from unprotected cropland is significant, this erosivity measure is inadequate. However, procedures were recently developed for this situation in the Western United States (Brooks and Turelle, 1975); though tentative, they were used to compute an erosivity factor for the Polish loessial region. The average annual R-factor for the Lublin Plateau, based on the 2-yr, 6-hr rainfall and precipita-

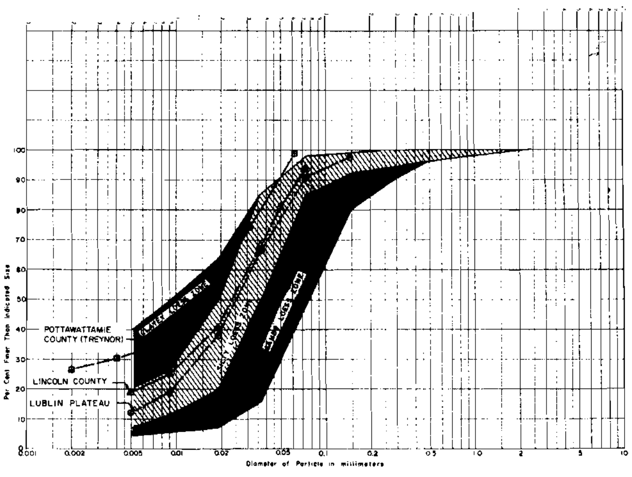

FIG. 3 Particle-size distributions of loess.

tion during the winter snowfall period, was 60 erosivity units. The R-factor was also estimated by using the modified Fournier index (Arnoldus, 1978)

$$\sum_{1}^{12} \frac{p^2}{P} \quad \text{.......................................} \quad [2]$$

where p is mean monthly precipitation and P is annual precipitation (mm), and conversion to Wischmeier's erosivity (R) unit is accomplished by dividing by 1.74. From 12 yr of record at Lublin, Poland, and the 10-yr record at nearby Sandomierz, R was computed to be 65. A rounded value, R=60, was used in this analysis.

The R factors for western Iowa and south-central Nebraska are 160 and 110, respectively.

Soil Erodibility Factor, K

Initially, the soil erodibility factor, K, was determined by directly measuring soil loss from standard test plots or smaller rainfall-simulator plots. More recently, K was related to soil physical properties (Wischmeier et al., 1971) because of the urgent need to determine erodibility for untested soils, subsoils, stripmine areas, and construction sites. The shaded area of Fig. 3 defines the range of particle-size gradations for loess in Nebraska and Kansas, based on 148 samples from Bureau of Reclamation projects (Gibbs and Holland, 1960). Superimposed are gradation curves representing loess from Lincoln County, Nebraska; Pottawattamie County near Treynor, Iowa; and the Lublin Plateau.

Loess from the surface 30 cm (1 ft) in Iowa is the finest textured and the Polish loess is the coarsest of those examined. Translated to the soil erodibility nomograph (Wischmeier et al., 1971) of Fig. 4, the K factors for Treynor and Polish loess are 0.32 and 0.44, respectively. Therefore, the inherent erodibility of Polish loess is much greater (about 38 percent) if no other factors are considered.

Topographic Factors, S and L

The erosion rate increases as slope length and steepness increase. The influence of these factors may be estimated (Holeman et al., 1975):

$$\text{LS factor} = \left(\frac{\lambda}{72.6}\right)^m \left(\frac{430s^2 + 30s + 0.43}{6.57}\right) \quad \text{...........} \quad [3]$$

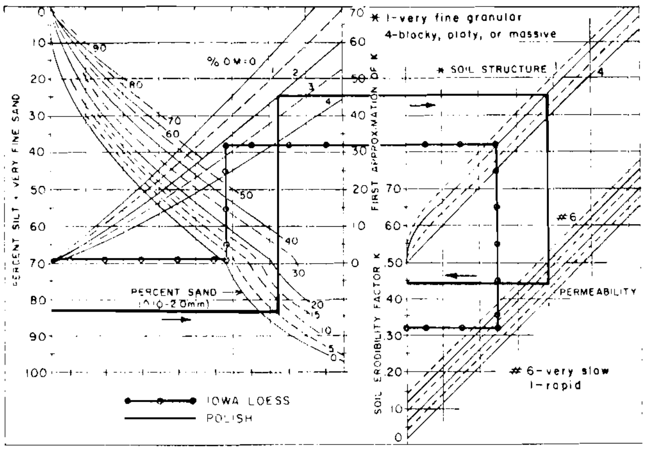

FIG. 4 Erodibilities of Polish versus Iowa loess.

where λ = field slope length in feet; s = sin Θ, Θ is the landslope in degrees. At landslope ⩾5 percent, m = 0.5; at landslope of 4 percent, m = 0.4; at landslope ⩽3 percent, m = 0.3.

The erosion-related factors of topography in Poland and the United States cannot be compared without considering differences in land use and management that especially affect the slope-length factor. Fig. 5 is a topographic map of a 14.6-ha (36.1-a) gullied watershed southwest of Lublin, Poland, that topographically resembles many watersheds in the United States. In the United States, this watershed would probably be farmed as a single unit or, at most, two units, but in Poland it is subdivided into more than a dozen ownership units. This is not unusual because the median-size Polish farm is between 2 and 5 ha (5 to 12 a) (Kostrowicki, 1972), and each farm would be subdivided into several fields. Crops on this land included potatoes, sugarbeets, and small grains; the region is generally planted to cereal crops, 60 percent; root crops, 18 percent; hay crops, 12 percent; with the balance in crops like tobacco, orchards, and woodland (Polish Ministry of Agriculture, 1974).

The result of such land management is to shorten the average length of overland flow, which decreases the slope length (λ) factor of the Universal Soil Loss Equation. Considering typical Polish field patterns on an 8- to 10-percent landslope, the slope lengths (distances of overland flow) are perhaps 15 m (49 ft) as compared with 45 m (147 ft) for similar terrain in Iowa. Referring

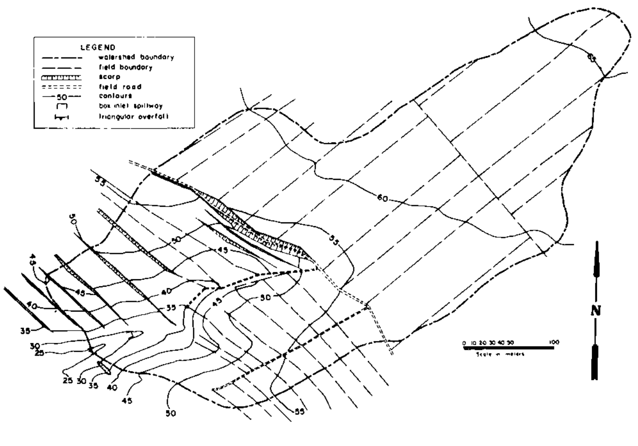

FIG. 5 Topography and field layout of a small watershed near Annapol, Poland.

TABLE 1. DIMENSIONLESS PORTRAYAL OF EROSION ON TYPICAL ROW-CROPPED FIELD BY CROP STAGE, AT LUBLIN, POLAND AND TREYNOR, IOWA*

	Lublin, Poland					Treynor, Iowa				
	Dates	R	C†	RC	RC percent of total	Dates	R	C†	RC	RC percent of total
Fallow period	May 1-May 15	0.05	0.70	0.035	7	Apr. 26-May 11	0.04	0.36	0.014	4
Crop stage 1	May 16-June 15	0.20	0.78	0.156	29	May 12-June 11	0.18	0.63	0.113	28
Crop stage 2	June 16-July 15	0.25	0.54	0.135	26	June 12-July 11	0.27	0.50	0.109	34
Crop stage 3	July 16-Nov. 1	0.30	0.27	0.081	15	July 12-Nov. 4	0.42	0.26	0.109	27
Crop stage 4	Nov. 2-Apr. 30	0.20	0.62	0.124	23	Nov. 4-Apr. 25	0.09	0.30	0.027	7
		1.00		0.531‡	100		1.00		0.398‡	100

*Best estimates based on Kostroski (1972) and Polish weather records.
†Ratio of soil loss, by crop stage, compared to tilled, continuous fallow.
‡Average annual value of cover influence on erosion.

to equation [3], we calculated an LS factor for Iowa that is two-thirds greater than that for Poland.

Cropping and Practice Factors, C and P

Cropping and supporting practice factors are evaluated on the basis of type and condition of vegetal cover and the cropping-management systems (C), plus all other supporting practices, including contour tillage, contour strip-cropping, and terracing (P). To compare the effect of these practices on erosion, we assumed that vegetal cover and land treatment practices in Poland and the United States could be roughly equated. This assumption was not entirely valid. Mechanical disturbance of the soil profile is greater in the United States than in Poland, where draft animals are used extensively for tillage operations.

The most important differences probably are due to the seasonal interaction of cover condition with rainfall occurrence. This is best shown in Table 1, where dimensionless values of the RC product are given. We can sum the RC products for each location to compare the seasonal effect of rainfall and cover on erosion rate. If we consider only the seasonal distribution (not the magnitude) of erosion-causing rainfall, the rainfall-cover interaction on typical row crops planted in the Lublin region creates an erosion hazard one-third greater (0.531/0.398 = 1.33) than the rainfall-crop interaction in the Treynor region.

Finally, when the greater erosivity of annual rainfall at Council Bluffs (Treynor) is considered (160 vs. 60 units), the protective effect of vegetal cover in Poland is reduced to 50 percent of that in Iowa.

Overall Sheet-rill Erosion Differences

We found major differences in four of six USLE parameters, at the two locations, when we compared unterraced rowcrop fields with an 8-percent average landslope (Table 2). Rainfall erosivity and the length of overland runoff were less at Lublin, and together were one-fifth of the RL product at Council Bluffs (Treynor). But crop cover and soil characteristics caused an erodibility that was double the Council Bluffs' CK product. The net result is that soil loss in the Lublin area can be considered to be about two-fifths of that from similar topography near Council Bluffs, or 22.6 t/ha/yr (10.1 t/a/yr), as computed by USLE.

These figures cannot be substantiated, except in general terms. The 12-yr (1964-1975) measured sediment yield from sheet-rill erosion for two corn-cropped watersheds near Treynor, Iowa, averaged 38 t/ha/yr (17 t/a/yr). The USLE-computed soil loss is 63 t/ha/yr (28 t/a/yr), which is slightly greater than the long-term value of 55.6 t/ha/yr (24.8 t/a/yr) given in Table 2. This sediment yield-erosion rate ratio (sediment delivery ratio) of 0.6 is considered reasonable for 32-ha (80-a) cornfields. The 44-yr (1882-1925) erosion rate, previously cited by Bac (1928) for cultivated Polish hillslopes, was about 63 t/ha/yr (28 t/a/yr) and seems somewhat high compared with the present estimate of 22.6 t/ha/yr (10.1 t/a/yr). If assumptions of climate, soils and management are valid, Bac's study must have been on slopes greater than the 8 percent landslopes.

GULLY EROSION AND COMPARISON

Extent and Severity

Gully erosion in western Iowa since pioneer settlement about 1850 has been attributed to increased surface runoff from row-cropping and to channel alterations (Piest et al., 1977). Downcutting and enlargement of channels in this loess terrain have been most serious in recent years. For example, West Tarkio Creek near

TABLE 2. COMPARATIVE RATES OF SHEET-RILL EROSION,* LUBLIN POLAND AND COUNCIL BLUFFS, IOWA, USING INPUTS TO UNIVERSAL SOIL LOSS EQUATION

Location	R	C	p*	S†	L	K	Soil Loss E
Ratio: ‡ Lublin/Council Bluffs	0.38	1.33	1	1	0.60	1.38	0.41
Lublin	60	0.53	1	1	0.72	0.44	22.6 t/ha (10.1 t/a)
Council Bluffs (Treynor)	160	0.40	1	1	1.21	0.32	55.6 t/ha (24.8 t/a)

*Assuming comparable practices.
†Assuming 8 percent average land slopes on row-cropped fields.
‡Each value indicates relative effect of USLE parameter on erosion.

TABLE 3. TYPICAL CHARACTERISTICS OF LOESS SOILS THAT AFFECT ERODIBILITY

Locality		Particle size, percent				Plasticity index	Liquid limit, percent	Bulk density	Organic matter, percent	pH (H_2O)	$CaCO_3$ percent	Na ME/100g
		Sand >50μ	Silt 50-2μ	Clay <2μ	Mean size, μ							
Treynor, Iowa	plow depth	2-4	65-75	25-30	15-30	14-20	38-45	1.0-1.4	0-5	6.5	0	0-2
	subsurface	2-4	60-85	10-35	15-30	11-18	32-40	1.2-1.6	0-5	7.0-8.0	4-8	0-2
Lublin, Poland	plow depth	10-30	70-80	15-30	20-40	4	29-30	1.1-1.3	1-2	6.5	0-14	<1
	subsurface	10-30	70-80	15-30	20-40	9-18	24-38	1.4-1.6	0-4	6.5-8.0	0-17	<1

the Iowa-Missouri boundary has scoured as much as 6.7 m (20 ft) since 1920, with commensurate widening. This lowering of channel base level, in turn, has triggered degradation of small tributary drainageways and caused active gully headcutting, with attendant dissection of fields.

During the 12-yr period (1964-1975), gully erosion rates and sediment yields were measured from four watersheds near Treynor, Iowa. Average sediment yields from active gullies draining cornfields with minimal conservation treatment were 9 t/ha/yr (4 t/a/yr); gully erosion rates from conservation watersheds were only 0.2 t/ha/yr (0.1 t/a/yr). Overall, gully erosion amounted to about one-fifth of the 12-yr sediment yield of all watersheds, and this proportion is considered to apply to the region (Piest et al., 1975).

Similar problems have been reported by Ziemnicki (1974) for the loess region of southeastern Poland. Aside from dissection of upland fields and resultant downstream sediment deposition, gullied roadways add to maintenance problems, and incising channels cause a lowering of water tables and moisture depletion in bottomland fields. Therefore a comparison of gully erosion trends, causes, and control between the two regions should be interesting.

Overall, Poland has an estimated 15,000 km (9,300 mi) of gullies, many of which are located on the loess-mantled Lublin Plateau and adjacent areas of southeastern Poland. About 10 active gullies, studied by Ziemnicki (1974), were estimated to have been formed before 1900, some as early as 1800. He also reported that streambed profiles of active gullies have lowered about 1 m (3 ft) per decade. Although it is not possible to quantify gully erosion in the Lublin Plateau, severe gullying seems to be more localized than in the Treynor area.

A Comparison of Gullying Variables, Treynor vs Lublin

Table 3 compares some characteristics of Polish and United States loess soils that may affect gullying. Although the Treynor, Iowa, loess is finer, few other differences emerge.

Overall processes common to both locations include linear extension (headcutting), lateral enlargement, and runoff entrainment of gully debris. This soil debris is produced primarily from the gully perimeter by moisture loadings that simultaneously reduce soil strength and increase soil stresses. Seepage forces and runoff tractive forces are secondary causes.

Only a few natural differences are apparent from Table 3. Quite possibly, any lower gully erosion rates in Poland are a complex function of a lower rainfall-runoff regime and differing land use. Piping, or tunnel rosion, is common on the Lublin Plateau but is a minor use of gully erosion in western Iowa. Piping is often characteristic of dispersive soils that contain high levels of sodium (Heede, 1971), but neither location has excessive concentrations.

Grade-control differences probably are more significant. Ziemnicki (1974) reported that limestone outcrops in the lower reaches of some upland gullies limit gully scour. Soils developed on limestone outcrops in the loess area (labeled rendzina soils in Fig. 2) are not gullied. Bedrock or erosion-resistant strata occur at relatively greater depths near Treynor and do little to deter scour. Dry-weather seepage occurs along the perimeter of nearly all gullies in the Treynor area, but is rare on the Lublin Plateau. By contrast, snowmelt is an important gullying cause in Poland but is inconsequential in southwestern Iowa.

The effects of many other variables are not readily discerned. Soil texture and mineralogy at Lublin and Treynor are somewhat different. Lublin soils are coarser, with illite the predominant clay material. Montmorillonite is the most prevalent clay mineral in the Treynor area (Hanway et al., 1960).

Also, the effect of differing rainfall and runoff regimes on gullying cannot easily be evaluated. Surface runoff rates and intensities in Iowa probably exceed those in Poland but are less uniformly distributed. For example, more than 80 percent of the soil loss from the Treynor gullies during a 13-yr period (1964-1976) of measurement occurred during May and June. The Treynor studies (Piest et al., 1977) have shown that gully debris is cleaned out by relatively minor runoff rates and tractive forces, which then cause renewed bank failures; thus, gullying is a function of clean-out frequency as well as of runoff rate.

Differences in land management, as they affect gullying rates between Iowa and Poland, are the most difficult to assess. Iowa fields are relatively large and generate appreciable runoff, but field sizes are conducive to contour tillage, terraces, contour strip-cropping, and other conservation measures. The 15-ha (36-a) watershed near Annapol, Poland (Fig. 5) is divided into about 30 fields; many of them are shaped so that farming operations are up and down the hill, and scarps have formed along some field boundaries.

An extreme example of field division that has caused lateral enlargement of gullies is shown in Fig. 6. Ten fractional-acre fields exist on the south side of the gully and drain northward to the 10-m (30-ft) deep gully at a moderate slope. Because the strips have been owned and farmed by different individuals for many years, a berm has formed along the west edge of each strip where runoff concentrates and flows into the gully. Some of the resulting nickpoints shown on the map are identified on the photograph (Fig. 6).

Gullying is endemic to secondary roads in loessial regions of both countries and is an important source of

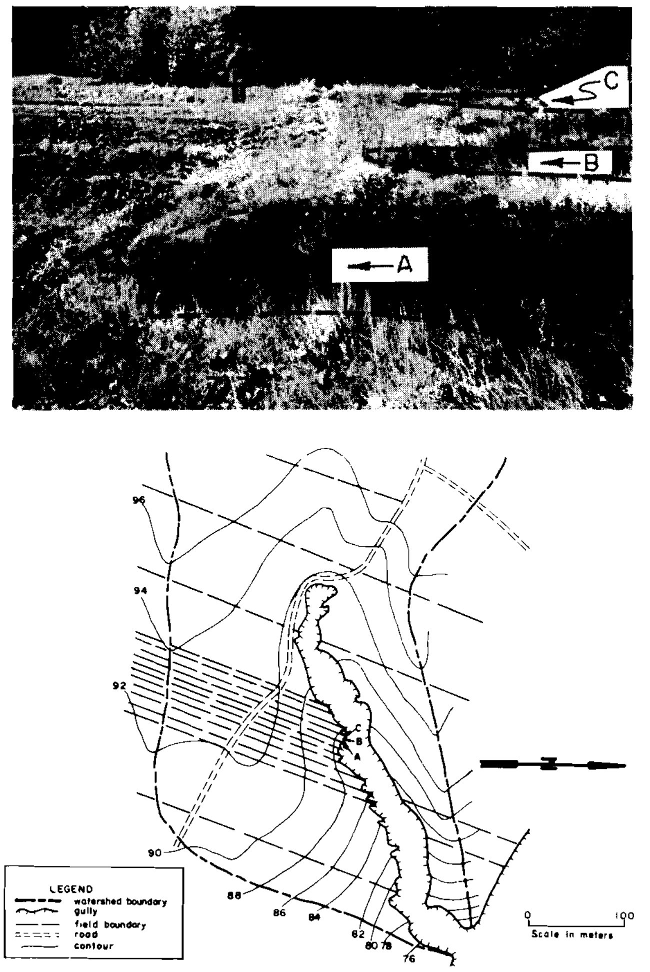

FIG. 6 Gully enlargement resulting from field subdivision near Magierow, Poland.

FIG. 7 Road gully near Kwaskowa Gora, Poland.

downstream sediment. But it is probably most severe on the winding rights-of-way in Poland. Fig. 7 shows a roadway near Kwaskowa Gora, Poland, that began to erode about 1880. It remained open to traffic until 1940, when deterioration from several large storms and heavy Nazi tank traffic caused its abandonment. Although still actively eroding, it is used as a municipal dump.

DISCUSSION

Concern over excessive erosion in the loess hills region of the western Corn Belt during the past century has raised questions about future agricultural productivity there. One research option was to examine historic and present-day erosion in a similar Old World region—the Lublin Plateau in southeastern Poland.

In western Iowa, erosion rates are known within reasonable limits, and they are generally excessive. Although sediment yields measured from watersheds of the region averaged less than 13 t/ha/yr (6 t/a/yr) (Piest and Spomer, 1968), the erosion rate from principal contributory areas, like unprotected row-crop fields, gullies, and channels, was much greater. For example, the measured denudation rate from continuously cropped corn watersheds near Treynor was about 2.5 cm (1 in.) per decade; the measured gully erosion rate, by scarp retreat, from an active gully draining a 30-ha (75-a) watershed averaged 356 metric t/yr (392 t/yr) (1964-1975); the average annual channel erosion rate for a 24-km (15-mi) reach of West Tarkio Creek (1920-1975) was 119,000 metric t (131,000 t) (Piest et al., 1977). It is clear that conservation efforts on loessial soils of western Iowa must be increased to preserve long-term productivity.

Historic erosion patterns in Poland and the United States proved difficult to compare. Erosion rates and resulting changes in soil productivity from centuries of agriculture in the loess soil region of Poland could not be well quantified with information available. Climatic and cultural variations were especially great between the two regions so that crop yield comparisons could rarely be interpreted. For example, overall wheat yields in Poland averaged 18.8 q/ha (28 bu/a) during the 1960's but had increased to 26.5 q/ha (39 bu/a) by 1973. Kostrowicki (1972), however, stated that low yields were related to "inappropriate land utilization (faulty agrotechnics)" and less to "inappropriate farming orientation... than to the conditions of geographical environment such as poor, in general, quality of soils in Poland."

But continued efforts to measure the historic erosion of the Polish landscape would be most rewarding. The Polish coauthor considers land dissection in Poland to be greater than in the United States, but the shallow tillage practiced there is more beneficial for conserving soil than the deep tillage practiced by mechanical agriculture in the United States. These two circumstances, if confirmed by further study, would mean that historic Polish erosion rates have caused deterioration of the landscape (Dissection) and that sheet-rill erosion in Poland has been excessive but at rates lower than now exist in southwestern Iowa.

Without more authoritative measurements, factors of the Universal Soil Loss Equation (USLE) were evaluated to compare present-day sheet-rill erosion rates for Lublin, Poland, and Treynor, IA. Rainfall erosivity and slope length factors were lower for Polish fields, but soil erodibility and the mean annual vegetative cover factors were greater. The integrated effect of all USLE factors was that Polish sheet-rill erosion rates were 41 percent of those in the Treynor area.

Gully erosion problems are serious in both areas, although present Polish gullying rates probably are less than historic Polish rates and present Iowa rates. Valley bottom gullies in Poland have migrated nearer to watershed divides, and rock outcrops in the downstream reaches of some gullies have limited further downcutting.

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Erosion Rates Compared

(Continued from page 827)

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